Developing an RD&E project to address loss of productivity in Queensland pastures invaded by Indian couch (*Bothriochloa pertusa*)

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Summary

Rapid, widespread dominance of exotic, stoloniferous, perennial Indian couch (*Bothriochloa pertusa*) grass is occurring in Queensland pastures, with reports also for the Northern Territory. This transformation is not necessarily due to overgrazing but, nonetheless, may lead to a 50% decline in productivity and resilience in beef grazing systems, and be associated with ecological penalties, such as increased sediment run-off to the Great Barrier Reef lagoon and a decline in biodiversity. Despite several early introductions into Australia in the 1930s, and subsequent rapid spread of a less desirable strain noted in Queensland in the 1960s, there is relatively little information on the ecology, management and economics of *B. pertusa*.

This scoping study has been successful in collecting comprehensive, present-day feedback from beef producers on *B. pertusa* invasion for three catchments: Burdekin, Fitzroy, and the Burnett-Mary. Agency staff research findings relating to *B. pertusa* and key findings from the literature have also been collated. A synthesis of the producer knowledge and research results has identified the research gaps and priorities, and has provided the basis of a project proposal submission made to Meat & Livestock Australia Limited (MLA). The recommended specifications for RD&E include:

- mapping the extent of *B. pertusa* invasion
- understanding the drivers of invasion
- quantifying both landscape function and production impacts
- developing the different guidelines required for managing *B. pertusa* monocultures; reversing *B. pertusa* invasions; and options for targeted elimination of *B. pertusa*.

Major outcomes of this scoping study:

- full proposal submission made to MLA (*currently being considered*)
- abstract submission accepted for the 10th International Rangeland Congress, Saskatoon, Canada (*oral presentation delivered on 19 July 2016*)
- successful AW Howard Memorial Trust recipient (*travel funds to attend IRC, Saskatoon*)
- oral presentation at the Northern Beef Research Update Congress (*paper submitted, titled ‘Managing and reversing the decline in productivity for northern rangelands: what don’t we know?’* – 16 August 2016.

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Background

Indian couch (*Bothriochloa pertusa*), an exotic grass naturalised in many parts of Queensland, is spreading, and potentially threatens the feedbase that underpins many beef grazing businesses. Initial introductions in the 1930s and in 1950 (Bisset, 1980) were typically for amenity purposes but aided by drought and overstocking, the Bowen ecotype spread rapidly into native Black speargrass (*Heteropogon contortus*) pastures in the seasonally-arid regions of north-east Queensland (McKeon *et al*. 2004). Extensive monocultures now exist in this region. These monocultures are grazed by cattle and give good ground cover on otherwise bare soil. More recent invasions into intact native pastures on fertile basaltic soils are, however, being reported (Stacey, 2014) and are a source of concern. The encroachment of *B. pertusa* into sown Buffel grass (*Cenchrus ciliaris*) pastures is also occurring in central Queensland and poses the risk of significant productivity declines (Stuart Buck, *pers. comm*.).

Any significant alteration to the feedbase resources is cause for concern, in both economic and ecological terms. Landscapes dominated by *B. pertusa* are running at well below the productive potential and are far more vulnerable to climate variability than the original systems. Monocultures are moreover inherently unstable and susceptible to collapse through disease or pests, as happened with Townsville stylo (Partridge *et al.* 1996). Adaptation of ecosystems to climate change will also be more difficult with single species or simplified ‘novel’ systems. Furthermore, the increased runoff resulting from reduced landscape function with *B. pertusa* dominated systems (Bartley *et al*. 2014) is adversely effecting reef water quality and eroding the social licence of the extensive grazing industry.

The limited available research (e.g. Howden, 1988; Scanlan *et al*. 1996a; Ash *et al*. 2001) indicates that overgrazing alone does not necessarily drive *B*. *pertusa* invasion. There are also many competitive advantages that *B. pertusa* has, such as it is:

- being stoloniferous
- a very prolific seeder
- a good coloniser of bare soil
- a species tolerant of defoliation.

Nevertheless, there is a lack of understanding of the drivers of invasion, and relatively limited available data on the impacts on landscape function, and the management and economics of *B. pertusa*. The latter aspect was investigated by Jones (1997) who reported that *B. pertusa* did not reduce steer performance when compared to native pasture at moderate and high stocking rates. However, in this study, native pasture was oversown with *B. pertusa* and was thus an ‘intact’ pasture not analogous to a native pasture invaded by *B. pertusa*.

Reduced run-off and soil loss has been reported for *B. pertusa* relative to native tussock grasses (Scanlan *et al*. 1996b), but this is at variance with the results of a recent longer, larger scale study, which emphasised the critical role of deeper rooted, tussock grasses in reducing runoff (Bartley *et al*. 2014). There is, therefore, an opportunity to build on the existing knowledge, to quantify both production and landscape function impacts of *B. pertusa* in pastures, and to also consider animal/grazing factors, such as the extent of soil compaction. Possible allelopathic effects of *B. pertusa* (Hussain *et al*. 2010) that may make it difficult to restore land condition should also be considered.

Similarly, while there is evidence to suggest heavy grazing pressure may exacerbate the rate of *B. pertusa* invasion in pastures, it is not known if management strategies; such as prescribed burning, spelling and the introduction of more productive pasture species or better and non-invasive strains, can be used to combat or reverse *B. pertusa* invasion. For sown pastures, it is also not known if spraying and cultivation are viable options for reducing the soil seedbank to eliminate *B. pertusa*.

The purpose of this scoping study was to consult with beef producers and agency staff to determine the specifications for an RD&E project that will address productivity and ecosystem function losses in native and improved pastures invaded by *B. pertusa*.

Project Objectives

The objective of the study was to determine the specifications for an RD&E project that would address productivity and ecosystem function losses in native and sown pastures invaded by exotic Indian couch (*Bothriochloa pertusa*).

Methodology

A consultation process with beef producers and agency staff (researchers, extension officers and retired government personnel) was used. Consultation occurred in two steps:

- Step 1: An initial workshop was held in Charters Towers, north Queensland with agency staff and a selected group of local beef producers to discuss the various aspects of *B. pertusa* invasion and to consider potential research ideas and questions.
- Step 2: Separate beef producer workshops took place across three different catchments:
    1. 'Kirkton': capturing feedback from producers in north Queensland (Burdekin) with native pastures on Granodiorite (aka Goldfields) landtypes
    2. 'The Brook': north Queensland (Burdekin), native pastures on Basaltic soils
    3. Middlemount: central Queensland (Fitzroy), native and sown pastures
    4. Moura: central Queensland (Fitzroy), native and sown pastures
    5. 'Brian Pastures': north Burnett (Burnett-Mary), native pastures.

The workshops captured different view-points, knowledge and experiences of participants on the subject of *B. pertusa*. First, producers discussed multiple aspects of *B. pertusa*, including extent of invasion, changes over time, the virtues and shortcomings of *B. pertusa*, and possible management options. Agency staff then presented findings from their own research or from the literature. Each workshop utilised small group activities as well as open discussions, and ended with participants identifying and nominating key R&D questions and priorities on *B. pertusa* invasion in pastures.

The information collected from all of the workshops, including producer knowledge and research findings, was synthesised and used to develop an RD&E project proposal.

Results

Background: how did Indian couch get here?

Indian couch (*Bothriochloa pertusa*) grass, also known as Pitted bluestem or Indian bluegrass, was introduced into Australia in the 1930s and in 1950 (Bisset 1980). Most accessions were from India, but some also came from Africa. Earlier plantings were typically for amenity purposes, such as for lawns, golf courses, research facilities and the planting of aerodromes across drier parts of Queensland. An early botanical record (Figure 1) for Queensland in 1962 indicated that *B. pertusa* had already became naturalised in a few places in the Leichhardt and Port Curtis districts, north Queensland.

A less desirable lawn grass strain, the 'Bowen' ecotype, spread like wildfire in north-east Queensland and continues to expand its range. It is early to seed (January) and is less vigorous, but it is also the best naturaliser. Some of the better and later flowering strains have become commercialised, such as Capella (cv. Capella; good lawn grass), Biloela (cv. Dawson; superior lawn grass) and Yeppoon (cv. Keppel; forage variety and good lawn grass).

B. pertusa is a C4 grass naturally occurring in tropical Africa, India and south-east Asia. It has become naturalised in tropical parts of America and Australia. In Australia, the ideal growing conditions for Indian couch include the 500 and 1400 mm isohyets across northern Australia (Figure 2), but herbarium records also show Indian couch grows outside of this range (Figure 3). It also grows on a wide range of soil types, including poorer fertility soils.

The spread of the Bowen strain was aided by overgrazing and drought, but also coincided with the collapse of Townsville stylo to anthracnose (Partridge *et al.* 1996). Figure 4 shows an example of a more recent *B. pertusa* invasion in native pastures in north-east Queensland.

Initial workshop in north Queensland: B. pertusa invasion in native pastures on Granodiorite soils versus basaltic soils

The initial workshop held in Charters Towers on 12 November 2015, revealed distinct differences between *B. pertusa* invasions in native pastures on granodiorite soils (aka Goldfields) versus basaltic soils. Invasions into pastures on the goldfields have had a longer history, occurring over the last 45 years or more. By contrast, observations and reports of *B. pertusa* on the basalt landtypes has been over the last 20 years, with invasion generally localised to areas of seed spread (such as along roads) or areas of greater grazing pressure (e.g. front paddocks or holding yards).

Producers revealed that *B. pertusa* was '*not on their radar'*, either because they did not think it was a problem or because they were simply not aware of it. An older generation beef producer from the goldfields, for instance, explained that '*In those days, Indian couch was good to the last drop – just like Johnny Walker whiskey!*' '*Cattle ate it all! That was seen as a positive.*' But in retrospect '*it's not good!*' '*I think Indian couch is with us and we got to live with it – just like the cane toads!*' Another producer, but from the basalt, mentioned '*Sign of the times – everyone is running more cattle as per economic environment. Indian couch takes advantage of this*.'

Beef producer workshops: feedback relating to the extent of invasion, the value of B. pertusa, possible drivers of invasion, and management options

Extent: The extent of *B. pertusa* invasion in north Queensland varies from anything between zero or very little (e.g. on the basalt) to 100% (e.g. monocultures on goldfields country). In central Queensland, beef producers reported that invasions were more recent, taking place over the last 15 years but more noticeable over the last 5 years, and were occurring in both native and sown pastures and old cultivated lands. The encroachment of *B. pertusa* in pastures in central Queensland was either reported to be isolated on property or scattered through the pasture, but had not reached full extent. Beef producers in the Burnett-Mary were not concerned about *B. pertusa* invasion, either because they did not have *B. pertusa* in the pasture or, if they did, they did not feel it was a concern.

Virtues: There are many virtues of *B. pertusa*. For example, '*It holds the soil together'*; provides good ground cover and may assist with minimising soil surface erosion. It is '*short green feed'* and '*cattle will eat it'* – so it provides some carrying capacity. It also grows on less fertile soils and responds well to very little rain.

Shortcomings: The shortcomings of *B. pertusa* included '*It doesn't last'*; it has reduced drought tolerance; and produces less bulk when compared with the desirable 3P (perennial, productive and palatable) tussock grasses. *B. pertusa* is also invasive and many producers were concerned about the negative impact it might be having on soil health. For instance, reduced cycling of nutrients from less litter, or any possible allelopathic effects of *B. pertusa* that then may make it hard to restore land back to its original condition.

Drivers: Producers generally felt that overgrazing and droughts were the key drivers of *B. pertusa* invasion, but heavy rains (flooding) was also indicated as a potential driver for central Queensland. There was speculation that rains may allow for spread of seed, but speculation was mainly associated with the reduced competitiveness of Buffel grass during heavy rain and, therefore, providing a competitive advantage to *B. pertusa* to invade, as *B. pertusa* is tolerant of inundation.

Management options: Producers identified a number of possible options for management of *B. pertusa*:

- increasing the competitiveness of 3Ps grasses: reduce stocking rates and rest pastures where practical
- renovating land where financially feasible: strip ploughing and sowing other grasses and legumes
- managing for *B. pertusa* monocultures: incorporate legumes to provide some stability to pastures dominated by Indian couch
- the possibility of fire: producers in general were not sure about prescribed burning to control *B. pertusa;* either they weren't using fire as a management tool or they weren't sure if fire could effectively reduce the Indian couch soil seed bank.

Research findings: ancillary research results and findings from the literature

Rapid colonisation: An important finding from the literature and from ancillary research results is the ability of *B. pertusa* to rapidly colonise native pastures. A prediction that *B. pertusa* will continue to spread and increase in frequency in native pastures in Queensland and under different levels of defoliation was made in the late eighties (Howden 1988). Data collected from the Wambiana long-term grazing trial (O'Reagain 2014) has also tracked the rapid colonisation of *B. pertusa* in native *Bothriochloa ewartiana* pastures under different grazing treatments (Figure 5).

Landscape function impacts: CSIRO research results show reduced water infiltration under a *B. pertusa* pasture when compared with a pasture dominated by native grasses (Figure 6). However, the impact of cattle and soil compaction on these results is not known, and the decline in water cycling and ability of the landscape to retain water may have occurred prior to *B. pertusa* invasion. A reduction in run-off and soil loss has been reported for *B. pertusa* relative to native tussock grasses (Scanlan *et al*. 1996b). Thus a decline in landscape condition and health may trigger a marked change in pasture species composition. Accordingly, the dominance of *B. pertusa* may not be the actual problem, but rather a symptom of a range of issues.

Production impacts: An earlier study (Jones 1997) showed *B. pertusa* in native pastures gave good steer gains equal to, or higher than, the gains from native pasture without *B. pertusa*. However, this study used an 'intact' native pasture oversown with *B. pertusa* and thus was not analogous to a degraded native pasture landscape invaded by *B. pertusa.* Nevertheless, this study showed *B. pertusa* pastures can be productive. Observations of *B. pertusa* invasions in sown pastures (Figure 7) and in native pastures (Figure 8) indicate production losses in terms of reduced biomass. These production impacts, including nutritional value, are yet to be quantified.

The role of fire: Some ancillary findings (unpublished data) for the effect of fire on suppressing *B. pertusa* are shown in Figure 9 from work conducted by Wayne Vogler at DAF's Tropical Weeds and Research Centre, Charters Towers. Although this work was focussed on the annual weed Grader grass (*Themeda quadrivalvis*), it shows prescribed fire every four years may be an effective tool for suppressing *B. pertusa* in native *Heteropogon contortus* pastures.

The scope of the issue: The geographical scope of *B. pertusa* spread in pastures is not known. While *B. pertusa* is known to have spread extensively (Figure 3), its current geographical spread, dominance and potential area of spread are unknown. In 1990, the estimated invasion area of *B. pertusa* in Queensland was 800 000 ha (Walker and Weston 1990). However, current estimates (Figure 10) suggest an area in the order of 11 million ha could be affected, with further range expansion very likely (Chris Holloway *pers. comm*.).

Conclusions/Significance/Recommendations

This scoping study has been successful in collecting comprehensive, up to date feedback from beef producers on *B. pertusa* invasion for the Burdekin, Fitzroy, and Burnett-Mary catchments. Various research findings relating to *B. pertusa* and key findings from the literature have also been collated. A number of research questions have been identified relating to *B. pertusa* invasion, including:

- Can we manage for *B. pertusa* where monocultures have formed?
- Are there better strains of *B. pertusa* available?
- How can we reduce the soil seed bank?

Key research ideas identified included:

- quantification of both production and landscape function impacts
- studies to identify potential management/control options.

A synthesis of the producer knowledge and research results has identified the research gaps and priorities, and has provided the basis of a project proposal submission made to MLA. The recommended specifications for RD&E include:

- roadside survey the extent of *B. pertusa* invasion, i.e. follow-up regional land condition assessments of Hassett *et al.* 2000; Karfs *et al.* 2009 and Beutel *et al.* 2014
- understanding the drivers of invasion
- quantifying both production and landscape function impacts
- developing guidelines required for: managing *B. pertusa* monocultures; reversing *B. pertusa* invasions; and options for targeted elimination of *B. pertusa*.

For the latter specification, the specifics include:

- managing *B. pertusa* monocultures: e.g. land reclamation techniques and sowing
- reversing *B. pertusa* invasion: e.g. determining the role and impact of fire, stocking rates and spelling
- eliminating *B. pertusa*: e.g. chemical treatment, cultivation techniques, and methods for reducing the soil seed bank.

A cost-benefit analysis of all options would also be required, to identify effectiveness and feasibility of the different recommended controls methods.

Key Messages

Indian couch (*Bothriochloa pertusa*) is a major issue in north Queensland linked to reduced production in the feedbase. Invasions of *B. pertusa* are also occurring in native and sown pastures in central Queensland. There is risk of widespread alteration to the feedbase and land managers should be proactive in both their awareness of Indian couch. Research, development and extension is needed to deliver practical guidelines for managing for *B. pertusa* monocultures, reversing *B. pertusa* invasion, and in some instances, complete removal of *B. pertusa*.

Where to next

It is anticipated that the outcome of our project submission made to MLA will be known by August 2016. If successful, the research will commence immediately. Irrespective, the next task will be the completion of a scientific review paper on the extent, mechanisms and management of *B. pertusa* invasion.

Budget Summary

The total operating budget was $5000.00. This was used to cover the following expenses:

- Travel
- Accommodation
- Catering at workshops
- Stationary
- Field equipment.

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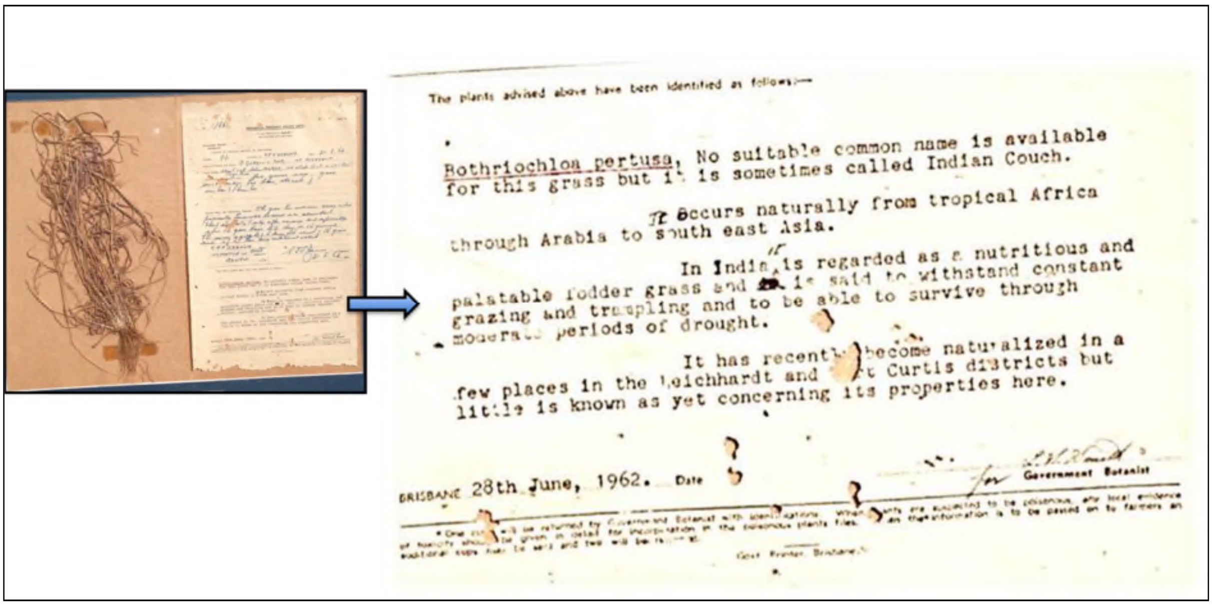
FIGURES



The plants advised above have been identified as follows:—

Bothriochloa pertusa. No suitable common name is available for this grass but it is sometimes called Indian Couch.

It occurs naturally from tropical Africa through Arabia to south east Asia.

In India it is regarded as a nutritious and palatable fodder grass and it is said to withstand constant grazing and trampling and to be able to survive through moderate periods of drought.

It has recentl[illegible] become naturalized in a few places in the Leichhardt and [illegible]t Curtis districts but little is known as yet concerning its properties here.

BRISBANE 28th June, 1962. Date

Government Botanist

Figure 1. An early botanical record for Queensland in 1962 indicating Indian couch (Bothriochloa pertusa) had already became naturalised in a few places in the Leichhardt and Port Curtis districts, north Queensland.

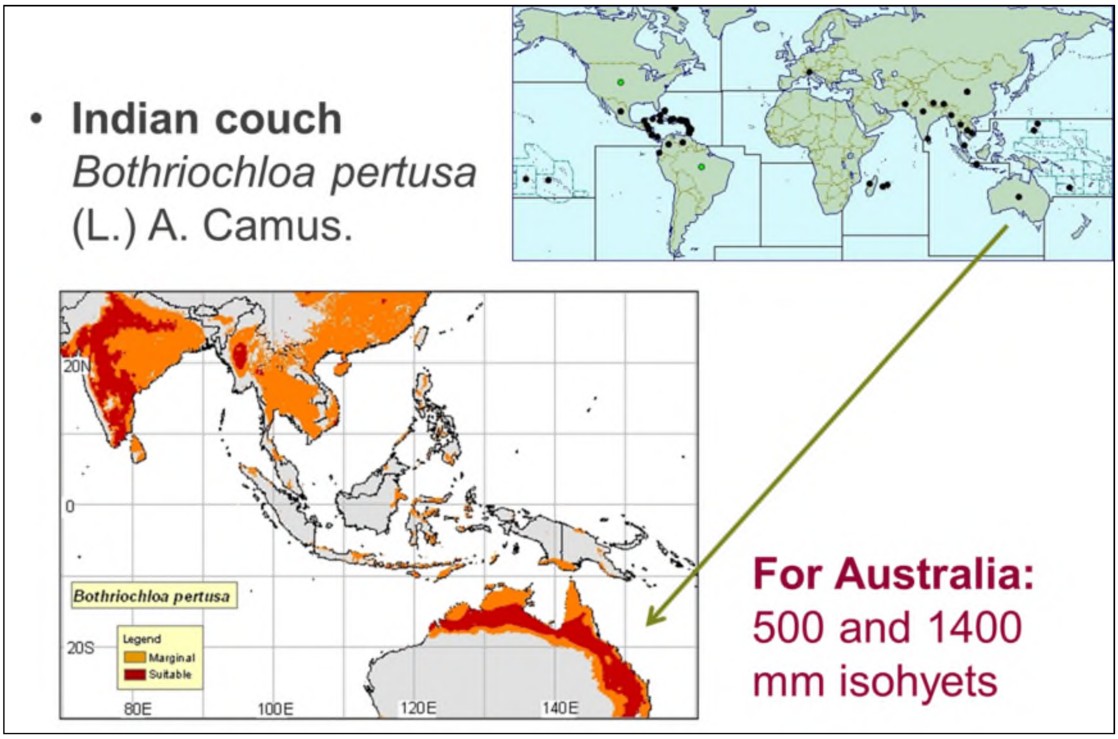


Figure 2. Indian couch is a C4 grass found in tropical locations. In Australia the suitable growing conditions for B. pertusa include the 500 and 1400 mm isohyets.

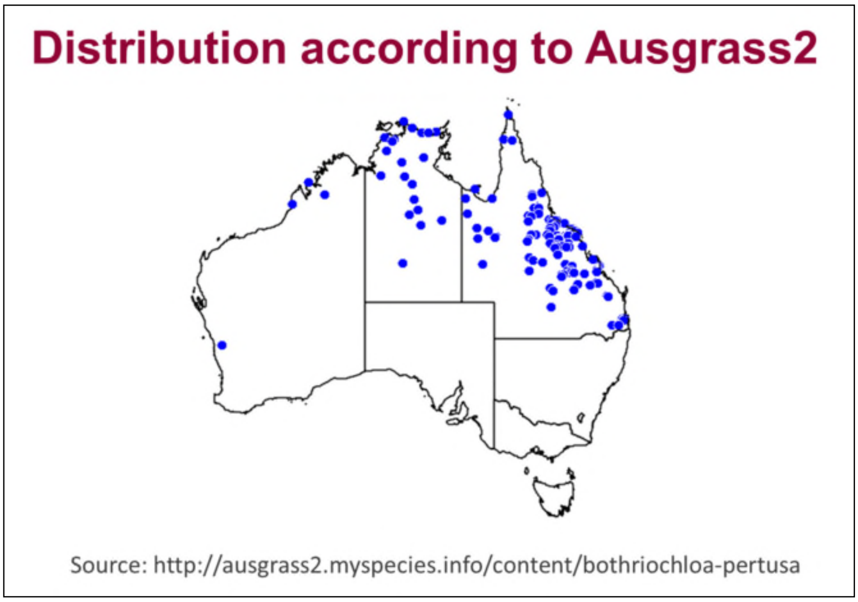


Figure 3. Herbarium records show Indian couch (B. pertusa) can be found across northern Australia inside and outside of a desirable growing condition of 500 and 1400 mm isohyets.

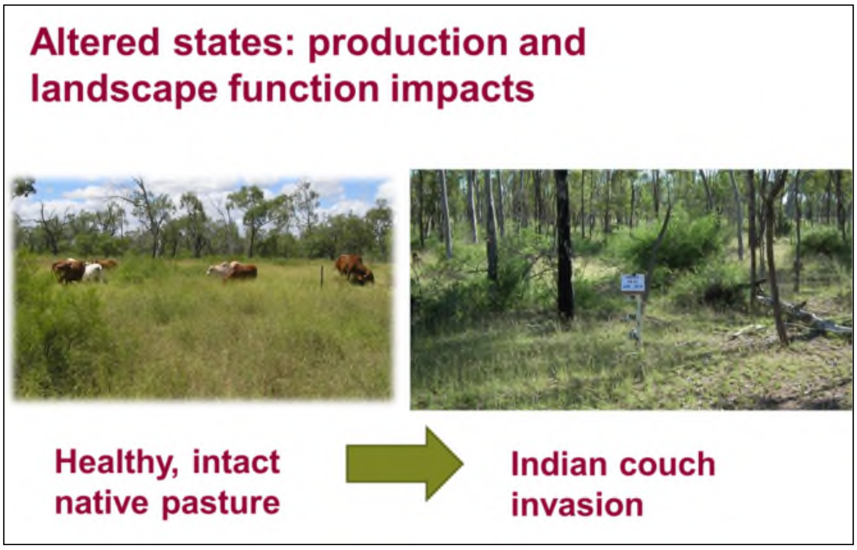


Figure 4. An example of a more recent Indian couch (Bothriochloa pertusa) invasion in native pastures in north-east Queensland. Left: native pasture dominated by Desert bluegrass (Bothriochloa ewartiana); Right: B. pertusa invasion in 2014. Source: Peter O'Reagain.

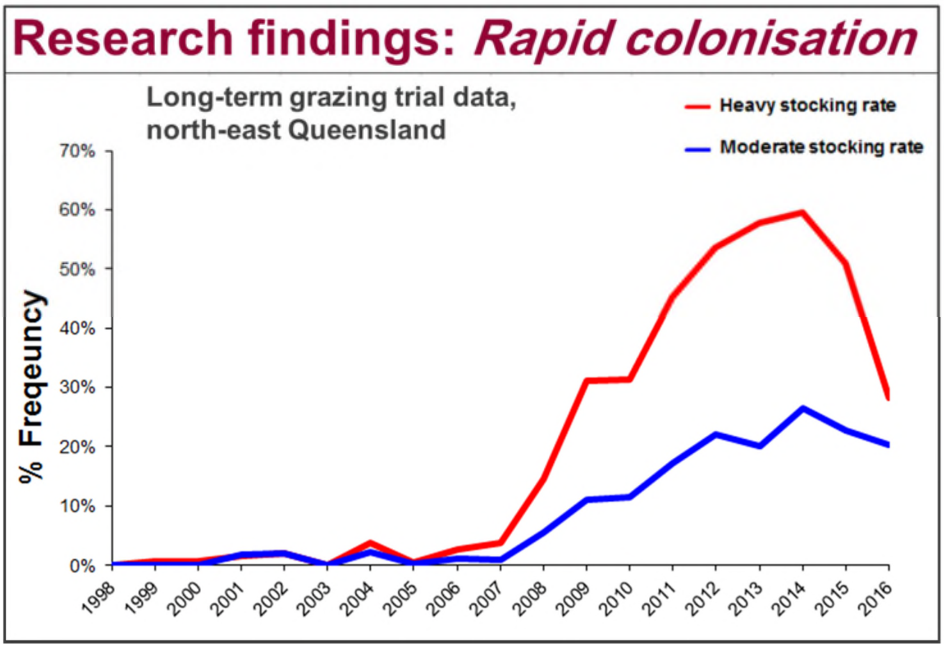


Figure 5. Data collected from the Wambiana long-term grazing trial has tracked the rapid colonisation of B. pertusa in native B. ewartiana pastures (unpublished data).

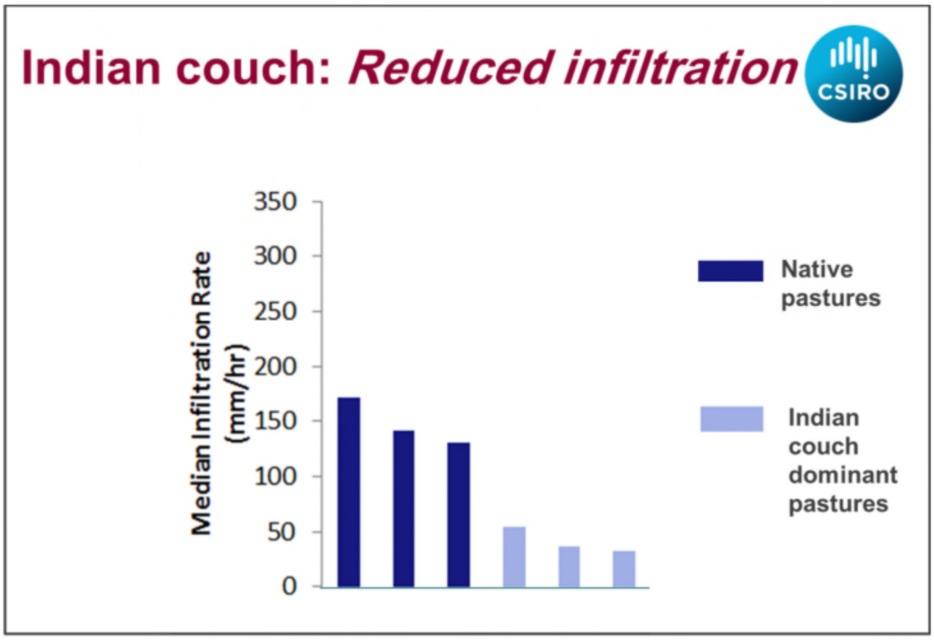


Figure 6. CSIRO research results show reduced water infiltration under a B. pertusa pasture when compared with a pasture dominated by native grasses. Figure sourced from Brett Abbott, CSIRO.

Figure 7. Fence-line effect indicative of different grazing land management: on the left is B. pertusa invasion and on the right is an intact Buffel sward. Contrasting differences in biomass can be seen.

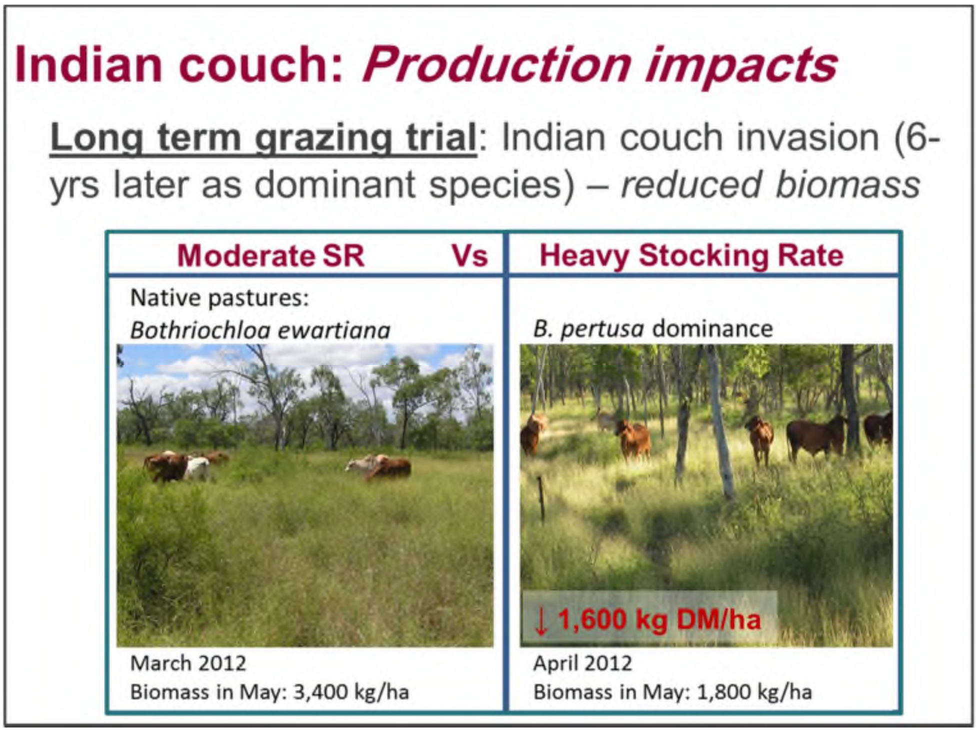


Figure 8. Reduced biomass with B. pertusa compared with native pasture.

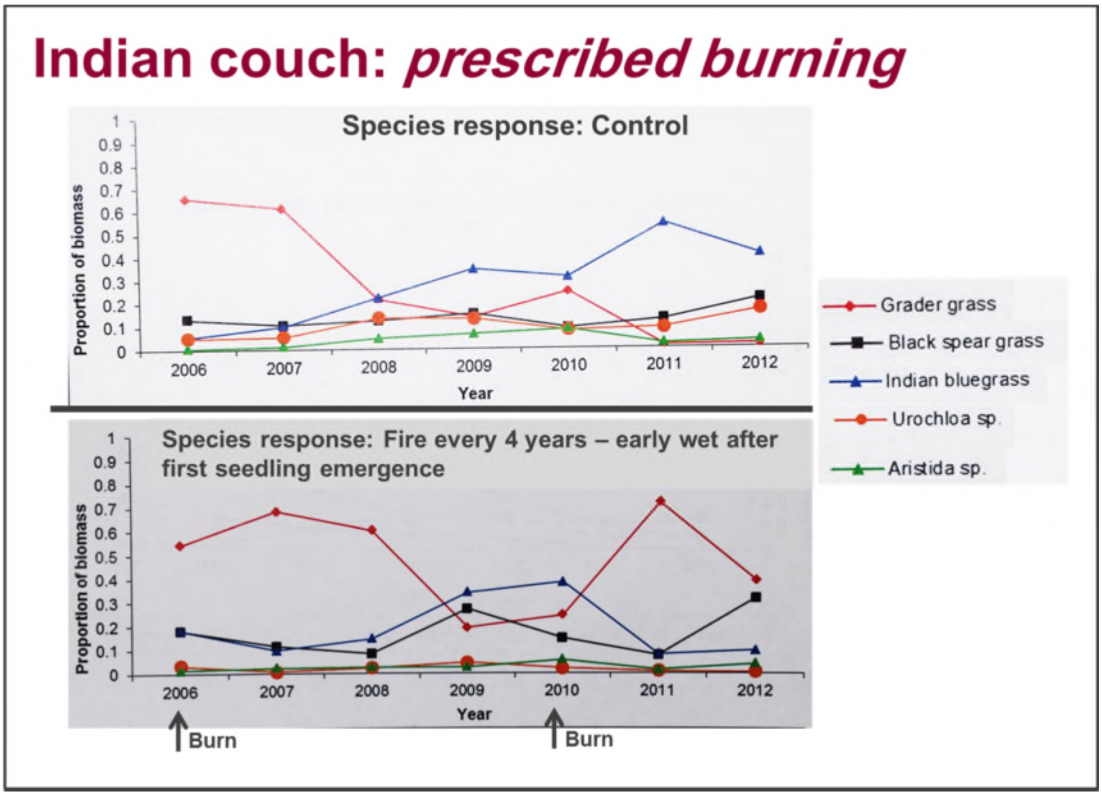


Figure 9. The potential role of fire to suppress B. pertusa in native pastures is shown.

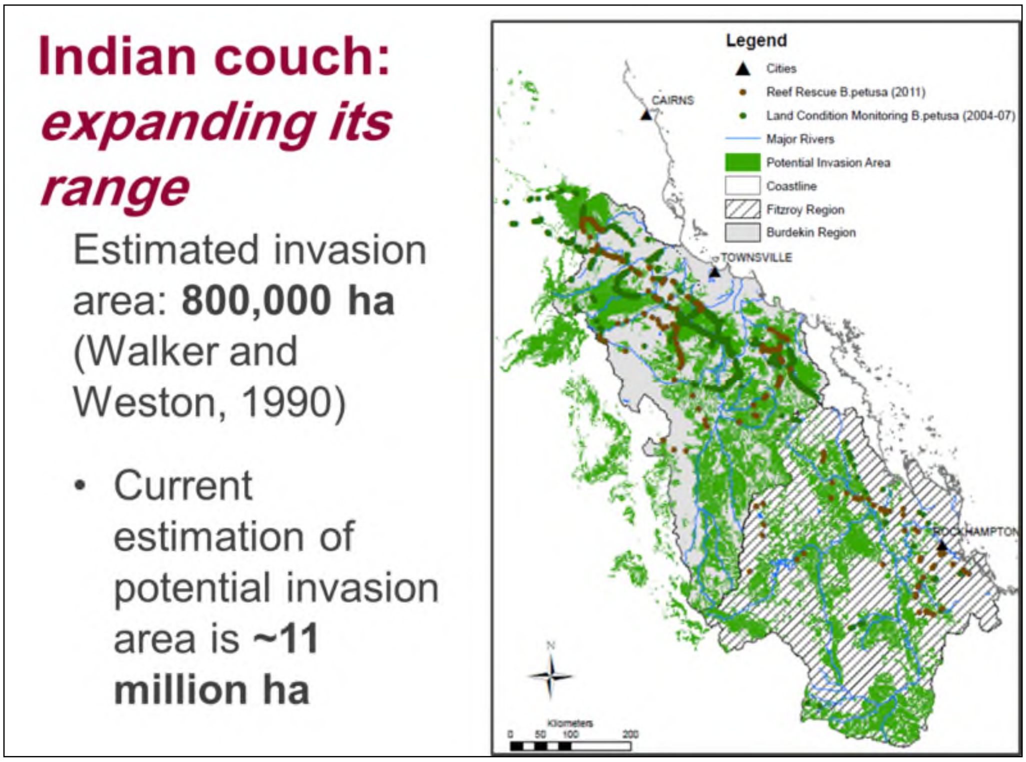


Figure 10. Estimated invasion area for B. pertusa in Queensland has increased from 0.8 million ha to an area in the order of 11 million ha.