Senate FPA Committee Inquiry
on Native Vegetation Laws etc

Insights from 40 Years of Research into Queensland's Grazed Woodlands*

Dr Bill Burrows FTSE
Emu Park, Qld
[*Senior Principal Scientist, QDPI&F*]
[Retired]

[*See suggestions for perusing on "Notes Pages" version of Slide 1]

1

This presentation is an amalgamation of invited talks given in late 2009 to a Meat & Livestock Australia 'Meat for Profit" day (Roma), the Northern Territory Agricultural Association AGM (Katherine) and the Fitzroy River & Coastal Catchments AGM (Rockhampton) respectively.

Note: This is a PowerPoint presentation which has been converted to PDF format for ease of transmission. [A functional PowerPoint slide version is available on request]. Furthermore the speaker's "notes pages" version of PowerPoint is the one copied here. This will enable explanatory text to be read in conjunction with the slides.

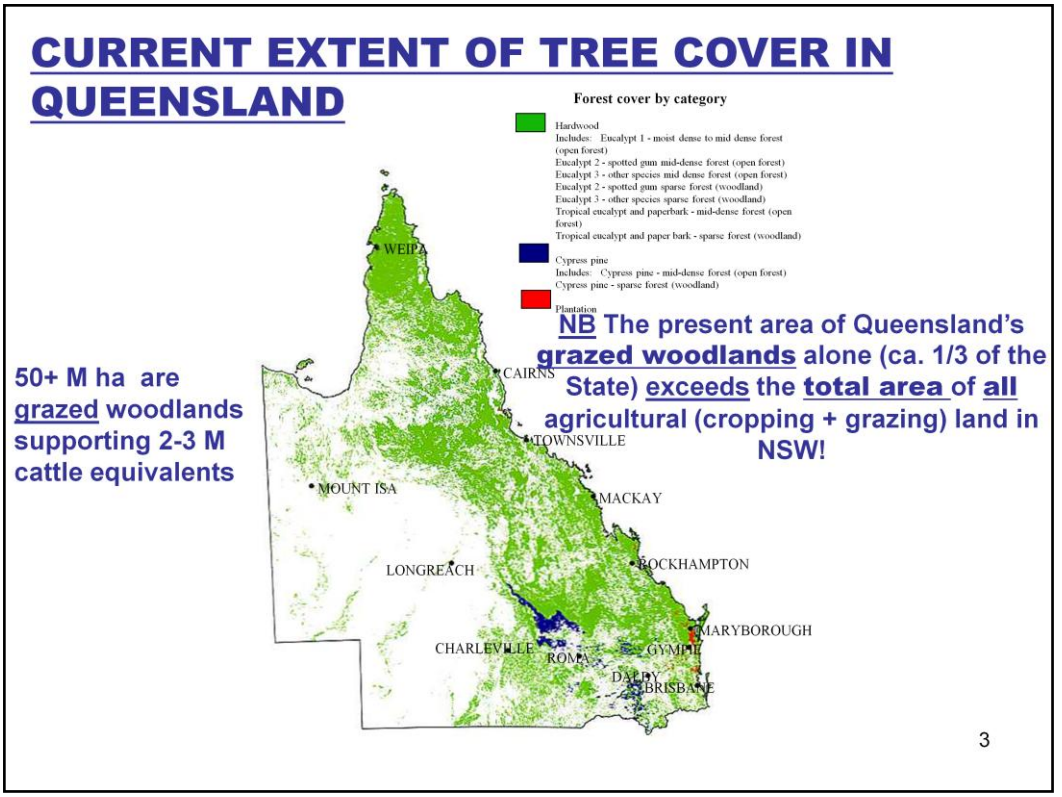
PRESENTATION OUTLINE

- **WOODLAND THICKENING**
- **FIRE – THE DRIVING VARIABLE**
- **TREE THICKENING IMPACTS**
- **THINNING/ REGROWTH IMPACTS**
- **"CARBON" PERSPECTIVES IN GRAZED WOODLANDS**

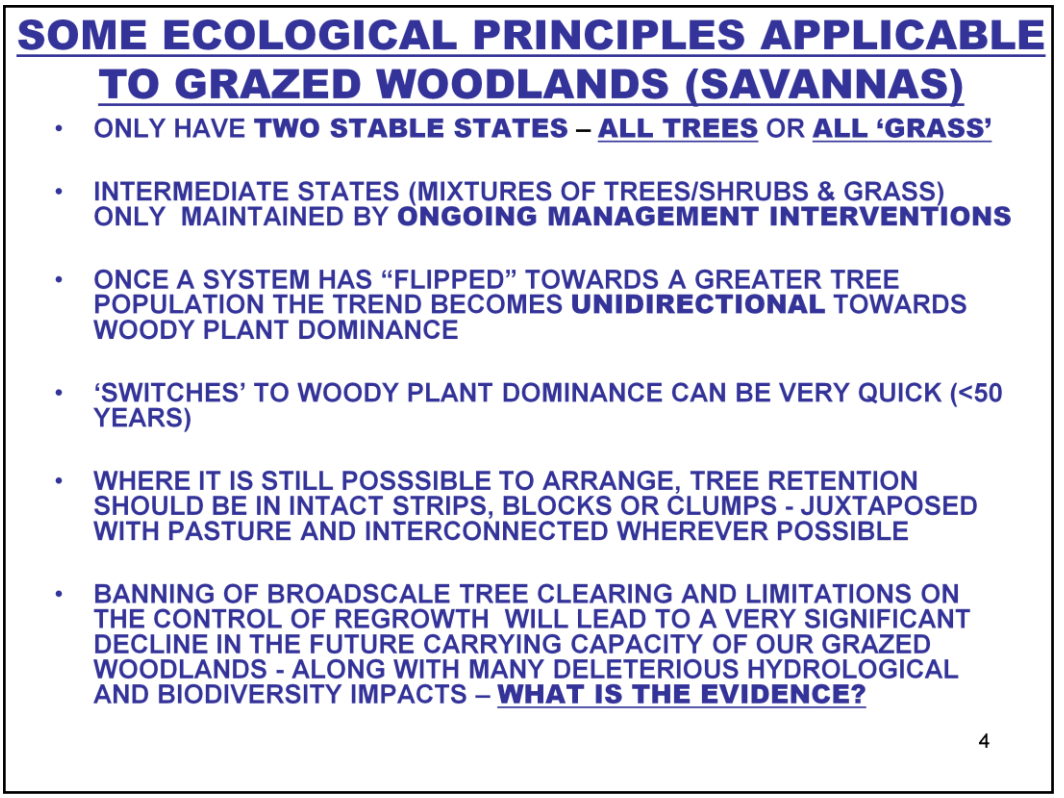
2

My presentation revolves around the population dynamics of trees and shrubs in Queensland's grazed woodlands. So there is much emphasis placed on the reader/audience obtaining an understanding of woodland thickening and its implication for the management of the state's grazing lands.

At the end of the presentation I'll also briefly cover some 'carbon perspectives' still 'in play', now that agriculture has been removed from the ETS.



There are c. 76 M ha of forest & woodland in Queensland – 84 M ha if you include shrublands detectable on satellite imagery. About 60 m ha is woodland grazed by domestic livestock. The actual woodlands themselves currently support **2-3 M** cattle equivalents.



Grazed woodlands only have **two stable states** – all trees or all 'grass'.

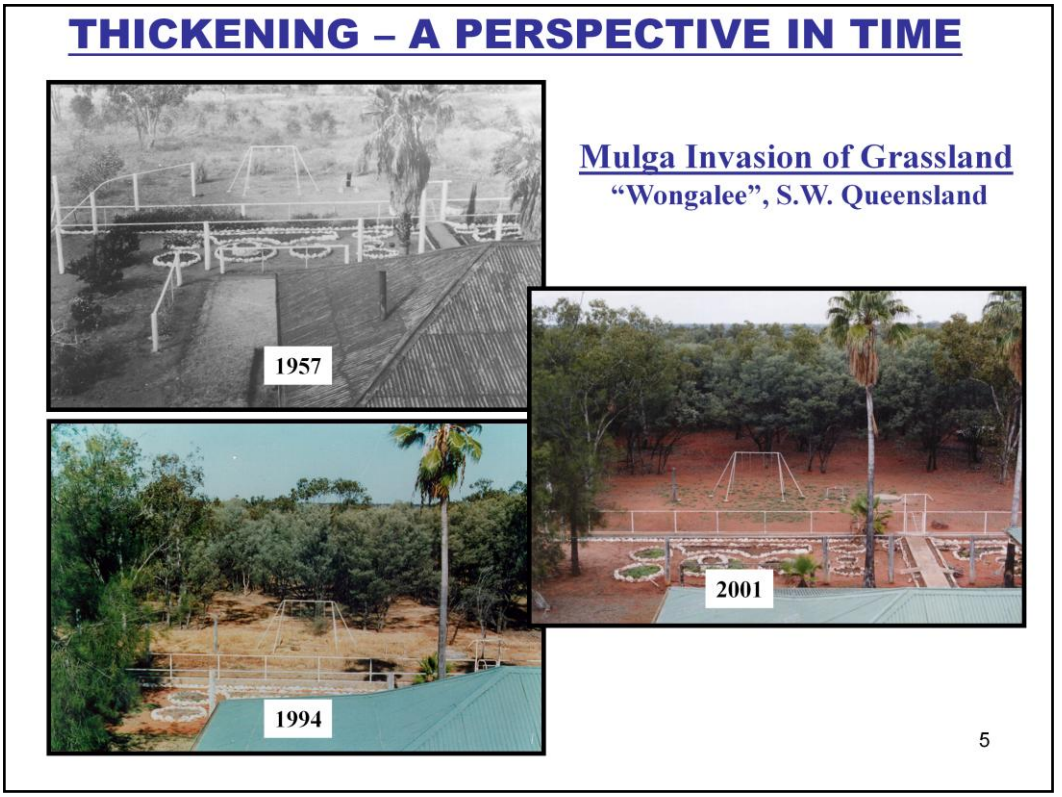
Intermediate states (mixtures of trees/shrubs & grass) can only be maintained by ongoing management interventions to favour either woody plants or grass (pasture) components.

Once a system has "flipped" towards a greater tree population the trend becomes **unidirectional** towards woody plant dominance.

If ongoing interventions (such as mechanical or chemical control of woody plants, frequent fire) are withheld, such woody plant 'switches' can be very quick (<50 years).

These observations are not a plea for the total removal of woody plants from grazing land – rather they suggest that on such land tree retention should be in intact strips, blocks or clumps juxtaposed with pasture and interconnected wherever possible.

Certainly the banning of broad scale tree clearing, combined with limitations on the control of re-growth, will have a huge detrimental effect on the future carrying capacity of our grazed woodlands, along with many deleterious hydrological and biodiversity impacts – **what is the evidence?**



First – let's consider tree thickening.

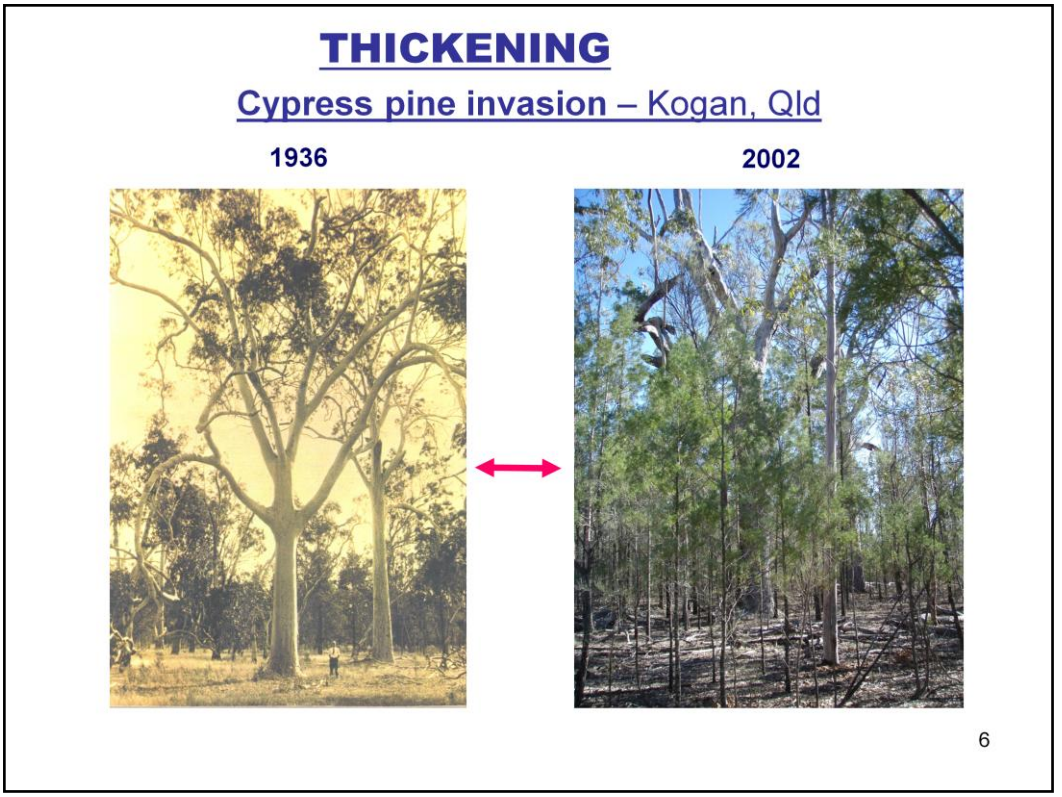
There have been many historical & anecdotal reports of increases in tree/shrub cover in un-cleared areas since livestock grazing commenced.

Jim Gasteen's father took up a soldier settlement block in the Bollon district after World War 1. In 1986 Jim wrote[i] that the ensuing decades were very dry and "in the absence of competition from ground layer species, and a lack of fires,------ inedible shrubs, mulga, cypress pine and eucalypt seedlings began to colonise the open spaces. By the late 1930's shrub re-growth had reached such proportions that some three year old ring-barked areas were so unusable, and so uneconomic to treat, that the usual follow-up treatment of suckering had to be abandoned – some of it still, 40 or 45 years later".

Dr Rosemary Purdie,[ii] a prominent Australian ecologist, was contracted to the Queensland Herbarium when she wrote in a 1986 paper that "as a result of land use the mulga region ecosystems can in no way be described as 'pristine' or identical with their pre-aboriginal or pre-european state". Yet the government has got itself into a lather to preserve this self designated remnant vegetation, not only in the mulga lands, but also elsewhere – so called 'remnants' - but our grandfathers & great grandfathers never knew them!

[i] Gasteen, W.J. (1986) Historical trends in the mulga lands of south west Queensland. In: "The Mulga Lands" (ed P.S. Sattler). (Royal Society of Queensland: Brisbane). pp. 72-78.

[ii] Purdie, R.W. (1986) Development of a National Park System for Queensland's Mulga Region. In: "The Mulga Lands" (ed P.S. Sattler). (Royal Society of Queensland: Brisbane).pp. 122-127.

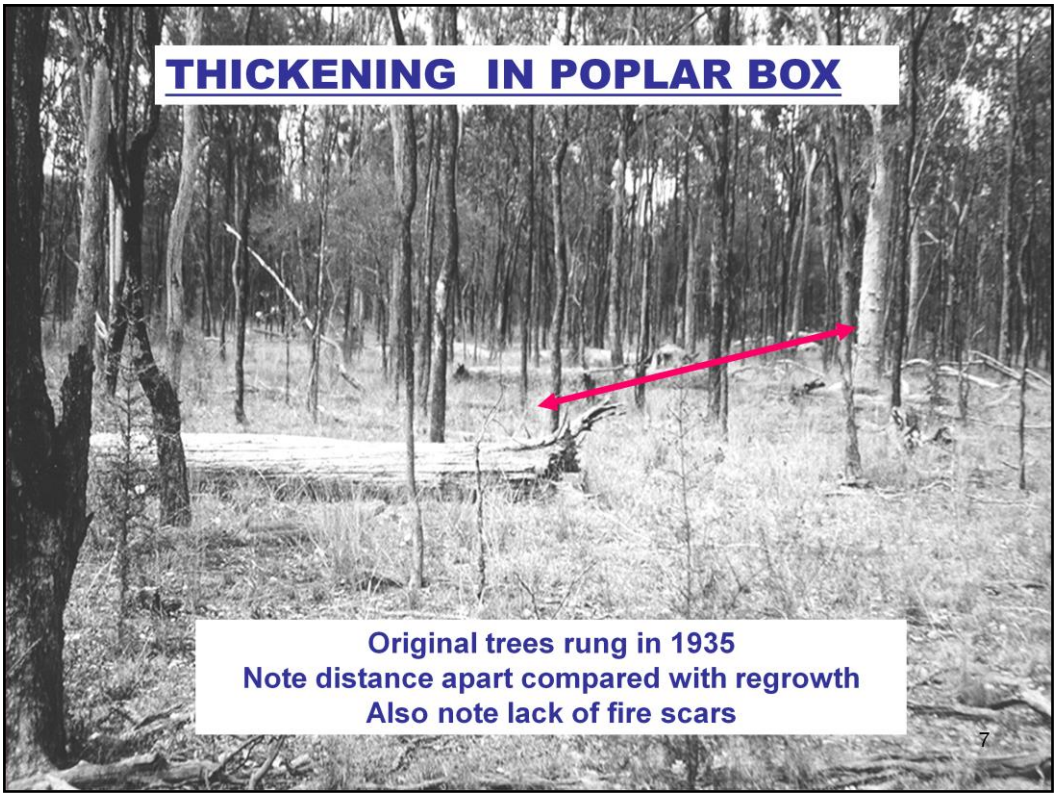


In his award winning book, 'A Million Wild Acres' Eric Rollls[i] wrote evocatively of the history of the Pilliga scrub in NSW – he observed "the cypress pines came up 10,000 to the hectare.----- 'One year the stockmen saw the little pines just to the top of the horses hooves' one man told me, 'the next year the pine tops brushed their boots as they rode. --------Soon they just mustered their stock and got out. There was no room for grass to grow.'"

Given this history it is not surprising that when the Australian forest profile series was compiled for white cypress pine[ii] in 1997 the author stated that "because of management changes white cypress pine forests currently cover a greater area than they did before European settlement".

[i] Rolls, E.C. (1981) A Million Wild Acres. (Nelson: Melbourne).

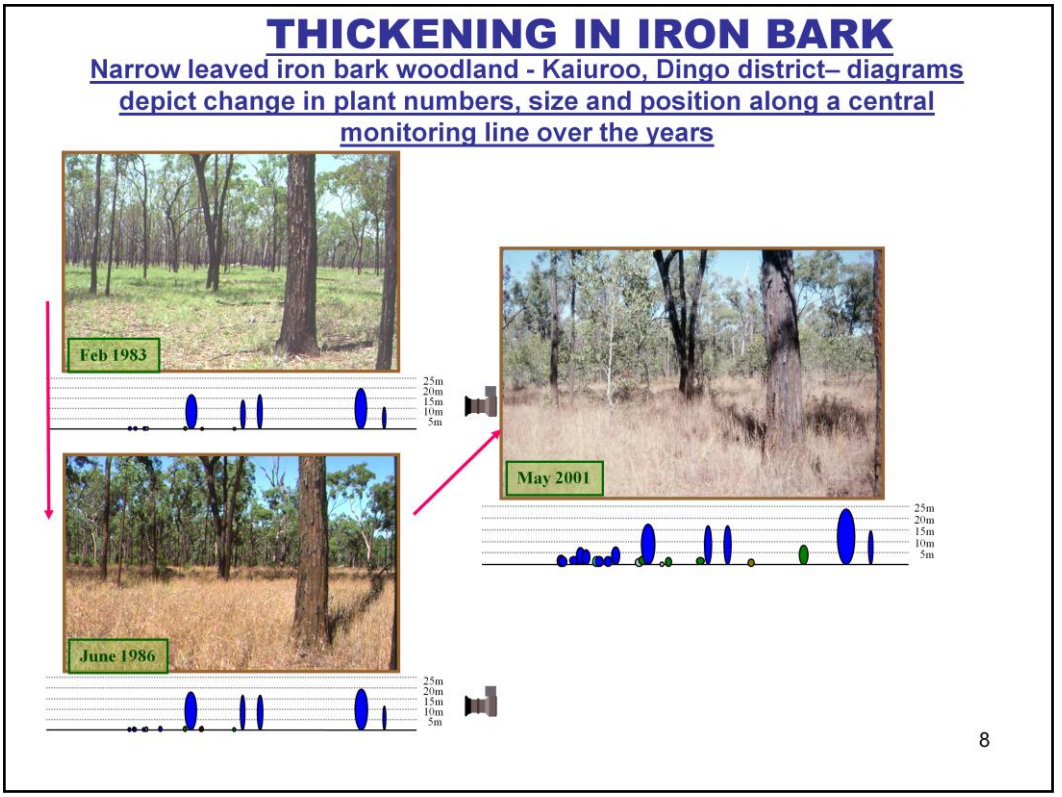
[ii] Binnington, K. (1997) Australian Forest Profiles 6. White Cypress Pine. (National Forest Inventory – BRS: Canberra).



Eucalypt woodlands have also thickened. This slide depicts poplar box woodland near Dingo. The large standing dead and fallen trunks were trees ring-barked c. 1935. Note the absence of fire scars on the dead tree trunks. These dead trees clearly pre-dated the commencement of livestock grazing. The smaller live trees represent subsequent re-growth.

In his 1847 journal Ludwig Leichhardt had observed that box trees in the Maranoa were 1-2 fathoms in circumference and 50-100m apart – just like the old rung trees in this slide.

Leichhardt, L (1847) Journal of an Overland Expedition in Australia. (London)

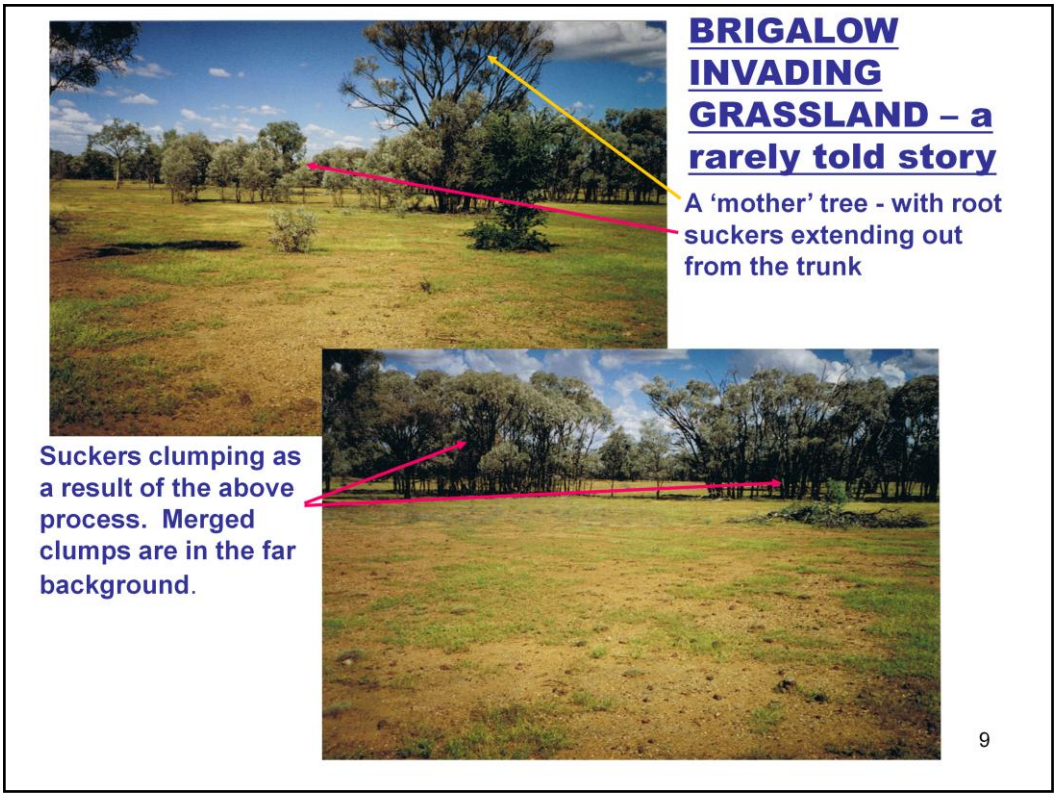


Obviously, many vegetation changes occurred soon after the Europeans arrived - so there was a Royal Commission in 1901 into the emerging native woody weed problem in the western division of NSW. A follow-up inquiry in 1969 found the problem was no better than in 1901 and that woody plant populations continued to increase.

We are also aware that tree thickening is still a very active process in many un-cleared woodlands - right up to the present day. Permanently positioned ground monitoring sites, aerial photo sequences available since WWII, and satellite imagery captured since the 1980's, are all powerful trackers of change in the woodlands.

Royal Commission (1901) Royal Commission to Enquire into the Conditions of Crown Tenants – Western Division of NSW. (Govt. Printer: Sydney).

Interdepartmental Committee (1969) Report of the Inter-Departmental Committee on Scrub and Timber Regrowth in the Cobar-Byrock District and other areas of the Western Division of NSW. (Govt. Printer: Sydney)



But there is one case of thickening that is rarely highlighted. It is the history of brigalow.

In 1938 Dr Stan Blake reported that - "brigalow scrub is slowly but surely extending its range, many changes having taken place within the memory of living men. Both grassland and *eucalyptus* forest have been invaded and replaced. All stages of this invasion can be seen, and in some older scrubs, box (tree) stumps are to be found".

More recently Judith Wright inspected the diaries of early settlers in the Dawson river country and in her book "The Cry for the Dead" noted that "by1885 the country of the upper Dawson had changed a great deal since Leichhardt had crossed it. Wattle scrubs (probably lancewood?) were spreading on the sandstone country, while brigalow was invading those open downs which Leichhardt had seen".

These observations suggest that the pre-European extent of brigalow ecosystems has probably been grossly overstated, if it was estimated solely on the basis of the area occupied after WWII.

[i] Blake, S.T. (1938) The plant communities of western Queensland and their relationships, with special reference to the grazing industry. *Proceedings of the Royal Society of Queensland* **49**: 156-205.

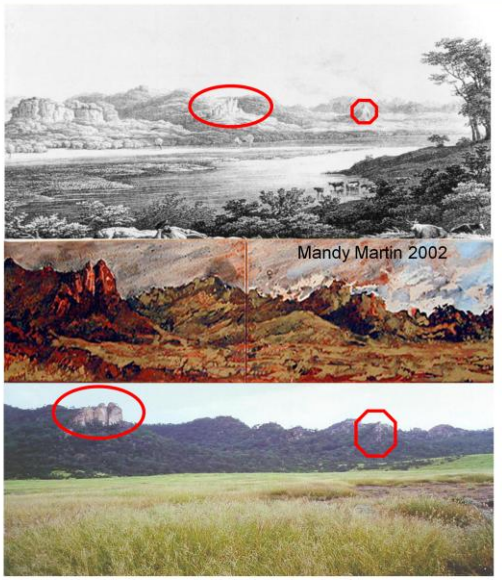
Wright, J. (1981) *The Cry for the Dead* (Oxford UP: Melbourne).

SALVATOR ROSA NATIONAL PARK – MT PLAYFAIR

Sketched by Sir Thomas Mitchell 1846

As painted in the 'Salvator Rosa style' by MM in 2002

Photographed by Mandy Martin c.1998



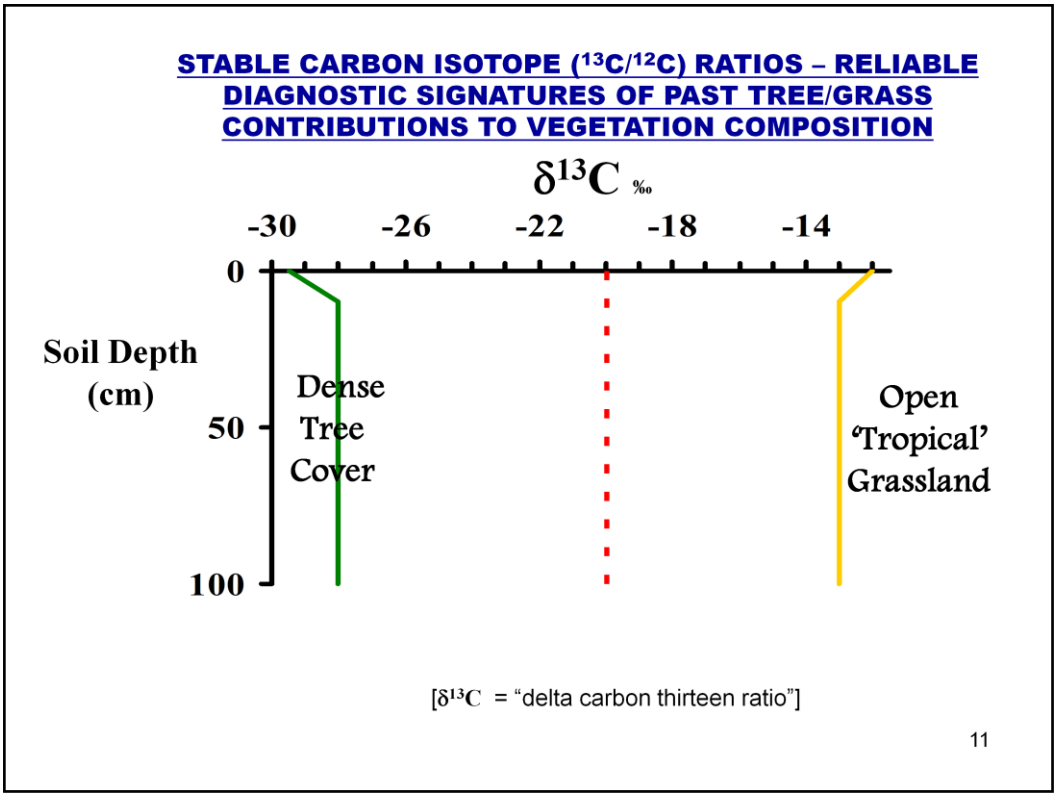
Notes
1. Red symbols identify common peaks in both pictures.
2. There seems to be a much denser tree cover (lancewood?) on the sandstone hills in Mandy's photo cf. Mitchell's sketch

The foreground flat was also clearly 'open' in Mitchell's sketch. It now appears to support buffel grass pastures – possibly developed after the 'recent' clearing of brigalow scrub on Mt Playfair, but such scrub was apparently not present in 1846?

Further perspective to the brigalow story is provided by these scenes recorded **152** years apart.

In recent times Moorinya NP south of Torrens Creek, has also developed a problem with native acacias (blackwood, gidgee, myall etc) invading the Mitchell grass community which is the main feature of that park.

[*The cattle in the foreground of Mitchell's sketch are not allegorical. He took both sheep and cattle with him on his expedition as a food source - so the aborigines would not be upset with his party, because they could then see the explorers were not competing with them for indigenous tucker.]*



A modern development in reconstructing vegetation history involves the study of stable carbon isotopes in soil organic matter.

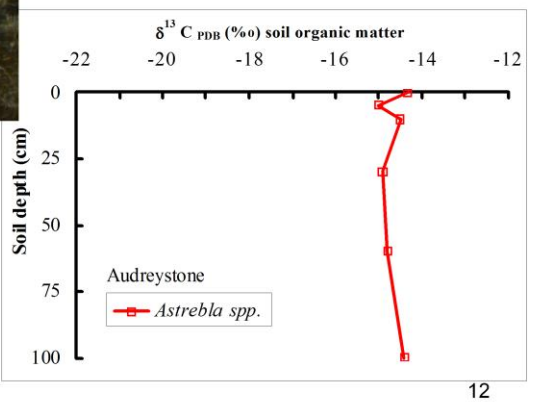
The ratios of 13C/12C (expressed as $\delta^{13}C$) provide diagnostic signatures which can be used to differentiate organic carbon derived from trees/shrubs and tropical grasses. Woody plants possess the C3 photosynthetic pathway ($\delta^{13}C$ range = -27 to -32‰ (per ml), whereas vegetation of tropical grass dominated zones is characterised by grasses with the C4 pathway ($\delta^{13}C$ range = -13 to -17‰).

If woody plants have been long term constituents of the landscape the $\delta^{13}C$ signature of the soils beneath them should reflect this and fall within the –27 to –32‰ range. However if C3 trees and shrubs had displaced C4 grasses: (i) the soil $\delta^{13}C$ value would be less negative than –27 to –32 ‰ (ii) the degree of departure from the expected ratio would decrease as time of site habitation by woody plant increases, and (iii) the soil $\delta^{13}C$ values would become less negative with depth in the soil profile (i.e. along the chronosequence).

[Tieszen & Archer (1990) Ecological Studies **80**: 293-321.].

MITCHELL GRASSLAND

- TYPICAL "TREELESS" $\delta^{13}C$ SIGNATURE



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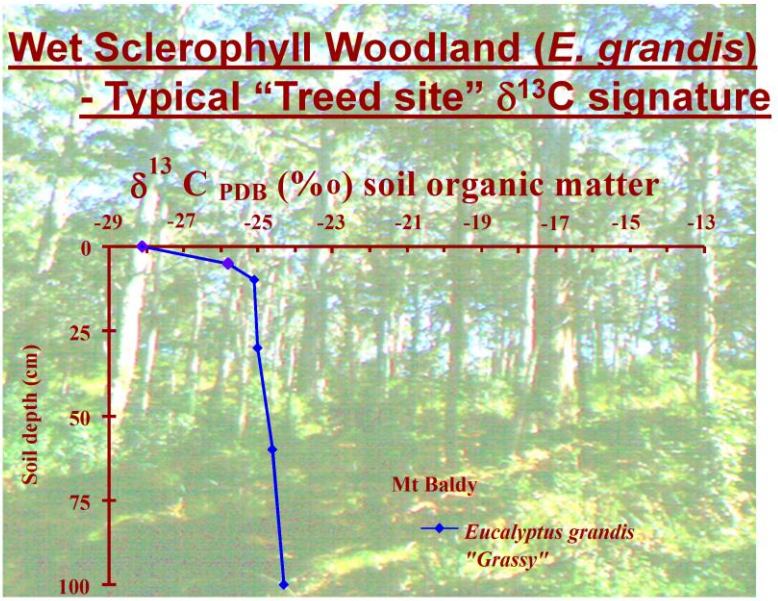
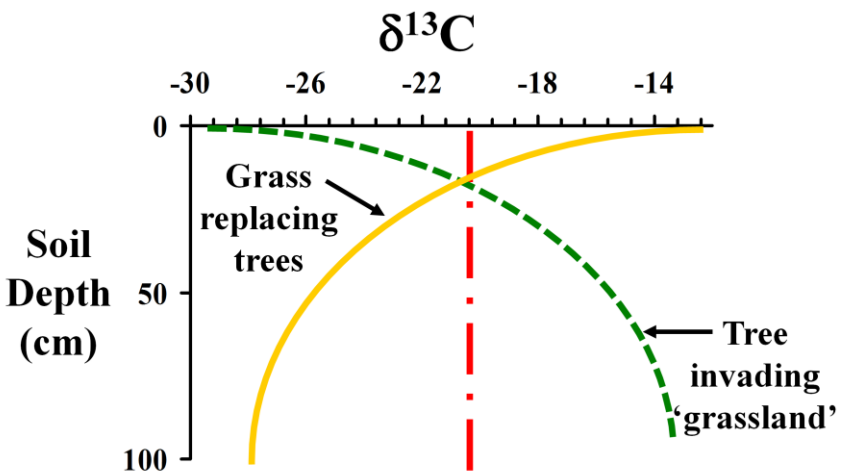
A typical tropical or C4 grass soil $\delta^{13}C$ profile is shown here for a Mitchell grassland near Barcaldine. It displays values closely in line with the theoretical, as one would expect for a stable grassland which has maintained its structure for millennia.



Likewise we can see a typical soil $\delta^{13}C$ profile for a wet sclerophyll woodland long occupied by trees near Atherton.

TYPICAL $\delta^{13}C$ SIGNATURE PATTERNS IN SOIL

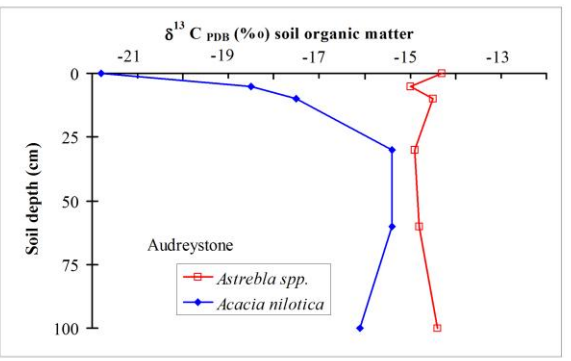


[Depth signature is a surrogate for time – verified by 'post-bomb' spike ^{14}C dating]

14

So if we analyse the soil $\delta^{13}C$ profile beneath a vegetation community of unknown history we can infer that history by interpreting the pattern of $\delta^{13}C$ changes with increasing depth. For example a pattern similar to the green line (small dashes) would imply that trees are invading grasslands or thickening up, compared with a more open woodland structure in the past. A pattern similar to the gold line (solid) would imply that tropical grasses had replaced a previously closed woodland.

PRICKLY ACACIA – A KNOWN RECENT INVADER OF MITCHELL GRASSLANDS

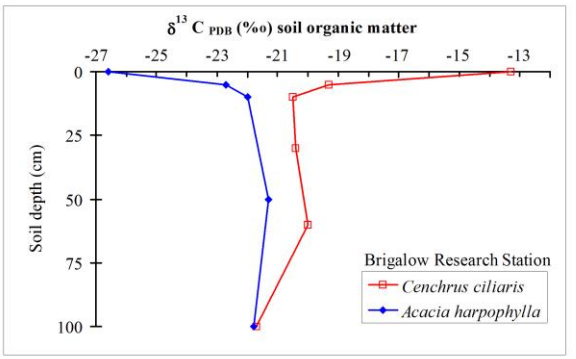


15

It is well known that prickly acacia (*Acacia nilotica*) has invaded areas long occupied by Mitchell grass (*Astrebla* spp.) since the 1950's. So the $\delta^{13}C$ signature of the surface soil under prickly acacia is "woody" while at depth the soil $\delta^{13}C$ is more akin to the Mitchell grass profile it is replacing.

BRIGALOW SCRUB – CLEARED AND PLANTED TO PASTURE

Brigalow
(*Acacia harpophylla*)
woodland



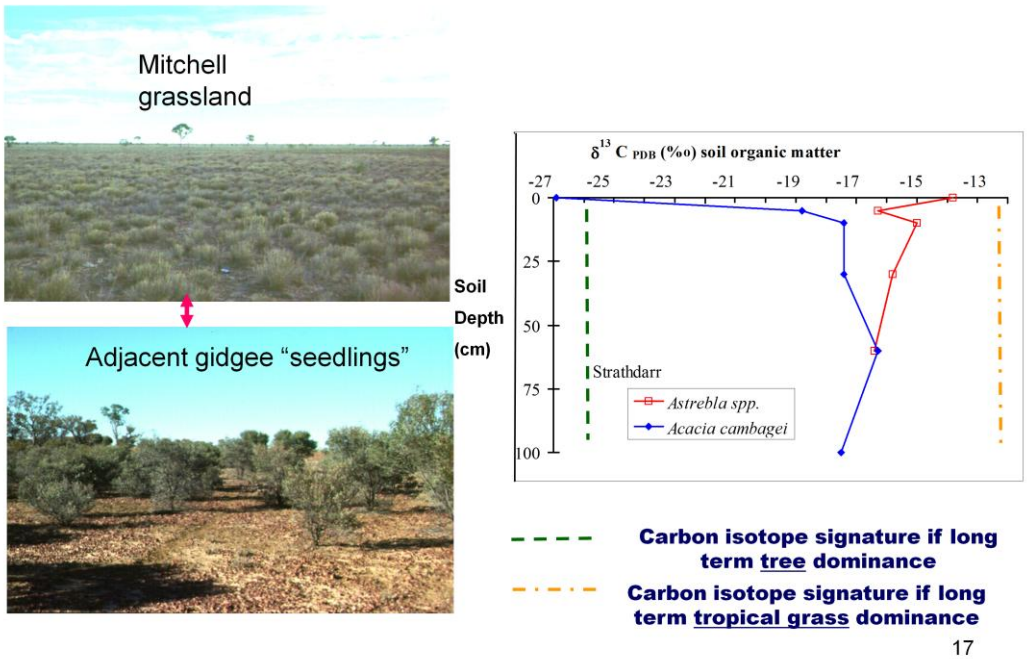
Brigalow replaced by
buffel grass
(*Cenchrus ciliaris*)

16

These profiles are from Brigalow Research Station, Theodore. The 'open' brigalow scrub was pulled and burnt and replaced by buffel grass (*Cenchrus ciliaris*) about 40 years ago. The upper soil $\delta^{13}C$ profile under the buffel reflects the tropical grass signature while at depth the long term profile established by the brigalow scrub is mirrored.

Note that this scrub is presenting a carbon ratio signal (the blue line) that indicates it is a "mixture" of woody plants and grass components. In fact in this area of central Queensland the scrubs were known as 'patchy plain brigalow' – signifying they were in the throes of being invaded by brigalow when Europeans first arrived in the area . [Refer back to earlier slides].

INTERPRETING UNKNOWN VEGETATION HISTORY



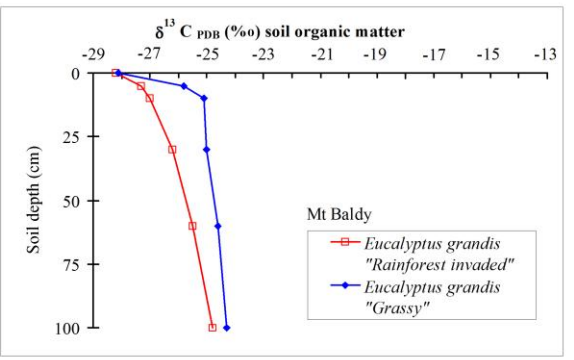
17

Therefore, in the absence of other evidence, stable soil carbon isotope ratio signatures, along with carbon dating, can now tell us whether woody plants or tropical grasses occupied a site and over what timeframe - extending back for hundreds of years. For example, there has been much conjecture about the status of gidgee in areas juxtaposed with Mitchell grassland in western Queensland.

The 'recent' signature on the soil surface of this gidgee (*Acacia cambagei*) site says it is dominated by trees, while the 'older' signature at depth mirrors that of the Mitchell grass (*Astrebla* spp.) site. Post-bomb carbon dating confirms gidgee has only invaded the grassland in quite recent times (since the 1950's).

Before the soil carbon signature technique proved otherwise Environmental Protection Agency staff classified this gidgee regional ecosystem as a remnant of vegetation present before livestock grazing commenced!

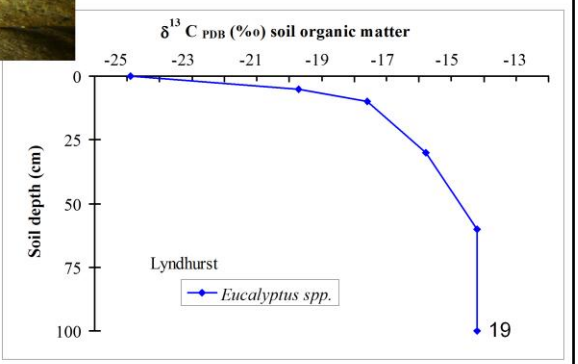
INTERPRETING UNKNOWN VEGETATION HISTORY



18

These profiles are of wet sclerophyll and recent 'rainforest invaded' sites near Atherton. The profile hasn't changed since woody plants have dominated the vegetation in both instances and this is reflected in the $\delta^{13}C$ signatures.

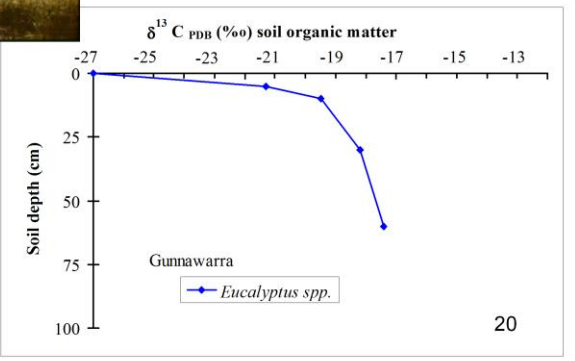
INTERPRETING UNKNOWN VEGETATION HISTORY



The next series of slides depict woodland sites in north Queensland for which the past vegetation history is unknown or cannot be confirmed by independent data up to this time.

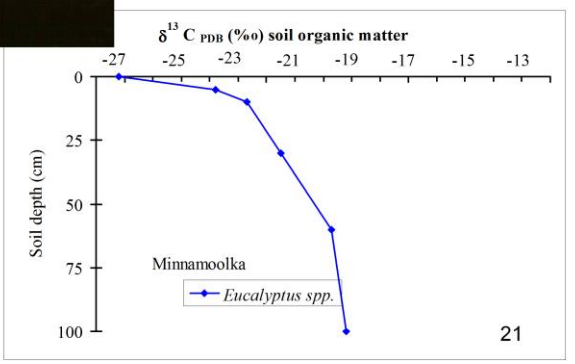
The photograph for this site clearly suggests an expanding population of young trees. This is confirmed by the $\delta^{13}C$ curve, but surprisingly the values at depth indicate that this site was virtually dominated by tropical grasses in the past ($\delta^{13}C$ values below 50cm depth approximate those in a Mitchell grassland profile!).

INTERPRETING UNKNOWN VEGETATION HISTORY



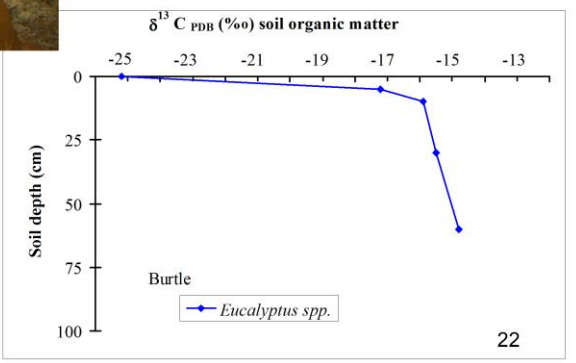
Another example of a woodland changing from an open to a more closed canopy state.

INTERPRETING UNKNOWN VEGETATION HISTORY



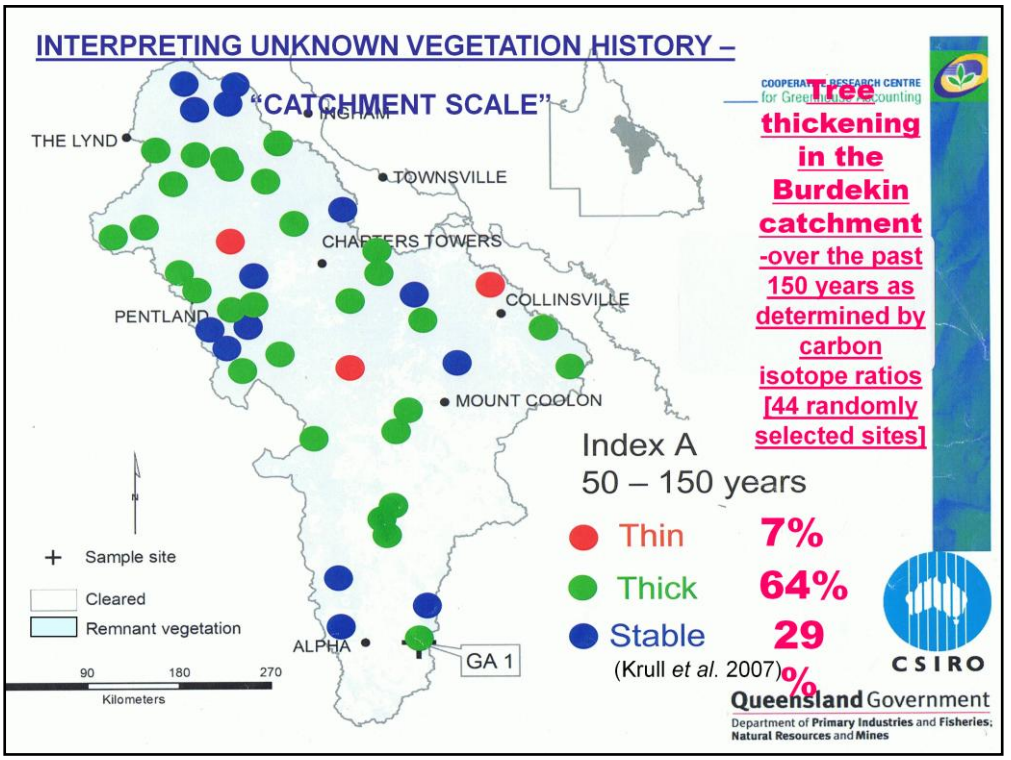
The shape of the $\delta^{13}C$ curve suggests that woody plants have definitely proliferated on this site.

INTERPRETING UNKNOWN VEGETATION HISTORY



This site is north of Alpha in central Queensland. It is typical of large areas in the region where silver leaved ironbark has apparently proliferated since the 1950's. $\delta^{13}C$ signatures suggest this site supported very open woodland or grassland in the past.

The site overlays the newly announced Galilee Basin coal measures which have attracted proposals for huge coal mines (from Clive Palmer and Gina Rhinehart respectively). These will be strenuously opposed by conservation groups wanting to protect the so called "pristine" woodland vegetation on the overburden!

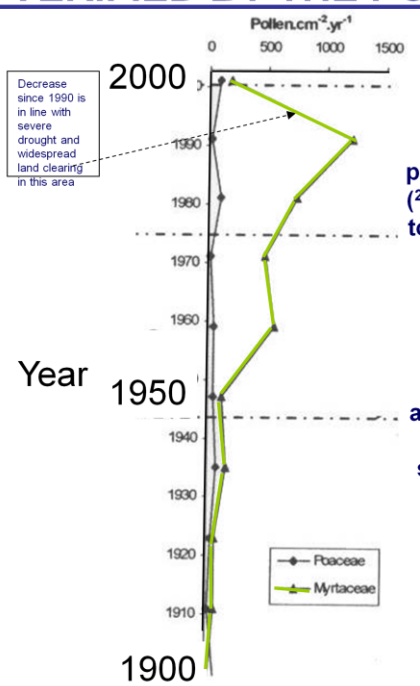


An overview of tree thickening in the Burdekin-Belyando river catchments has recently been published. This elegant research also utilised stable carbon isotope signatures and revealed significant tree thickening has occurred in most of the Burdekin-Belyando catchment over the past 150 years – with the vegetation shown to be relatively stable in the preceding centuries (Krull *et al*. 2007), when it was managed by the indigenous people.

In other words the pristine, or 'pre-European' condition of our northern woodlands was far more open than it is today. Because of on-going tree thickening, 'locking up' the remaining woodlands to preserve them will in fact cause them to depart further and further from their pre-European or "original" structure and composition. This is counter to the aims of all tree clearing bans.

Krull et al. (2007) Development of a stable isotope index to assess decadal-scale vegetation change and application to woodlands of the Burdekin catchment, Australia. *Global Change Biology* **13**: 1455-1468

TREE THICKENING IN EUCALYPT WOODLANDS AS VERIFIED BY THE POLLEN RECORD



Lake Dunn

Anna Sim *et al.* (2004) studied the pollen record and utilized lead isotope (^{210}Pb) dating of Lake Dunn sediments to investigate vegetative thickening in the Desert Uplands (200 km W of Clermont). They found:

"that a significant increase in Myrtaceae (eucalypt family) pollen appeared from the 1950's, reflecting a change from continuous grass with scattered trees to a near continuous 'scrub' in the surrounding areas"

24

The Burdekin results have been strongly supported by a study of the pollen record in sediments from Lake Dunn, which is situated in the middle of the desert uplands bioregion – west of the Belyando river. This area also overlies the Galilee Basin coal measures.

Sim, A (2004) Hons Thesis. (UNSW: Sydney)

TREE THICKENING AS EVIDENCED BY API

(Fensham *et al.* 2003)

Changes in over-storey cover in intact woodlands

Eucalypts on clays (1960-96) ⇒ 58% incr.*

Eucalypts on sand (1951-96) ⇒ 22% incr.*

Eucalypts on hills (1952-94) ⇒ 16% incr.*

Eucalypts on duplex (1952-93) ⇒ 29% incr.*

Mean over all sites/times⇒ **29% incr.***

(*cf. initial baseline levels)

[108 'remnant' sites sampled; 100 points/25 ha area/site per cover estimate]

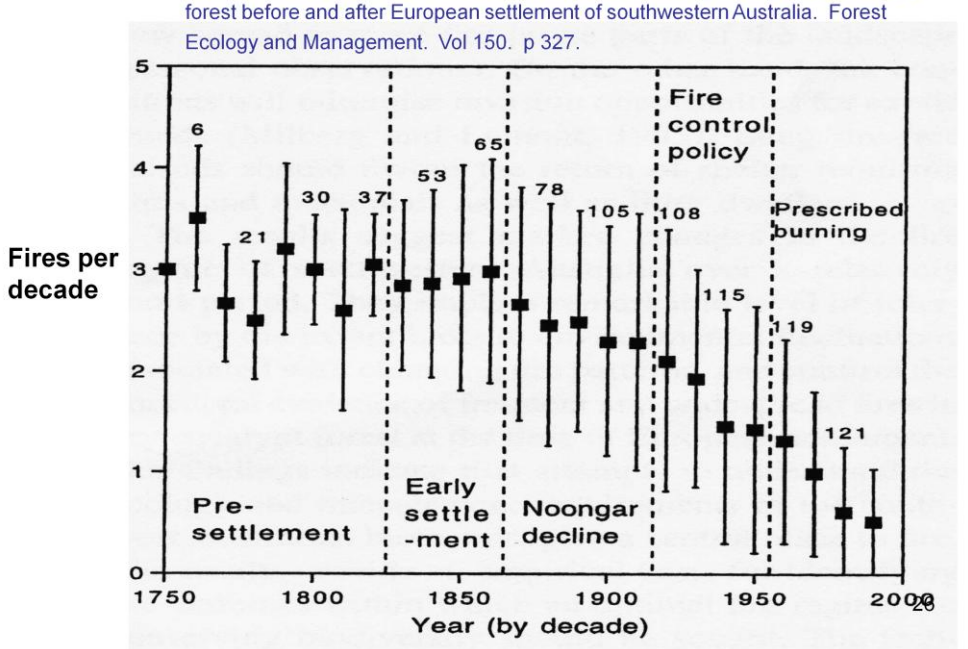
And finally, if any further proof of tree thickening in central Queensland woodlands was needed, it is provided by aerial photo interpretation. Brigid McCallum (1999), for Moorinya N.P., and Rod Fensham and Russell Fairfax (2003), for the central highlands/coalfields , recorded 25-30% increases in tree canopy cover in these areas in un-cleared ('remnant') woodlands over the 1950-1990's period.

Fensham, R. & Fairfax, R (2003) *J. Environmental Management* **68**: 409-420.

McCallum, B. (1999) Hons Thesis. (JCU: Townsville)

THE DECLINE OF FIRES IN AUSTRALIA

Source: Ward *et al.* (2001). Grasstrees reveal contrasting fire regimes in eucalypt forest before and after European settlement of southwestern Australia. Forest Ecology and Management. Vol 150. p 327.



Well, what has caused this proliferation of woody plants in our grazing lands? There is now a widespread consensus that it results from changed fire regimes brought about by the introduction and management of domestic livestock - and this phenomenon is quite common in most areas of the world previously managed by hunter-gatherer people.

Indications that fire frequencies have declined since European settlement are displayed in growth 'rings' and biochemical signatures left by fires in grass trees. These fire signatures were much more frequent when the landscape was managed by the Noongar aboriginal people of SW WA.

[Unfortunately we do not have reliable statistical data showing the area burnt or fire incidence in Queensland compared with earlier years. However a similar pattern to that in WA would be expected in this state.]

[Incidentally a just published analysis of fire incidence in SW WA over 52 years has found that prescribed burning pronouncedly changed the spatial distribution of fuel age in the study area and has significantly reduced the incidence and extent of unplanned fires. (Boer *et al*. (2009) *Forest Ecology and Management* **259** : 132–142)]

INDIGENOUS FIRE MANAGEMENT?

- ABORIGINES MANAGED COUNTRY BY **BURNING** IT - IN 3 WAYS – **FREQUENTLY, REGULARLY & OFTEN**
- A RESEARCHER FROM THE TROPICAL SAVANNAS CRC EXPRESSED IT THIS WAY - **"ABORIGINES LIT FIRES ALMOST ANYTIME IT WAS NOT RAINING"**
- IN HIS BOOK "TRIUMPH OF THE NOMADS" GEOFFREY BLAINEY WRITES **"WITHOUT THOSE (ABORIGINAL) FIRES THE GRASSY WOODLANDS THAT OCCUPIED MUCH OF THE FERTILE CRESCENT IN SOUTH-EASTERN AUSTRALIA WOULD HAVE BEEN SCRUBLAND OR FOREST**. A PERIOD OF 50 YEARS WAS SUFFICIENT TO CHANGE THE CHARACTER OF THAT SAVANNAH COUNTRY IF NO FIRES BURNED------. THE WIDESPREAD RINGBARKING THAT WAS CARRIED OUT AT THE TURN OF THE (20TH) CENTURY OCCURRED IN THE REGROWTH. THE LANDHOLDERS WERE ATTEMPTING TO RE-ESTABLISH THE ORIGINAL GRAZING CAPACITY"!
- LIKEWISE THE NATURALIST KARL DOMIN CONCLUDED IN A 1911 REPORT THAT THE FORESTS IN ALL PARTS OF QUEENSLAND WERE NOT A NATURAL ASSOCIATION, BUT A SECONDARY ONE, CHANGED THROUGH THE INFLUENCE OF ABORIGINES, **MOSTLY BY MEANS OF BUSHFIRES.**

27

So our vegetation was burnt much more frequently under aboriginal management than under current day European management. Rhys Jones, a well known anthropologist who did much of his research in the NT, coined the descriptive term "fire stick farming" to describe this aboriginal practice.

Blainey, G. (1982) *Triumph of the Nomads*. (Sun Books)
Domin, K. (1911) *Proc. Roy. Soc. Qld* **23**: 63-67.

FIRE – A SAVIOUR FROM 'THICKENING'?

- IN "THE CRY FOR THE DEAD" JUDITH WRIGHT NOTED THAT **BY THE LATE 1800'S** "INSPECTORS OF STOCK HAD POINTED OUT THAT THE GREAT GROWTH OF BRIGALOW AND WATTLES WHICH ENCROACHED ON THE PASTURES HAD FOLLOWED THE ABANDONMENT OF THE USE OF FIRE – WHICH, AS THE OLDER SETTLERS KNEW, HAD BEEN **ANNUAL** IN THE EARLY DAYS OF QUEENSLAND WHEN - THE ABORIGINES STILL CARRIED OUT THEIR DUTIES"! [i.e. when they managed the country in traditional ways?]
- IN HIS **1955** BOOK "GROWTH HABITS OF THE EUCALYPTS" PROF JACOBS OBSERVED THAT "HUNTING FIRES WERE LIT BY THE ABORIGINES AND THE WHITE MAN HAS CONTINUED TO BURN THE WOODLAND TO GET RID OF THE COARSE GRASS AND OBTAIN A GREEN SHOOT MORE FAVOURABLE TO CATTLE. THESE **REGULAR** FIRES KEEP REGENERATION OF EUCALYPTS IN CHECK. IF FIRES WERE CONTROLLED THE EUCALYPTS WOULD MAKE A MUCH CLOSER FOREST IN THE FAR NORTH OF AUSTRALIA".
- BUT THEN IN **1970** GRAEME ALEXANDER, DAN DALY AND MAX BURNS ADVISED THAT "WHERE DROUGHT IS A RECURRING THREAT TO ANIMAL PRODUCTION **THE NEEDLESS OR AUTOMATIC BURNING OF ALL MATURE HERBAGE EACH YEAR IS NO LONGER WISE**, SINCE EVEN LOW QUALITY HERBAGE CAN BE USED TO MAINTAIN (BRAHMAN) CATTLE, IF SUPPLEMENTED WITH UREA-MOLASSES LICKS"!
- AND NOW ROD FENSHAM & RUSSELL FAIRFAX HAVE CONCLUDED FROM A **2006** STUDY OF THE DISAPPEARING GRASSY BALDS OF THE BUNYA MOUNTAINS THAT "EVEN WITH **BIENNIAL BURNING, UNDER OPTIMAL CONDITIONS, EUCALYPT FOREST WILL REPLACE GRASSY BALDS** WHERE THEY ADJOIN".

28

Could we employ fire to help avoid tree thickening in the grazed woodlands?

[Read slide]

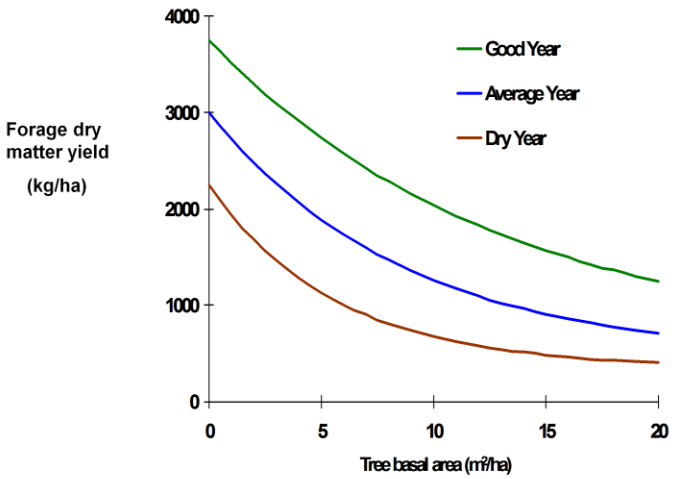
In practice, it is unlikely that any grazier will burn his pasture today at the frequency necessary to stop tree thickening – even if it was possible to burn.

Alexander, G.,Daly, J. & Burns,M. (1970) *Proc. XI Int. Grassld Congr., pp.*793-796.

Fensham, R. & Fairfax, R (2006) *Austral Ecol.* **31**: 317-325.

Jacobs, M. (1955) *Growth Habits of the Eucalypts* (Govt Printer: Canberra).

TREE THICKENING IMPACTS - ON PASTURE PRODUCTION



The effect of increasing woody plant basal area on forage production in a poplar box woodland in central Queensland. [data generated from 'GRASSMAN' (1990)].

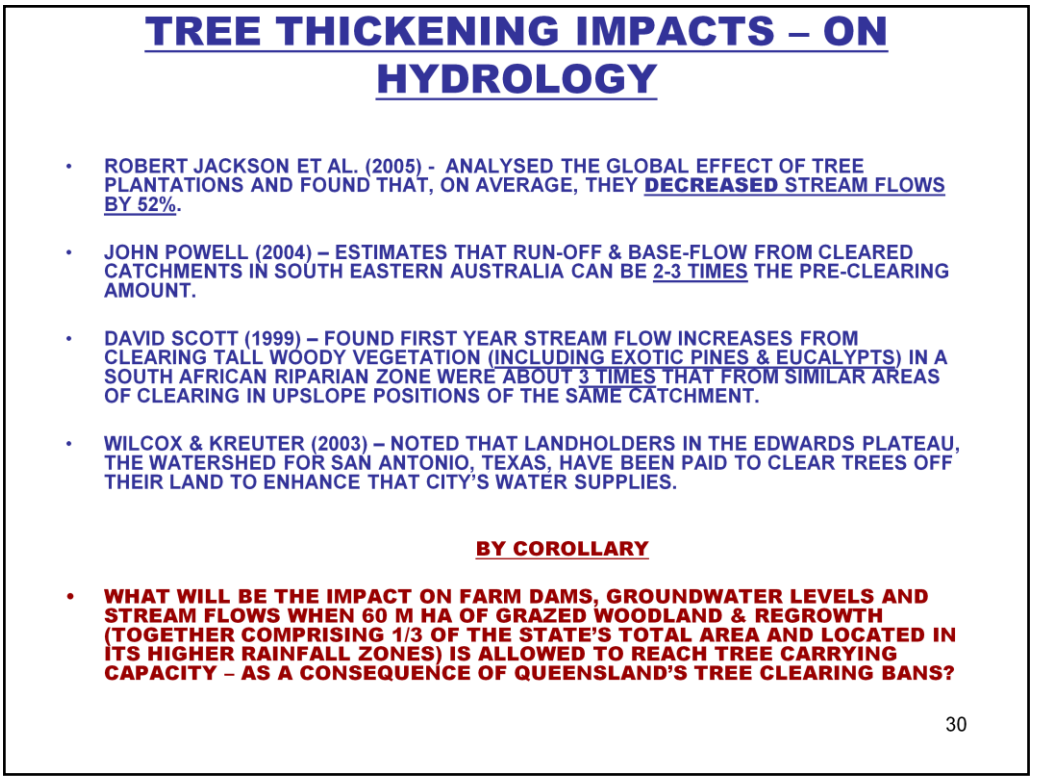
29

What are some tree thickening impacts?

There have been a large number of studies throughout Queensland which show that trees are very competitive with associated pasture (*see Burrows 2002). This diagram illustrates the generalized response in pasture yield as tree basal area increases. It is best described by a negative exponential curve. This means that the largest competitive effect from the trees occurs at quite low tree densities. [This observation helps explain why thinning does not pay –see later]. And not unexpectedly the competitive effect varies with seasonal conditions – suggesting that competition for soil moisture is a major driving variable in the relationship.

Put simply – trees use a lot of water!!

*Burrows, W.H. (2002) *Tropical Grasslands* **36**: 202-217.



Robert Jackson and co-workers analysed the global effect of tree plantations and found they decreased stream flows by an average of 52%, with 13% of streams drying completely for at least 1 year.

John Powell has estimated that run-off & base-flow from cleared catchments in south eastern Australia can be 2-3 times the pre-clearing amount.

Again David Scott found first year stream flow increases from clearing tall woody vegetation (including exotic pines & eucalypts) in a South African riparian zone was also about 3 times that from clearing similar areas of land in upslope positions of the same catchment.

And Wilcox & Kreuter reported in 2003 that landholders in the Edwards Plateau, the watershed for San Antonio, Texas, have been paid to clear trees off their land to enhance that city's water supplies.

By corollary

What will be the impact on farm dams, groundwater levels and downstream flows when 60 M ha of grazed woodland & re-growth (1/3 of this state's total area and located in its higher rainfall zones) are allowed to reach tree carrying capacity – as a consequence of Queensland's tree clearing bans?

Jackson , R. *et al*. (2005) *Science* **310** : 1944.
Powell, J. (2004) *Focus on Salt.* #30: 7.
Scott, D. (1999) *Canadian J. Forest Research* **29**: 1149-1157.
Wilcox, B. & Kreuter,V. (2003) *Proc. VIIth International Rangelands Congress. Pp. 989-996.*

TREE THICKENING IMPACTS - ON BIODIVERSITY

- **DONALD FRANKLIN (1999) – FOUND A MARKED DECLINE IN GRASSLAND BIRDS IN BURDEKIN CATCHMENT SAVANNAS OCCURRED BEFORE WIDESPREAD TREE CLEARING TOOK PLACE. IT CORRESPONDED WITH THE PERIOD OF DOCUMENTED TREE THICKENING FOR THE SAME STUDY AREA. (MEANWHILE A 2009 IBRA REPORT EQUATES SOME RECOVERY IN GRASSLAND BIRD POPULATIONS IN THIS REGION WITH 'RECENT' WIDESPREAD TREE CLEARING!!).**

- **AND GABRIELLE CROWLEY AND STEPHEN GARNETT (1988) – SHOWED THAT THE DECLINE IN THE ENDANGERED GOLDEN SHOULDERED PARROT WAS CORRELATED WITH THE INVASION OF TI-TREES INTO CAPE YORK GRASSLANDS.**

- **JODI PRICE & JOHN MORGAN (2008) - FOUND WOODY PLANT ENCROACHMENT REDUCED THE SPECIES RICHNESS OF WOODLANDS IN SOUTHERN AUSTRALIA; AND SCANLAN & BURROWS (1990) NOTED MARKED DIFFERENCES IN GROUND FLORA COMPOSITION BETWEEN TREED AND 'OPEN' AREAS IN CQ WOODLANDS.**

- **IN SHORT, TREE THICKENING (AND RESTRAINTS ON REGROWTH CONTROL) CHANGES BIODIVERSITY. IT DOES NOT NECESSARILY IMPROVE IT.**

31

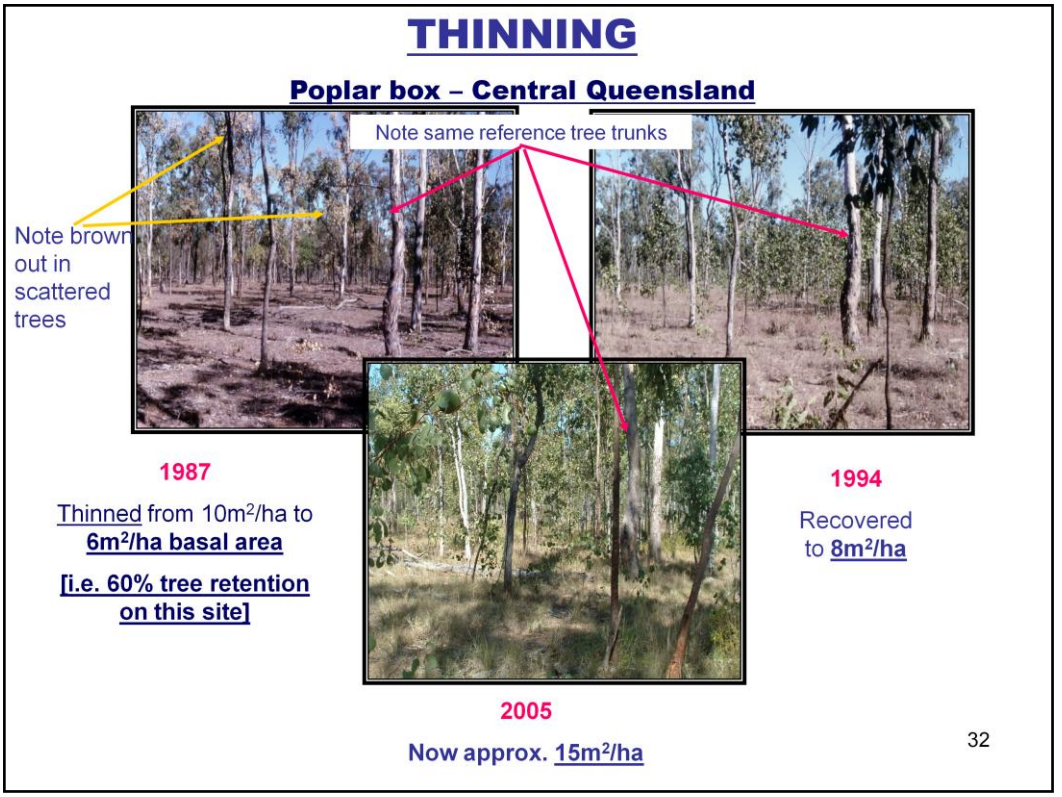
Finally, let's turn our attention to some impacts of tree thickening on biodiversity.

Crowley, G. and Garnett, S. (1998) *Pacific Conservation Biology* **4**: 132-148.

Franklin, D. (1999) *Biological Conservation* **90**: 53-68.

Price, J. and Morgan, J. (2008) *Austral Ecology* **33**: 278-289.

Scanlan, J. and Burrows, W. (1990) *Aust. J. Ecology* **15**: 191-197.

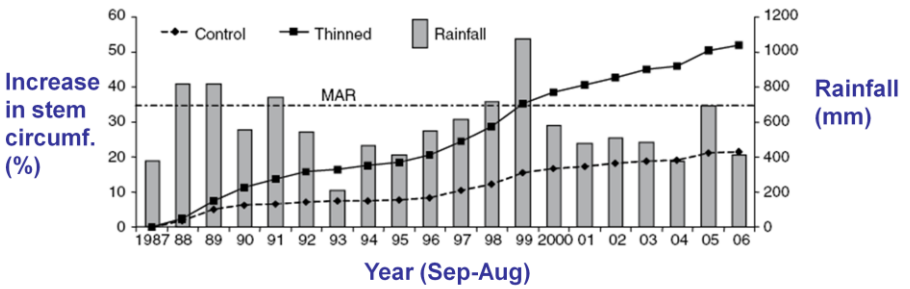


Thinning is promoted by the government as a permissible way to manage tree thickening, now that clearing bans are in place. My colleagues and I set up a long term clearing strategies trial on a poplar box woodland site in central Queensland in 1987. The results of the trial have just been published*. Thinning was one aspect of woodland management that was studied. The particular plot illustrated here was thinned from a tree basal area of 10 m^2 /ha to 6 m^2 /ha. However within 7 years basal area had recovered to 8 m^2 /ha and reached 15 m^2 /ha within 18 years of the initial thinning. This is because thinning initially reduced inter-tree competition (allowing the retained trees to grow faster) and removed older, 'slower growing' trees, which were quickly replaced by younger and more numerous 'fast growing' seedlings and suckers.

The effect of thinning on remaining (retained) tree growth is well illustrated in the next slide.

*Back et al. (2009a,b) *Tropical Grasslands* **43**: (a)37-52; (b)188-190..

HOW THINNING ACCELERATES GROWTH IN SURVIVING TREES



Cumulative increase (%) in circumference of poplar box trees over the initial values for Control (un-thinned) and Thinned (20% trees remaining) plots at 'Wandobah', Dingo. (Back *et al*. 2009b).

33

Both landholders and professional foresters routinely 'thin' forest and woodland stands by removing trees that are unlikely to provide suitable logs for milling - because of faults in their form, growth habit and so on. This also reduces competition with the retained trees and enables those retained to grow faster.

In grazing land trees are thinned to promote pasture growth. But as can be seen in this diagram the retained trees also grow faster in these situations - such that the competition with the underlying pasture is soon back to the pre-thinning levels. In this case, well before the cost of the thinning operation was recouped in increased pasture and beef production.

RESPONSE RELATIVE TO 'CONTROL' OF VARIOUS TREE CLEARING TREATMENTS ON A POPLAR BOX WOODLAND SITE IN CENTRAL QUEENSLAND.

Clearing method	NPV/ha
Control (intact woodland – initial tree basal area 10m2/ha)	--------
Retain 20% trees scattered over paddock, stem inject the remainder (= THINNING)	($21.00)φ
Retain 20% trees in intact woodland strips – tractor pull and burn the remainder	$47.00
Retain 20% trees in intact woodland strips – treat remainder with tebuthiuron (1.5kg a.i./ha)	$40.00
Retain 20% trees in intact woodland strips – treat remainder with tebuthiuron (1.0kg a.i./ha)	$63.60

Φ = Negative value

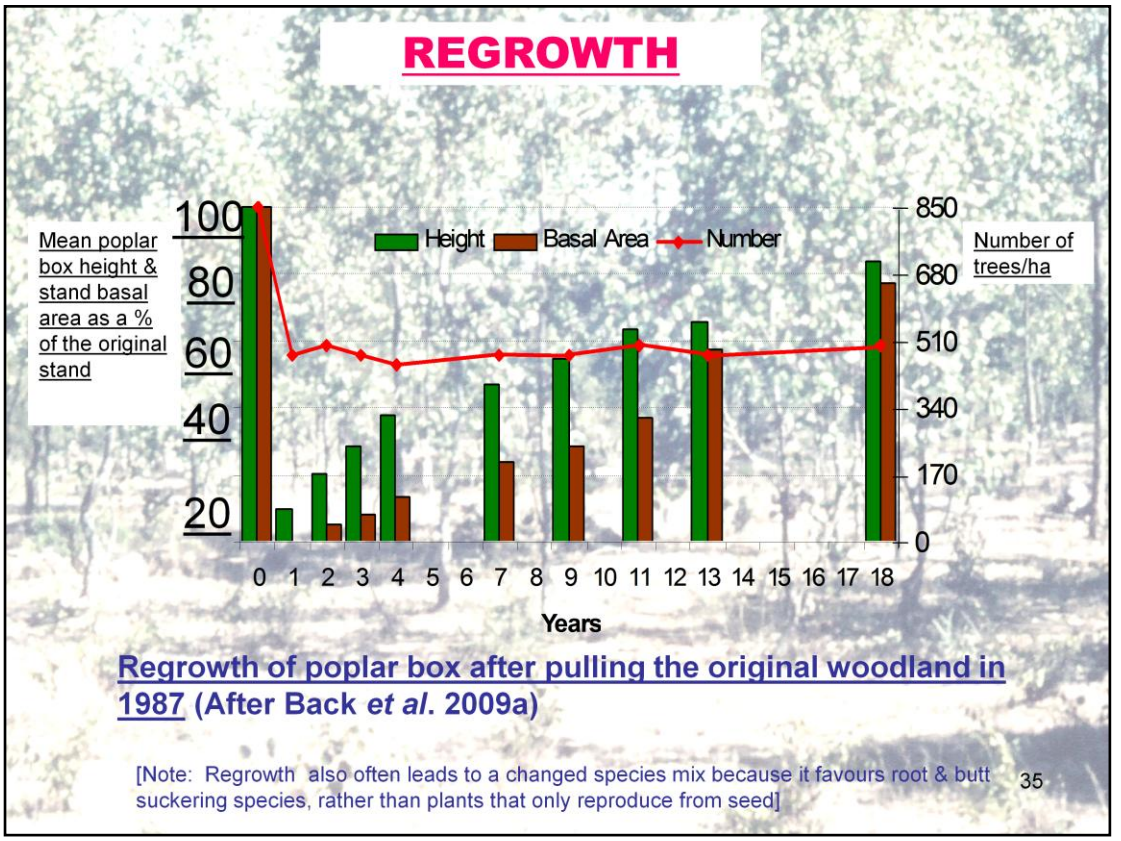
(Based on 1999 beef production costs, returns and interest rates)

34

Given the observations on the previous slides no one should be surprised that thinning does not pay on this site*. The speed of recovery in tree basal area, when trees are left scattered or 'park-like' over a paddock, is such that any short term boost in livestock production is insufficient to pay for the cost of the thinning operation (where fodder or commercial timber trees are not the targets of the thinning) – before the trees have again recovered to their pre-thinning basal area.

*For more details see:

Burrows, W. (2002) *Tropical Grasslands* **36**: 202-217.



Regrowth - after tractor pulling - was also followed in the same trial which included the previous thinning study. This clearing method was rewarding financially because - while the re-growth was still quite rapid - it started from zero tree basal area after the tractor pulling. Nevertheless the basal area of this re-growth had again reached 80% of that in the initial woodland within 18 years.

So if re-growth control is banned we can be sure that, within a maximum of 20 years, all affected re-growth on such sites will have zero grazing productivity – while at the same time it will present significant mustering problems to the livestock owner, as well as providing a haven for feral animals.

One other pertinent observation should be made - tree hollows only develop after about 50 yrs growth in eucalypts. So any fauna reliant on such hollows developing in re-growth would need to survive 50 yrs elsewhere, if the stated purpose of retaining regrowth vegetation was to provide habitat for such fauna. In short, any fauna benefitting from future tree hollows in maturing re-growth must be capable of surviving in the absence of that re-growth in any event.

REGROWTH CONTROL BANS

- REGROWTH – MAINLY EXISTS TODAY BECAUSE **TREE CLEARING OPERATIONS WERE PREVIOUSLY COUNTENANCED BY GOVERNMENT!**
- REGROWTH RARELY, IF EVER, MIMICS THE BOTANICAL STRUCTURE AND COMPOSITION OF THE ORIGINAL WOODLAND.
- **PLANTS THAT REGROW FROM ROOT AND BUTT SUCKERS ARE GREATLY ADVANTAGED AFTER CLEARING.**
- IN QUEENSLAND, BRIGALOW SCRUBS DID NOT TYPICALLY OCCUR AS MONO-SPECIFIC STANDS – BUT BRIGALOW REGROWTH FORMS DENSE CLONAL STANDS WITH LIMITED AGRICULTURAL USE.
- **ANY ALLEGED BENEFIT FOR CARBON-OFFSETS OR BIODIVERSITY BY BANNING REGROWTH CONTROL MUST MEASURE UP AS A COST COMPETITIVE LAND-USE FOR THE LANDHOLDER.**

36

Now a few comments about the impacts of controls on the clearing of re-growth.

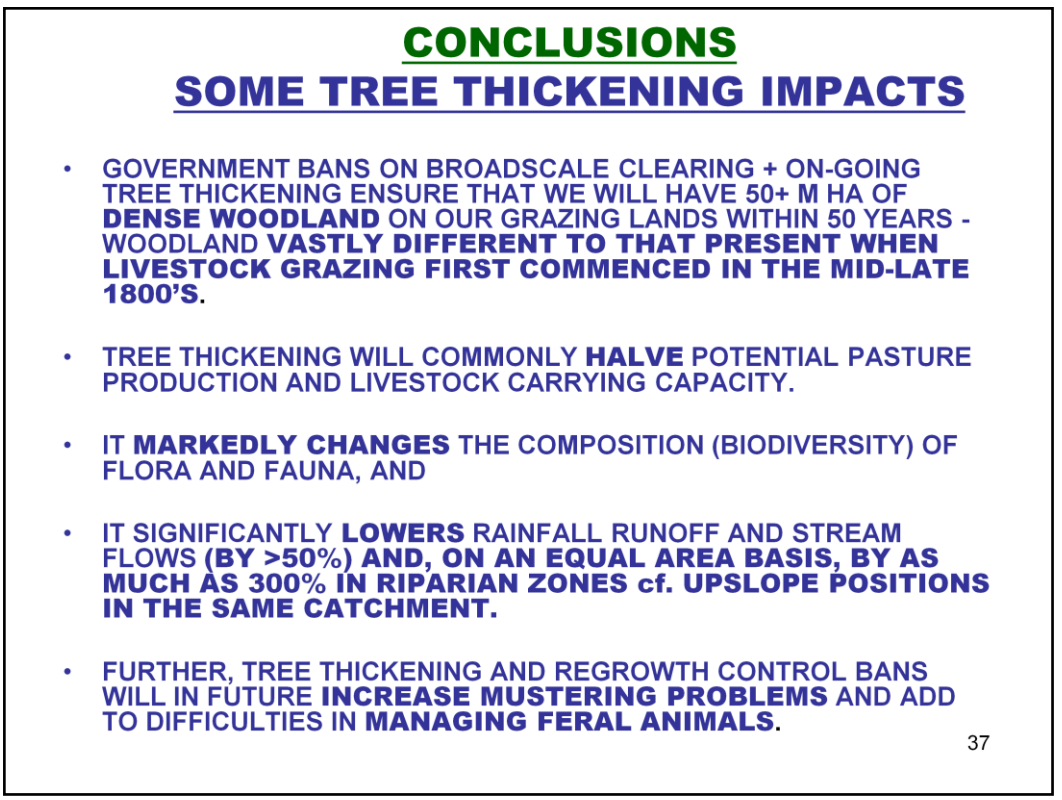
Everyone needs to be unequivocal about re-growth – it mainly exists today because tree clearing operations were previously countenanced by the Queensland government!

Once land is initially cleared (whether by bulldozer, axe or chemical methods) any subsequent re-growth rarely, if ever, mimics the botanical structure and composition of the original woodland. And of course, even the small likelihood of this happening falls away markedly with each additional re-growth control cycle. This is because generally, plants that re-grow from root and butt suckers are greatly advantaged after clearing, compared with those reliant for re-establishment on the germination of new seedlings. “First up – best dressed” is the rule of thumb in plant competition.

For example, brigalow scrubs did not typically occur as mono-specific stands – but brigalow re-growth forms dense clonal stands with limited agricultural use, even after numerous clearing attempts (John Dwyer et al. 2009).

Brigalow lands currently support >1800 enterprises in Queensland, mostly focused on beef production. Therefore any alleged benefit for carbon-offsets or biodiversity by banning re-growth control must measure up as a cost competitive land-use for the landholder.

Dwyer, J. et al. (2009) *Agriculture, Ecosystems and Environment* **134**: 1-7.



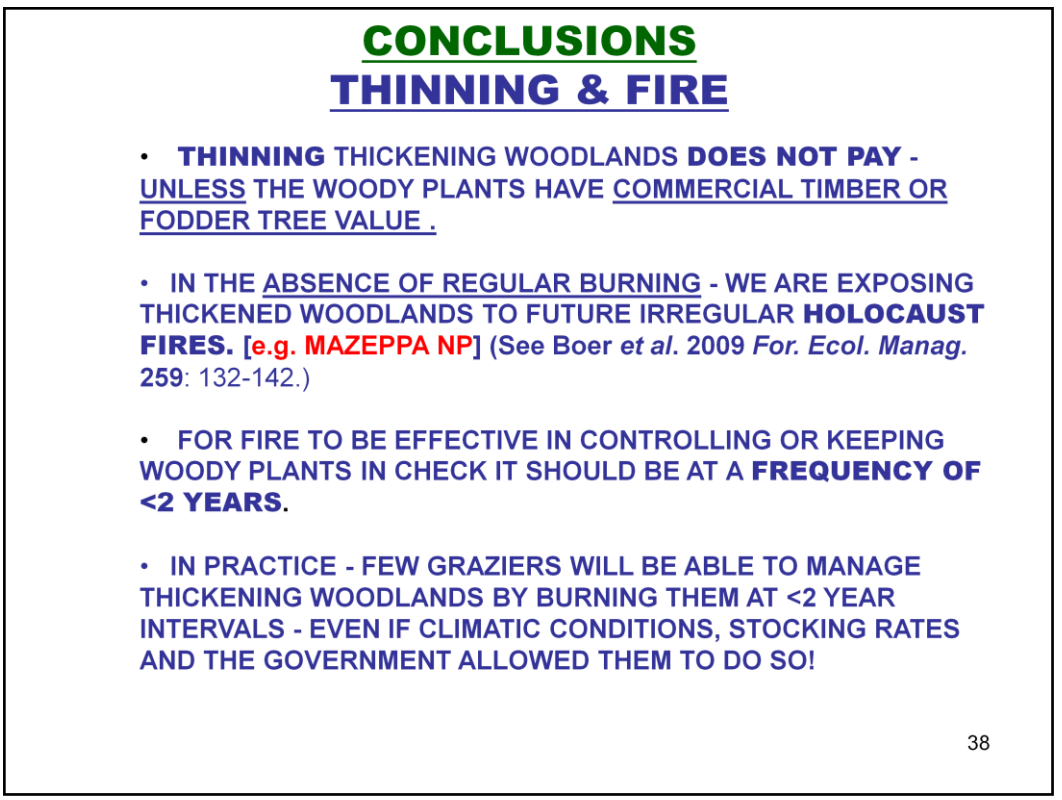
To summarize this presentation on woody plant dynamics the following conclusions can be reached.

Government bans on broad scale clearing ensure that we will have 50+ M ha of very dense woodland on our grazing lands within 50 years. This woodland will be a vastly different plant community to that present on the same landscape when livestock grazing first commenced in the mid-late 1800's.

Tree thickening is widespread in 'intact' or remnant woodlands throughout Queensland. It commonly halves potential pasture production and livestock carrying capacity.

It markedly changes the composition (biodiversity) of flora and fauna, and it significantly lowers rainfall runoff and stream flows (by >50%).

Further, tree thickening and re-growth control bans will in future increase mustering problems and add to difficulties in managing feral animals.

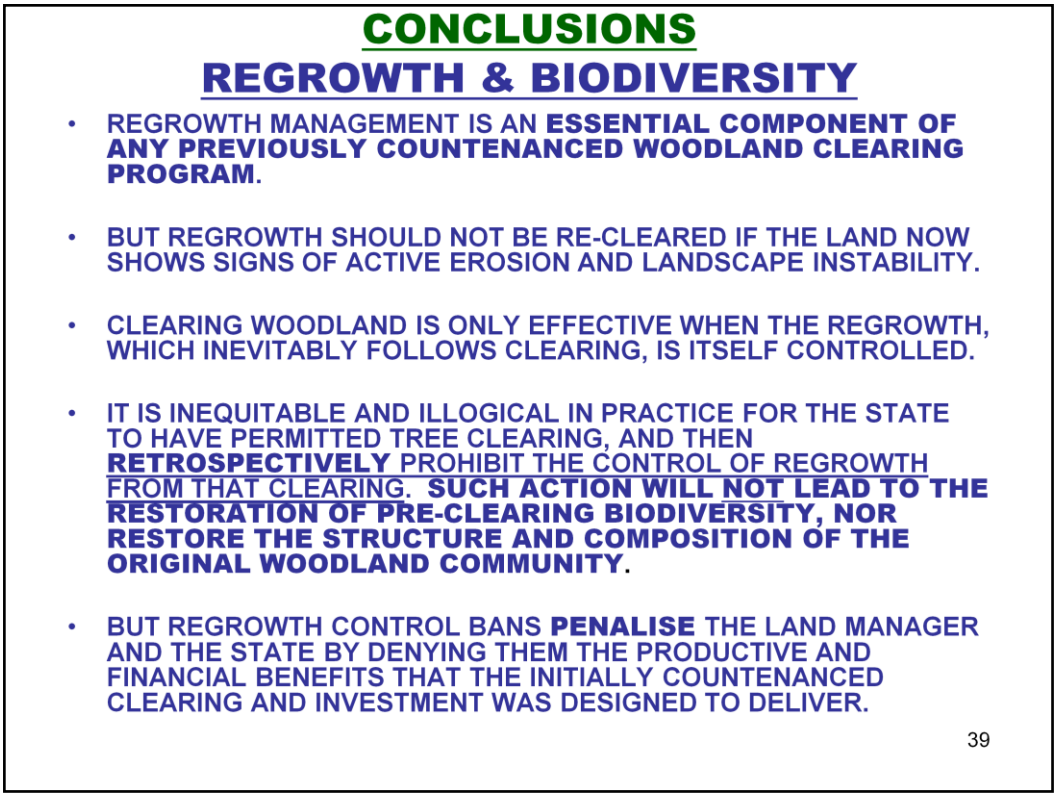


Thinning thickening woodlands does not pay - unless the woody plants have commercial timber or fodder tree value (the minority of cases).

The absence of regular burning - the cause of most tree thickening in the first place – paradoxically exposes thickened woodlands to future irregular holocaust fires.

For fire to be effective in controlling or keeping woody plants in check it should be at a frequency of <2 years. But on grazing land livestock substantially reduce the fine fuel loads that were common under aboriginal management, and which then fostered both lightning and man lit fires.

In practice - few graziers will be able to manage thickening woodlands by burning them at <2 year intervals - even if climatic conditions, stocking rates and the government allowed them to do so!



[Read slide]

The reason for these re-growth impacts is largely due to the fact that mechanical clearing tends to favour root and butt suckering species, rather than species relying on seed germination and establishment for regeneration.

So, for example, in brigalow areas belah and wilga tend to quickly disappear from the system after the initial clearing, whereas brigalow suckers profusely and often returns as a monospecific tree stand.

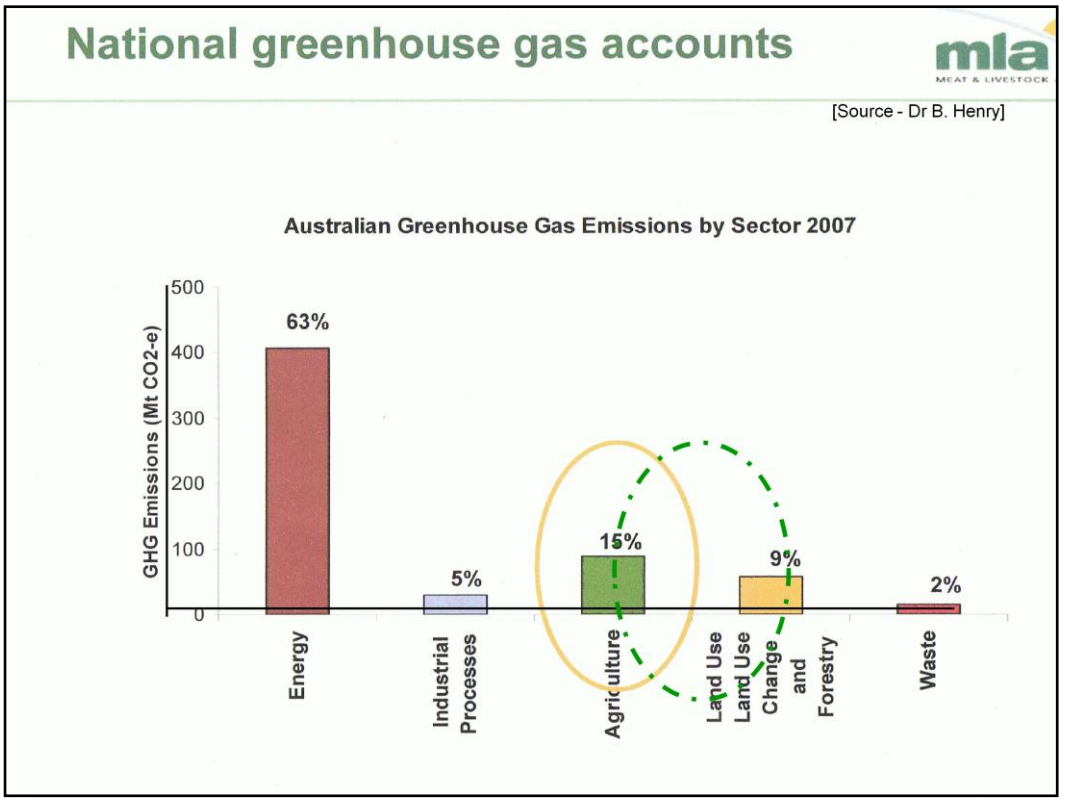
In the original mixed scrub eastern spinebills (honeyeaters) could thrive on the nectar of mistletoes commonly infesting wilga trees. There is rarely any wilga in regrowth following clearing so there is no food source for the spinebills and they do not return.

Now, I would like to give a few thoughts on carbon accounting in the agricultural cum pastoral sector.

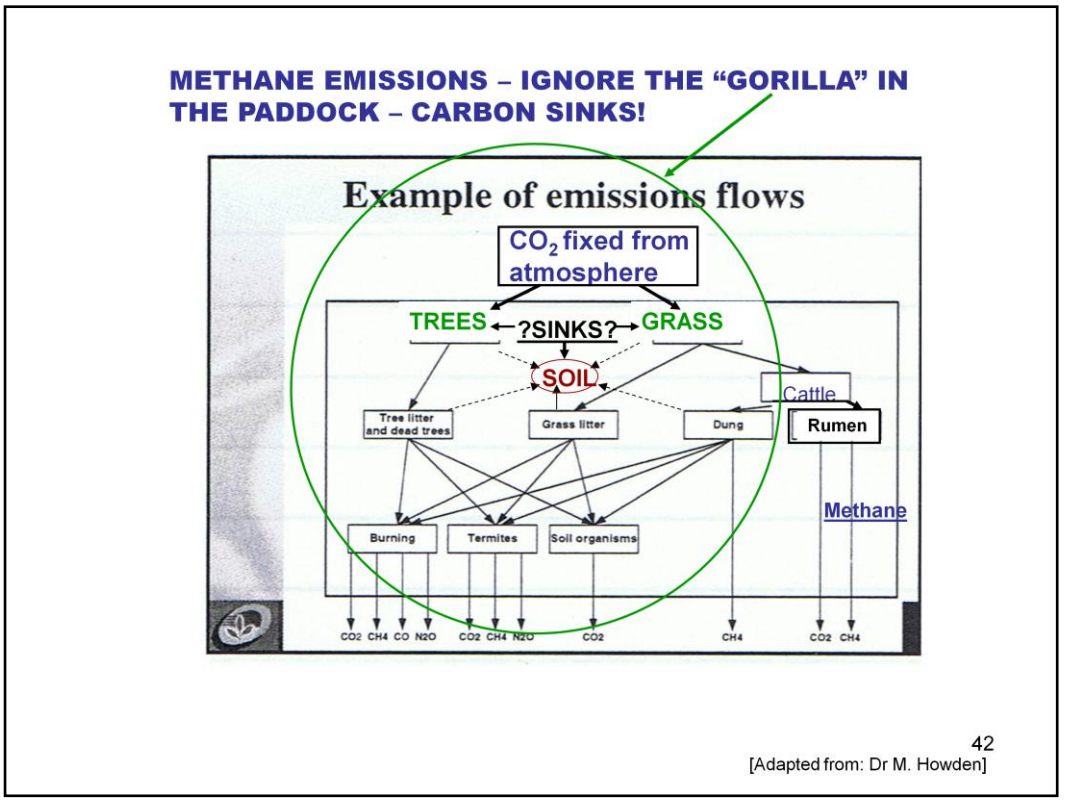
The government claims the figures it presents are based on the best estimates, and follow all the international rules, but estimates applicable to agriculture and pastoral lands are very debatable!

In my view there are many boxes ignored or only partially accounted for, such as growth in “forests”, carbon storage in soil, growth in pastures etc.. Meanwhile, up until very recently, the government continued to make noises about possible taxes on savanna burning and methane emissions from livestock if the CPRS was applied to agriculture post 2015.

The federal government ‘s current position on agriculture and the CPRS is that agriculture will be excluded from the scheme. But the opposition has announced that it will seek credits for carbon ‘sinks’ on agricultural land. Given this state of flux it is timely to briefly examine some carbon flows in agricultural systems.



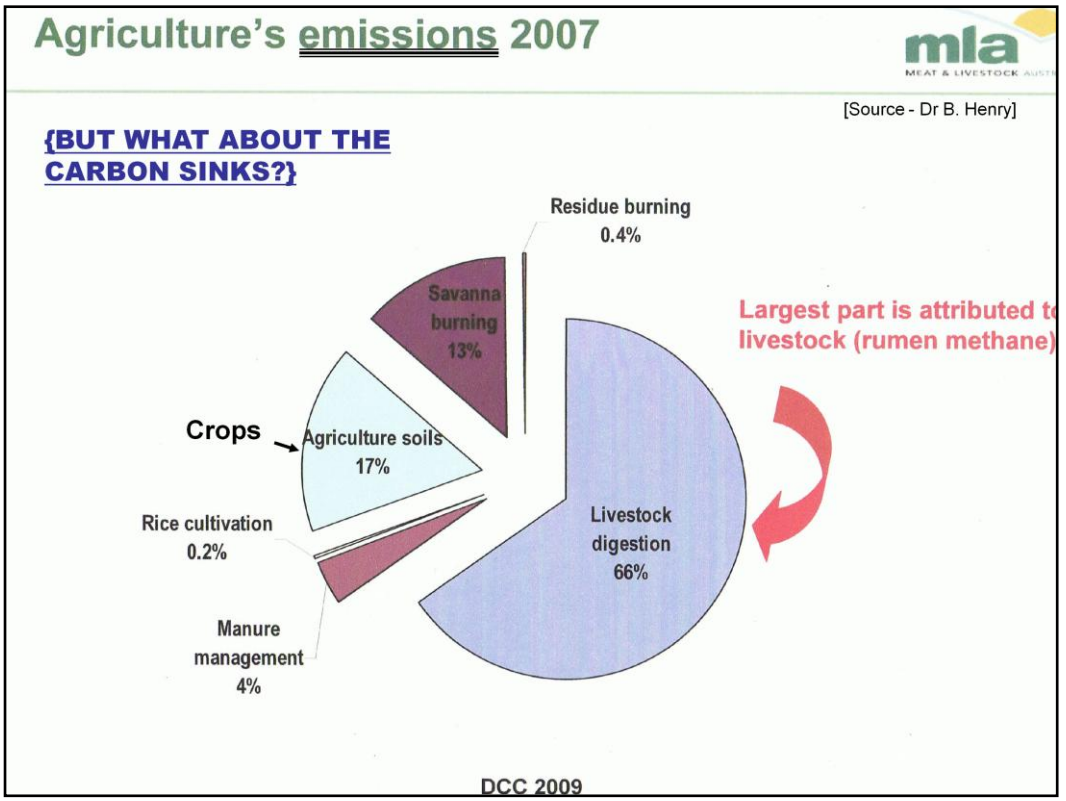
"Agriculture" is not included in the proposed CPRS but politicians still allude to possible benefits to accrue to landholders under the scheme. To me this very much remains blue sky as any credits must overcome huge measurement difficulties.



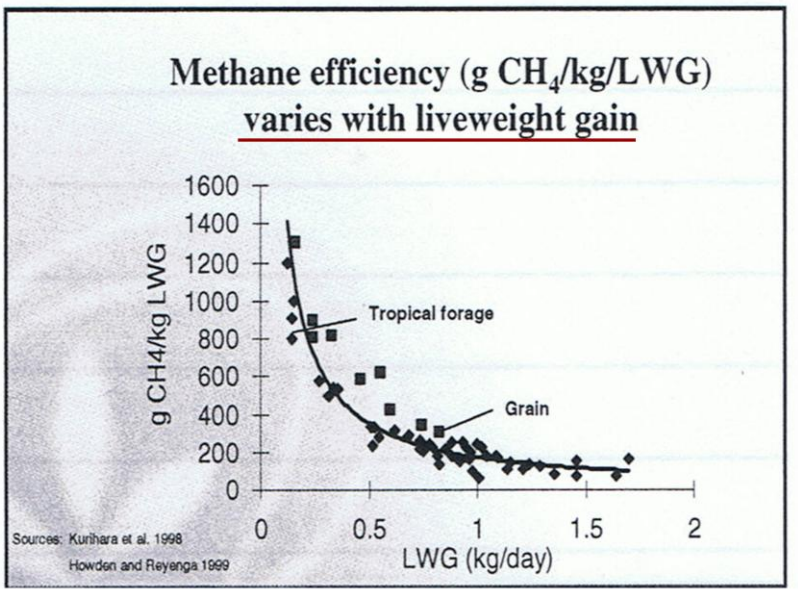
Livestock methane emissions are estimated to be about 1.5 t CO_2-e per adult beast equivalent per annum – although this varies markedly with season & food source.

Trees may fix around 0.5-1 t C/ha per year (or c. 2-4 t CO_2-e) in their above ground biomass – but this depends very much on the age of the stand, its composition, basal area, soil type & rainfall (seasonal conditions) etc. There is very little known about the gains and losses of carbon from the other "compartments" represented by the boxes in the diagram. And it would be impractical to measure most of them.

"Taxing" a landholder for methane emissions while not giving him credit for all sinks on his paddock would be the same as taxing the urban yuppie for his electricity use, without paying him for the electricity he feeds back into the grid from the solar panels on his roof! The yuppie would not let the government get away with it and neither should landholders pay a methane emissions tax unless they are also credited for all the carbon sinks on their property!



The extent of this potential 'taxing' problem had the CPRS been applied to agriculture is revealed by the estimated emissions breakdown in this pie diagram.

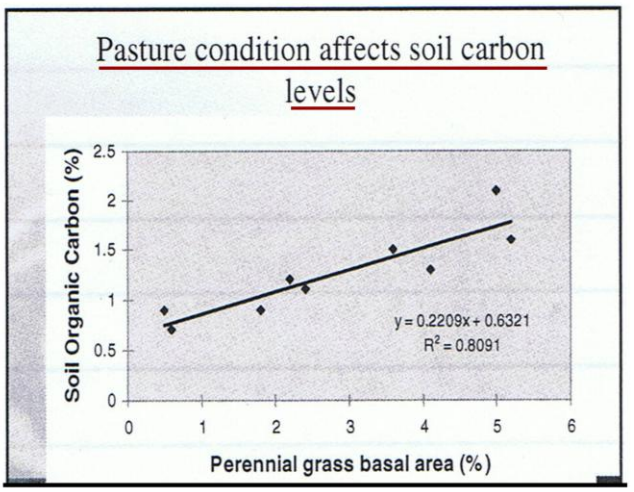


44

[Source - Dr M. Howden]

For example, a major potential problem in taxing livestock methane emissions is that it is highly variable. This slide shows that more methane is produced per kg live weight gain when animals are on poorer quality diets. At an MLA Meat Profit Day held in Roma in October 2009 Rodd Dyer presented performance data for a paddock of 387 heifers. They had an average LWG of 84kg, but the range varied from +157kg down to - 24 kg. Obviously such variable data would present huge challenges to estimating what methane tax would be appropriate to that paddock.

It should be easy to see how one could rort any system charging a methane tax – e.g. via manipulation of animal genetics, stocking rates, feed supplements and hormone implants etc. in your monitored paddock. [Assuming one let the government charge a methane emissions tax without giving you credit for any carbon sinks in the same paddock in the first place].

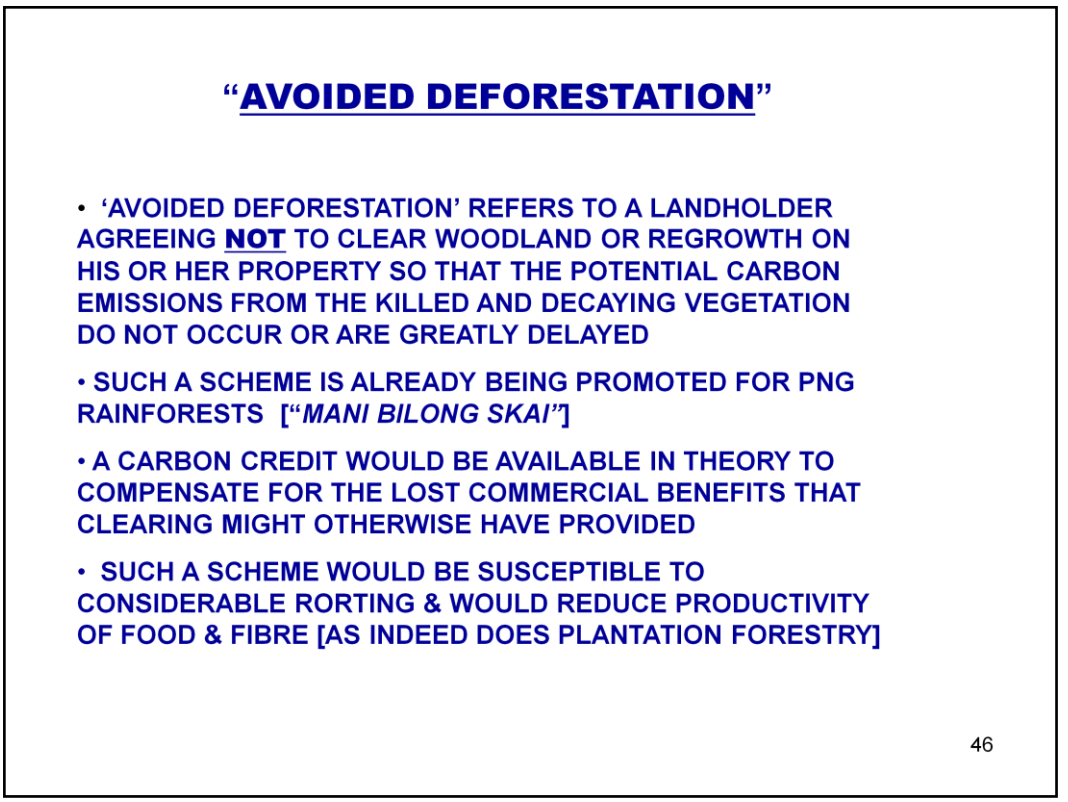


45

[Source - Dr M. Howden]

There also appears to be a growing recognition that if agriculture was to be included in either the government's or opposition' s response to greenhouse gas abatement proposals then changes in soil carbon will have to be accounted for.

However I believe it is impractical to measure fluxes in soil carbon over time at a landscape ('rural property') scale. About 100 soil cores/ha would need to be taken and analysed across rooting depth intervals at each sampling to provide confidence in the repeatability of estimates. [Because of this impracticality a prominent soil carbon expert (Dr Myles Fisher) has suggested that a surrogate measurement – livestock weight gain - might be appropriate, but this itself could be subject to manipulation (e.g. via animal genetics, stocking rates, feed supplements and hormone implants) to give inflated estimates of carbon fixation.]



"Avoided deforestation" is the latest in a long line of carbon "credit" promises held out to rural landholders.

Any estimate of above ground carbon fluxes in vegetation is challengeable as to its net sink or source effect if it cannot also account for soil carbon leakage or gains ("spillovers"). So, in the unlikely event that carbon offsets from accruing re-growth could be sold in the market place, they would have to be capable of surviving scientific audit as to the net (soil+vegetation) effects, in addition to all internationally accepted rules that are adopted.

In short, I believe that any attempt to justify a ban on re-growth control on rural lands, for example, on the basis that it could be marketed as a carbon sink is fraught with measurement difficulties. Any such scheme is wide open to rorting. It would be a scam capable of making Bernard Madoff blush. Further, 'avoiding' clearing re-growth is no different in principle to not clearing 50 M ha of intact woodlands which we know are still growing ("thickening") in Queensland alone.

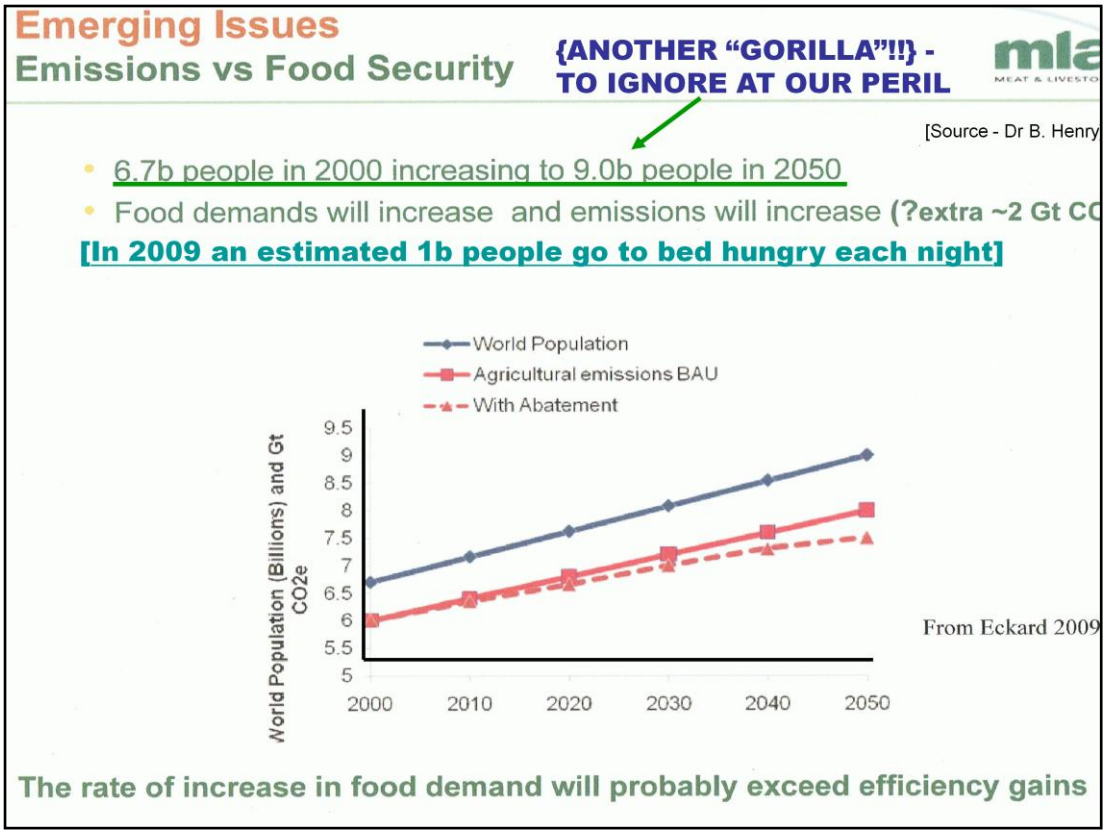
In the Weekend Australian 5-6 September 2009 Rowan Callick (Focus 13) provides an insight into the current marketing of carbon credits in return for saving ancient rainforests from destruction in PNG. In that country it is known as *mani bilong skai* – sky money – because it appears to be selling air. Not surprising I suppose from a country that co-invented the "cargo cult".

"OFFSETS"

- OFTEN PROMOTED AS A GREAT OPPORTUNITY FOR RURAL LANDHOLDERS TO MAKE MONEY OUT OF EMISSIONS TRADING.
- BUT OVER THE LONG TERM OFFSETS CAN HAVE LIMITED IMPACT ON TOTAL EMISSIONS (THEY ENABLE SECTORS COVERED BY THE **ETS** TO NOT REDUCE THEIR FOSSIL FUEL USE, WHILE RELYING ON 'AGRICULTURE' FOR A SUBSTITUTE EMISSIONS REDUCTION - WHICH IS NOT PERMANENT AS e.g. TREES ARE EVENTUALLY HARVESTED OR DIE)).
- ALSO OFFSETS ARE ALWAYS DEFINED RELATIVE TO A COUNTER-FACTUAL i.e. RELATIVE TO WHAT WOULD HAVE HAPPENED IF THE LANDHOLDER WAS NOT PAID FOR HIS 'SINK'. FOR EXAMPLE, THE PLANTATION COMPANY, ITC, MIGHT SEEK AN OFFSET PAYMENT FOR ITS GREENLAKES (CENTRAL QUEENSLAND) TREE PLANTATION – BUT IT HAS OR WOULD HAVE PLANTED THE TREES IRRESPECTIVE OF THE OFFSET PAYMENT. **[DOUBLE DIPPING?]**
- VERIFIABILITY IS A HUGE PROBLEM FOR ANY OFFSET PROJECT. ACCURATE MEASUREMENT OF SOIL CARBON IS EXTREMELY DIFFICULT AT THE LANDSCAPE, PROPERTY AND PADDOCK SCALES. YET REPEATED, RELIABLE MEASUREMENTS ARE ESSENTIAL TO GAUGE WHETHER CLAIMED OFFSETS HAVE ACTUALLY BEEN ACHIEVED.
- BECAUSE OF THE SCALE OF POTENTIAL PAYMENTS INVOLVED NO GOVERNMENT COULD COMMIT TO ANY 'CARBON OFFSET SCHEME' UNLESS THE SCHEME COULD SURVIVE RIGOROUS FINANCIAL AND BIOLOGICAL AUDIT. IN MY OPINION THIS IS A LONG WAY OFF!!

47

Read slide



The only sustainable agriculture is profitable agriculture. Yet government's seem to give scant recognition to this fact. e.g. Queensland has banned broad scale clearing on about 50 M ha of grazed woodland that currently supports 2-3 M cattle equivalents. This carrying capacity will drop markedly as woodland thickening continues.

Meanwhile, there is a great moral imperative confronting the world which most of us studiously ignore, as we turn off the lights each night. This is that in 2009 one billion of our fellow humans went to bed hungry.

Yet it is a demographic certainty that the world's population will increase by a further two or more billion people by the year 2050. None of us has the right to condemn these people, who will include our own descendants, to a lifetime of hunger and/or potential conflict that that hunger implies.

All politicians who, by virtue of their decisions & policies, allow land to be taken out of agricultural production, for whatever reason, have the heavy hand of this already known development in world population resting on their shoulders. Let's hope they gain wisdom & take more time to think it through!

THANK YOU!