Northern Guinea Savanna Zone of Nigeria. *P. curatellifolia* was the most preferred species at the time the palatability study was conducted and both young and old leaves were grazed. This may account for its rare to occasional occurrence in areas where the Fulani herdsmen grazed their cattle. Agronomic studies could not be conducted on this species as fruits had been eaten by monkeys and no seed could be collected. Plants of *P. curatellifolia* could be protected and seeds collected for further study. The possibility of establishing stands from vegetative materials should also be investigated. Some of the more palatable species were not included in the agronomic studies because they were thorny (*Dichrostachys cinerea*), grew into tall trees (*Terminalia avicinoides*) or were of economic importance (*Butyrospermum paradoxum*).

The agronomic studies indicated that the local species could be successfully established from seed. Two other species native to West Africa *D. velutinum* and *F. macrophylla*, would seem to hold even greater promise as dry season browse plants than *S. schweinfurthii* and *D. scorpiurus*. Further agronomic and feeding studies should be conducted to evaluate the promising species. Methods of seeding selected species into the savanna will have to be found. The search for potential forage plants needs to be intensified.

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PROCEEDINGS

TREE DIEBACK AND ITS EFFECT ON GRAZING IN QUEENSLAND FIELD MEETING—BRISBANE VALLEY—MARCH 30TH, 1984

The meeting was held on the problem of tree dieback and its interaction with grazing management of pastures. The problem was defined with roadside stops near Esk in the morning, and then a visit to the property "Inverstanley" to inspect an experimental planting of trees with potential value for re-afforestation.

INTRODUCTION TO DIEBACK IN NATIVE TREES

R. WYLIE

Queensland Department of Forestry, Indooroopilly

Dead or dying native trees are now common in many parts of Queensland. The problem of dieback is not a new phenomenon, it was widely reported throughout Australia around the turn of the century. However, its incidence has been markedly on the increase in the last 10–15 years in several states including Queensland.

In southern Queensland, dieback is particularly noticeable among forest red gum, grey ironbark, narrow-leaved ironbark, silver-leaved ironbark, spotted gum, red bloodwood, yellow box and river sheoak. Other tree species are also affected, including commercially important timber species.

Dieback is the progressive dying back of tips or branches in the crown of a tree which, if unchecked, may lead to tree death. A tree with severe dieback in its crown has mostly dead and leafless minor or major branches. The remaining crown is composed largely of secondary or "sucker" regrowth on branches or trunk.

It is important to understand that dieback is better described as a condition rather than a disease (although disease may be involved).

Causes

A combination of factors is usually involved in dieback, generally over a long period. For example, selective clearing of native forests for cultivation or grazing will drastically alter the environment of the remaining trees. These trees either adapt to their new conditions, or remain permanently stressed and prone to insect injury or disease. With old trees, any environmental change may be enough to cause decline or death.

Some trees may be more affected than their neighbours on the same site because of differences in their vigour, species, degree of disturbance or position.

Examples of factors which contribute to tree decline in Queensland are:

- overclearing of native vegetation (increases exposure);
- increased streamwater and soil salinity as a result of overclearing;
- defoliation by insects (e.g. leaf-eaters, sap-suckers);
- pathogens of roots and leaves (e.g. Phytophthora root-rot);
- climate (drought, flood, waterlogging, fire, lightning, hail etc.);
- excessive or improper application of herbicides;
- stock damage (rubbing, soil compaction, excreta accumulation);
- nutrient changes favouring insects (e.g. improved pastures, fertilisers);
- reduction in populations of insectivorous birds;
- reduction in populations of parasites of leaf-feeding insects (loss of nectar sources for some adult parasitic insects);
- mistletoe;
- old age.

Why is dieback important?

Until recently, dieback was mainly an aesthetic problem. However, studies in areas with serious tree loss have revealed grave economic problems for both rural and urban communities. For example, dieback can result in:

- higher soil and streamwater salinity affecting productive valley floors;
- more landslips on hill-slopes causing damage to roads and property, silting-up of streams and reservoirs;
- greater soil erosion by wind and water;
- more stream bank erosion and blockage of waterways by fallen trees;
- loss of stock shade, windbreaks, pasture shelter and fodder trees;
- loss of valuable timber resources (commercial timber species, farm fencing and building materials);
- loss of wildlife habitat (particularly for insect-eating birds);
- loss of honey production.

What can be done about dieback?

Because of the many factors involved, it is unlikely there will be a single cure for the problem. We must understand the dieback mechanisms operating, so that the causes and not just the symptoms are treated. With knowledge of how to keep trees healthy, we can act to arrest the decline and to re-establish tree cover on denuded and degraded lands.

Achieving these goals is the responsibility of the whole community and requires a co-operative effort by government, scientists and landholders. In Queensland, a state government committee on tree decline in rural areas has been formed and has already undertaken a number of field surveys and studies aimed at identifying problem areas,

tree species affected, factors contributing to tree disorder and community attitudes to trees and tree decline. Landholders have been asked to help in devising feasible solutions to the problem.

Community groups and individuals are also involved in tree planting programmes and efforts are being made through the media and special publications to promote awareness of the problem.

There is no doubt that any solutions will include radical changes in attitudes towards the role of trees on rural lands and in some land management practices. To prevent further land degradation and loss of long-term productivity, and to also maintain an ecological balance will require careful planning.

Hope for a solution to dieback depends on a thorough re-assessment of the role of land use generally, and of trees in particular.

DIEBACK IN TREES—ESK REGION

R. WYLIE

Queensland Department of Forestry, Indooroopilly

Dieback is very evident in the Brisbane Valley partly because of its long history of settlement, with clearing starting in the 1840's, extensive clearing at the turn of the century and another round of intensive clearing in the 1970's. The scattered, isolated trees left in many of the paddocks in the district are at high risk to dieback. Climatic changes can be a triggering factor to dieback and the recent periods of extreme wet (waterlogging in areas) followed by extreme drought has probably made many trees in this district more susceptible to dieback.

A pivotal factor in dieback is the density of trees left after clearing, more information is needed but the indication is that they should be left in clumps, perhaps as large as 4 hectares in area. A range of trees species should be left because insects, which can predispose trees to dieback, usually flourish on a monoculture. Provided sufficient trees are left then natural regeneration from seed can maintain trees in the area. However, if trees are sparse in the paddock and grazing is heavy then areas around the existing tree(s) may have to be fenced-off for perhaps up to 5 years to allow seedling trees to establish. Insects favour trees under stress, apparently because the foliage is of higher nutritional quality (usually high in nitrogen), and this exacerbates the original problem causing more severe dieback.

IMPORTANCE OF TREES FOR CATTLE

J. J. DALY

Department of Primary Industries, Brisbane

In property development, the importance of shade tends to be overlooked. Water for stock is obviously of prime importance and usually has the highest priority, once watering facilities are developed to a satisfactory level the next priority is more and better feed. So country is cleared to make way for more grass and trees for shade or shelter are an after thought or are not considered at all. Cattle can survive without shade so how important is it? There are some indications that they would do better with it.

Their daily activities are walking, grazing, drinking, ruminating and resting. When these are done, and the time taken, depends on the environment. Typically, in extensive areas they have three main grazing periods interspersed with

resting/ruminating periods of various durations. The first grazing period commences in the early morning, peaks around 8 a.m. and ends as the day heats up. Then from around 10 a.m. to 3 p.m. cattle rest at watering points and in the shade if available. As the afternoon cools off, cattle move out to graze reaching a peak of activity around 6 to 7 p.m. This is followed by a rest/ruminating periods of 2–3 hours and a third grazing period that peaks around midnight.

Shade-seeking in the day is influenced by temperature and humidity and the degree of stress experienced by different types of cattle. Calves and pregnant and lactating cows are more stressed than other types of stock and seek shade earlier. Tropical breeds are more heat tolerant and seek shade later than British breeds. At South Johnstone, Shorthorn steers use shade for 9–11 hours a day in the summer. This declines to 7 hours in the autumn and in June they do not seek shade at all.

In the extensive areas, cattle on average graze for 42% of the time, ruminate for 27%, rest for 23% and walk for 8%. Ruminating is the second most important function and the time taken depends on the quality and quantity of feed available and the grinding required. Cows ruminate for around 8 hours a day when on poor feed and only 5 hours on good feed.

Ruminating increases energy needs by 5% and in hot conditions with no shade, cows stop ruminating to reduce stress. The incidence and duration of night rumination is increased. This interferes with the grazing and resting/ruminating sequence and must reduce the rate of digestion and food intake—performance must suffer. Shade encourages a more appropriate distribution of time spent ruminating.

Shade also has significant effects on calf survival. Calves are more susceptible to heat stress because they have an undeveloped heat regulating mechanism at birth. In N.W. Queensland, 10% of calves born are lost before branding, mostly in the first week of life through heat stress. In this type of country the most significant factor effecting calf survival is whether a cow calves during the day or night. Night calving is a calf health hazard because the cow may calve some distance from shade and the new-born calf will not move far during the first few days. If the cow calves during the day, chances are that she is in the shade or close to it if it is available in the paddock.

At Belmont near Rockhampton in a less stressful environment, 5% of calves born are lost in the first week of life. Mortalities were greatest amongst small calves. Work at Belmont has also shown cow fertility decreases as body temperature increases under heat stress. The reduction in fertility is the same for Tropical and British breeds but Tropical breeds have higher fertility levels at any given body temperature. In all breeds the depression in fertility for every 0.1 °C increase in body temperature rises progressively from 0.9% when rectal temperature is 39 °C to a reduction as high as 3.5% for every 0.1 °C when rectal temperature approaches 41 °C.

Heat stress increases the length of the oestrus cycle, reduces the intensity of oestrus and increases the incidence of night oestrus. All these influences decrease the chance of a cow getting in calf. If a cow does get in calf, heat stress can cause embryonic death and terminate the pregnancy. If the embryo survives, heat stress can result in undersized calves that have a high mortality rate.

All phases of reproduction are probably vulnerable to heat stress. Obviously there is a need to select for heat tolerance and the culling of cows that fail to calve will assist this. There is also a need to modify the extremes in the environment and leaving trees to provide shade and shelter will assist this.

The area grazed by cattle in the more extensive areas is influenced by the palatability of the grasses, location of water and shade, topography and weather. The location of water and shade influence where cattle graze and the extent of over and undergrazing. In areas with few trees, large numbers of cattle will often congregate around unshaded watering points even though shade is available some distance from the water. Observations by Schmidt at Alroy Downs in the Northern Territory indicate that water is an inferior substitute for shade. Cattle that habitually camped in shade away from water were in much better condition than those who camped on water without shade during the heat of the day.

In conclusion, cattle production will improve if heat stress is reduced. Heat stress can be reduced through:

(1) Breeding heat resistant animals.
(2) Providing shade and shelter for more susceptible animals—calves and cows.
(3) Considering trees and shade in relation to distribution of watering points and additional fencing.
(4) Modifying cattle handling to reduce stress.

DIEBACK AT "INVERSTANLEY"

R. McConnel

"Inverstanley"—Murrumba

The property was one of the earliest settled in the district and was heavily ringbarked in the 1850's and 1870's being left with a park-like appearance. The severe drought of 1902 killed many more trees and since then dieback has made severe inroads into the few trees left. The region has a good rainfall, allowing good grass growth and heavy stocking rates resulting in a minimal amount of tree regeneration. Increase in tree numbers could be achieved by fencing areas from cattle around the few healthy old trees that still remain. Fire through the long ungrazed pasture would then be a major risk to the young tree seedlings. Many areas are, however, too denuded of trees to allow natural regeneration and a tree planting program will be needed. Test plantings of a number of species have recently been made.

PROPERTY TREE PLANTING PROGRAM

D. Cameron

Division of Forestry, C.S.I.R.O., Brisbane

Little work has so far been done to examine the requirements for tree re-establishment on properties in relation to site preparation, planting methods, species, fertilizer and post-planting management. Site will obviously depend on the purpose of the planting but consideration should be given to position in relation to ease and cheapness of the extra fencing (e.g. use a paddock corner) required during establishment years and perhaps also ease of controlling unwanted grass fires. Ideally, seedling trees should be about 30 cm in height and planted when soil is moist with perhaps some advantage gained by a mulch around the base. Burning the paddock before planting to reduce competition from tall grass is probably counter-productive because it removes some shelter and protection given to the young trees. Spraying with 'round-up' around the planting positions just before planting may reduce the initial grass competition. A dressing of general fertilizer (N, P, K) of about a handful per tree is recommended. The experimental plot here comprises about two hectares with 17 tree species planted in January 1983. The species are *Eucalyptus cloeziana* (Gympie messmate), *E. maculata* (spotted gum), *E. tereticornis* (forest red gum), *E. camaldulensis* (Murray R. red gum), *E. argophloria* (Qld western white gum), *E. crebra* (narrow leaf red ironbark), *E. drepanophylla* (Qld grey ironbark), *E. moluccana* (grey box), *E. tessellaris* (Moreton Bay ash), *E. propinqua* (grey gum), *E. sideroxylon* (red iron bark), *E. pilularis* (backbutt), *Casuarina cunninghamiana* (river oak), *C. torulosa* (forest she-oak), *Flindersia australis* (crow's ash), *Melaleuca leucadendron* (white tree) and *Leucaena leucocephala*.

The best of the species are now 1–1.5 m high 15 months after planting even though they experienced severe drought in the first few months. Only a small range of potential species have been included in this trial, the most promising so far are spotted gum, Gympie messmate, Casuarina and Leucaena.

This planting is co-operative between Australian Forest Development Institute, Men of the Trees, Institute of Foresters of Australia, State Department of Forestry and Primary Industry, CSIRO, and the property owner. So far there has been little evaluation of species suitable for the Brisbane Valley but currently an organization "Greening Australia" is evaluating 92 tree species in the Fassifern Valley on various soil types. It is hoped to increase the tree planting to assess as many as 150–200 species in due course.

TREES AND EROSION

D. HOUGHTON

Department of Primary Industries, Ipswich

Minimizing soil erosion is one of the main reasons given for keeping trees in the paddock. Shelter belts help reduce wind erosion problems with wind velocity lessened for a distance up to 25 times the height of the trees. Trees lessen surface runoff in many instances and when retained at the heads of gullies and on tops of ridges then the risk of gully erosion is greatly lessened. Tree clearing should be restricted to slopes less than 18%, keeping the trees on the steeper slopes will reduce the risk of landslips. Trees for this purpose should have a good canopy and be deep-rooted.

Trees are obviously helpful in maintaining streambank stability but they should be cleared from the bed of the stream where they may divert water towards the bank and create problems of erosion. Callistemons and Casuarinas are very useful trees for controlling erosion of streambanks. Willows are often less useful because overhanging branches in the stream may cause eddies towards the bank and erosion downstream.

The value of trees in lessening sheet erosion is less clear than for wind, gully or streambank erosion. Generally, a good pasture cover is at least as effective or often more effective than a dense stand of trees in stopping soil wash. Many types of trees are shallow-rooted and extract water from the surface soil resulting in sparse ground cover of grass and a high potential for sheet erosion (Moreton Bay ash and spotted gum are two examples). However, other tree species which are deep-rooted do not give this problem and protect the soil as well as allowing grass growth under the canopy (e.g. narrow leaf ironbark and blue gums). More shade-tolerant grasses are an advantage for use with trees to give a better ground cover and a good example is green panic which grows particularly well under shade. Trees do lessen surface run-off, and so as long as they do not create large bare soil areas under their canopy they should help control sheet erosion problems.

Finally, overclearing of trees can cause salinity problems downslope and in local streams. The extent of this problem depends on the soils and geology of the region and in the area of the Brisbane Valley where we are now, salinity would not be a problem. However, in the Gatton area the underlying geology makes the region prone to salting and any increase in tree clearing has accentuated salinity problems.

REVERSING THE RESULTS OF DIEBACK

P. JOHNSON

Department of Primary Industries, Brisbane

In severely denuded areas such as at "Inverstanley" and other parts of the Brisbane Valley, rehabilitation mostly requires a tree planting program. This needs co-operation between landholders and interested organizations and of course an infusion of money. This is what happened with the trial plot, with quite a few interested groups taking part. Some Federal financial help is available, firstly through a National Tree Program to aid tree planting with funds usually being allocated for group efforts or to

local councils, and secondly by providing labour through the Commonwealth Employment Program. Local groups can apply for labour to help re-afforest and the program in the Fassifern Valley organized by Greening Australia is an example of the latter arrangement.

A number of useful books are available on trees and also the first issue of the Queensland Agriculture Journal Vol. 1 (No. 1) in 1984 is entirely devoted to "Agro-Forestry" and is highly recommended.

The following books may be useful to landholders and groups contemplating tree planting programs:

"Growing Trees on Australian Farms"
A. Brown and N. Hall (Aust. Govt. Printer) 1968
"Australian Trees. A guide to their Care and Cure"
P. W. Hadlington and J. A. Johnston (N.S.W. Univ. Press) 1977
"Caring for Young Trees'
N. Inall and R. Drynan (Aust. Broadcasting Comm.) 1983
"Trees and Shrubs for Queensland"
(Dept. of Forestry) 1982
"Wildlife in the Paddock"
R. Breckwoldt, Aust. Natl. Sci. Library (Angus and Robertson) 1983

A number of points arose in the question time following the afternoon talks and these are briefly summarized below:

Role of exotic trees: These will be tried in due course in the Fassifern Valley trial but seed of them is usually difficult to obtain. *Pinus caribbea* is a possibility.

Influence of yearly burning on seedling regeneration: This usually causes damage to young trees and its long term effect on the pasture is now being questioned. Undoubtedly in the short term a green pick of feed is valuable but this may lead to overgrazing of the ridges and accelerated paddock erosion. Consideration should be given to burning less frequently and then only the tall grass on the flats and in the gullies—urea/molasses supplementation to improve feed utilization might be considered as an alternative to burning.

Herbicides to control grass competition around tree seedlings: Round-up can be used for short-term effect and with exotic trees Atrazine is also used for long-term residual effect. Atrazine however can damage Eucalypts, even if it is not directly sprayed onto plants (e.g. by accident) it can wash down to the roots and affect the trees. Many new herbicides are being tested but none so far that will not damage young trees.

What area of trees should be left: One study inland from Rockhampton is country with *Eucalyptus crebra*, *E. papuana* and *E. populnea* suggested that one-fifth the area should be left uncleared in perhaps a belt 100 m wide on the contour rather than scattered clumps. Much more study is needed on this point.

Incentives to reduce tree clearing: In the past there have been tax incentives to promote tree clearing and pasture development. Perhaps we need to look more critically now at tree clearing and in some areas we may need tax incentives to encourage tree planting. Probably also needed are education programs and wider publicity of the effects of dieback to convince more people that a potential problem is arising from severe deforestation in many areas.

To clear trees or not: To balance the day's discussion we should perhaps moderate the feeling that all tree clearing is bad—the key issue is really *OVERCLEARING*. Clearing trees is of great benefit to grass growth and is a sensible property management to increase beef production. In fact on many properties sucker regrowth is a major problem rather than a desired feature to help keep a satisfactory tree population. As with all biological systems, the key factor is to maintain a suitable balance. The property manager has to consider why and where trees should be left, what species, and how to maximise the advantage of clearing against the potential problems it may cause.