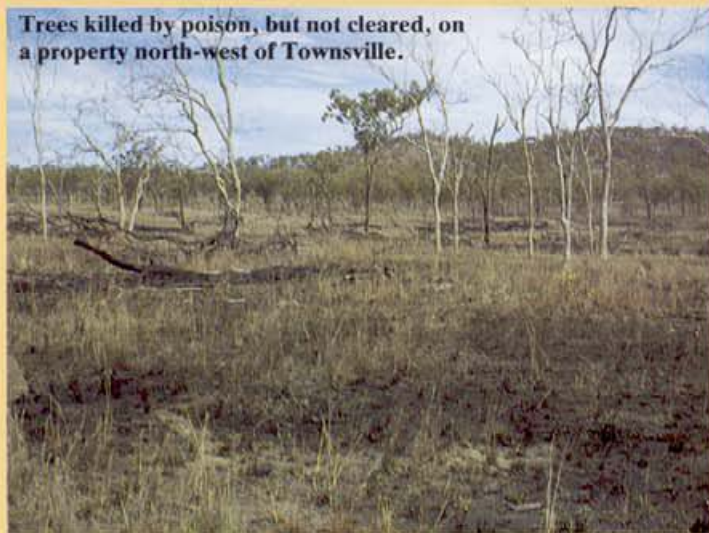


Measuring the costs of clearing

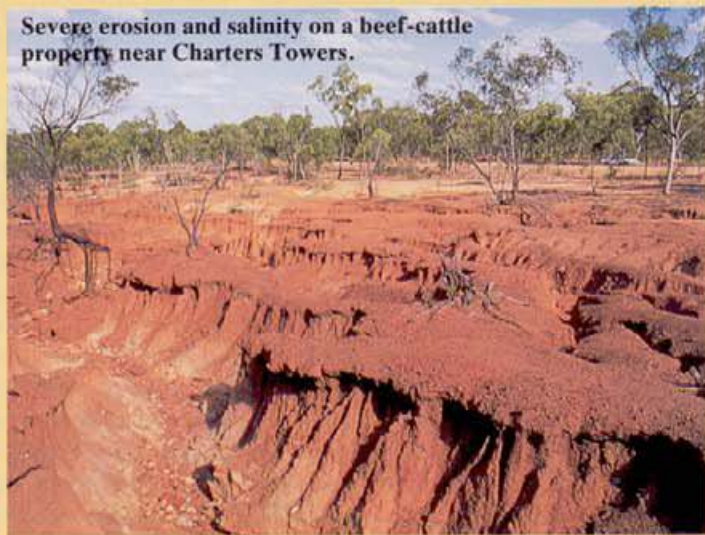


Tree-clearing on a property in the semi-arid tropics, south of Charters Towers. Bulldozing and ripping trees are still the commonest methods of clearing.

Trees killed by poison, but not cleared, on a property north-west of Townsville.



Severe erosion and salinity on a beef-cattle property near Charters Towers.



To European eyes, Australia has often seemed full of delusions. Whether it was inland seas, or limitless ideal farming country, the continent frequently promised more than it ever delivered.

Many of the mistaken beliefs of the early settlers were due to a lack of knowledge that we have since made good. But, to this day, in some parts of the country we still lack a sufficiently clear understanding of the ecosystem to predict the effects of any changes, and so our efforts may well not achieve what we expect.

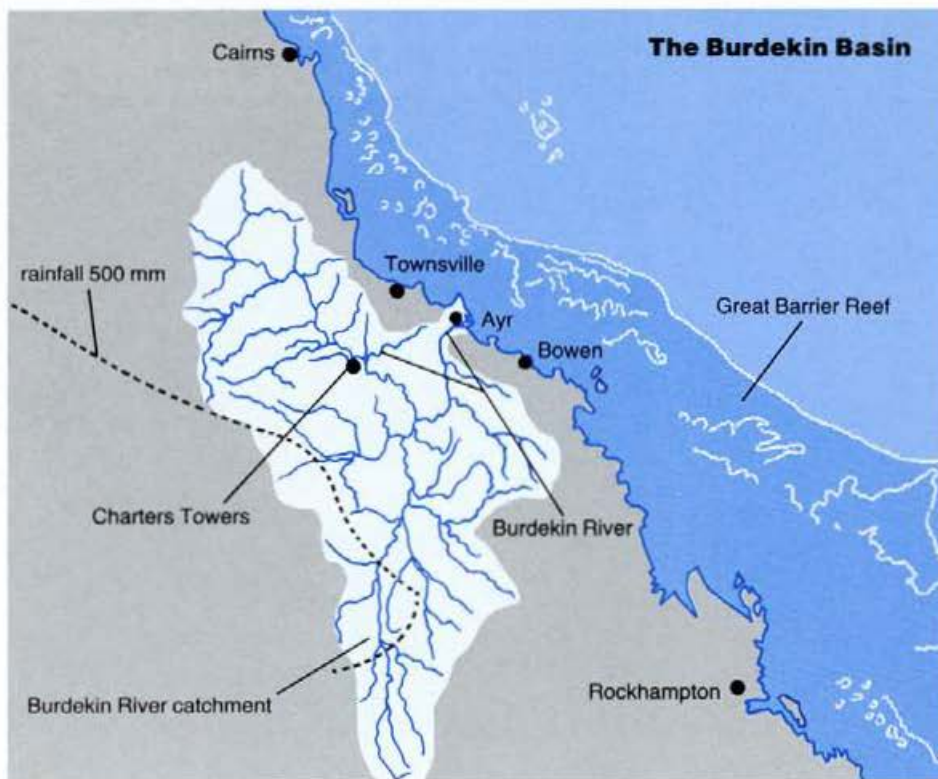
Consider clearing of native woodland on a large scale. It's still occurring in the semi-

arid tropics of Queensland in a bid to improve grazing. Hot, wet summers and mild, dry winters characterise this region, which lies between the coast — excluding the rainforest — and the arid interior where the average rainfall decreases to less than 500 mm a year.

The early white explorers had farming uppermost in their minds; among them, Leichhardt described the land in the Burde-

kin Basin as having 'feed everywhere most luxuriant, averaging from four to five feet in height'. Accordingly, the overlanders brought large flocks of sheep and cattle to graze this resource — but flesh-piercing grass seeds, fires, dingoes, low wool prices, footrot, and a loss of shepherds to the goldfields soon destroyed the sheep industry — and with it a few illusions.

Undaunted, the hopeful settlers tried many types of crops, but with little long-term success because of the infertility of the soil and the great variability and occasional severity of the climate. Cattle-grazing, at low numbers, was the only type of agriculture that proved viable for more than a few seasons.



The 500-mm isohyet marks the inland margin of the semi-arid tropics.

Naturally, farmers like to get the best returns from their land. Since those early days they have introduced non-native grasses and legumes that are more nutritious for cattle, and changed to animal breeds better adapted to the climate and conditions. As in the rest of the country, they have also cleared much of the land.

But now we know some of the problems that zealous land-clearing can cause. Two of the most important physical consequences are the appearance of salt at the surface as the water table rises, and the loss of nutrient-rich topsoil, which may accumulate where we don't want it. The destruction of a complex assemblage of plants and animals and its replacement with a less diverse and sustainable system is the biological cost.

Armed with knowledge our forebears didn't have, should we still be irrevocably changing the land over large areas? In parts of Queensland — for example, south of Charters Towers and west of Bowen — tracts of dry eucalypt woodland are being cleared for grazing land. Is this the best way to achieve economically efficient farming? In other words, does it deliver what it seems to promise?

Scientists Dr John Williams of the CSIRO Division of Soils and Dr Peter Gillard, formerly of the Division of Tropical Crops and Pastures, and economist Dr Richard Monypenny from James Cook University in Townsville decided to assess the situation. They reviewed the results of previous research carried out on stations in the semi-arid tropics, and devised a computer program to model the economic results, over

years, of various land management strategies.

Firstly, they wanted to confirm the widely held belief that tree-clearing improves the growth of pasture grasses. In experiments at Kangaroo Hills station north of Charters Towers, carried out by Dr Gillard, the biomass of pasture plants growing on a hectare of woodland averaged 1927 kg over a 10-year period. By contrast, on cleared land the average figure came to 3059 kg per ha. In other words, killing trees can substantially increase the growth of grass. In another grazing experiment conducted by Dr Bill Winter, near Katherine, N.T., land managers sowed legumes into a grassy understorey and then cleared the trees. (Legumes act to fertilise the soil with nitrogen derived from the atmosphere.) They noticed an increase in grass growth over the first 2 years, but eventually, with heavy grazing, the grasses disappeared and only the legumes remained.

There's little doubt about the next assumption: that cleared land will carry more cattle, at least initially. But will the beasts actually grow at a faster rate? At Kangaroo Hills and in the experiment near Katherine, clearing gave an increase in carrying capacity, but during the wet season the cattle gained similar amounts of weight whether in cleared or wooded areas. When times became hard, the animals in the woodlands did less well, presumably because they had less feed, as grasses had to compete with trees for moisture. So clearing produced grazing country with more resilience in times of drought, but it

improved neither the quality of the grass nor, therefore, the growth rate of the cattle.

Of course, landholders can first clear the country and then improve their pastures by sowing with legumes. So the scientists assessed this option, too.

Dollars and cents

Using a computer model, the researchers investigated the economics of three different production strategies on a property of 20 000 ha, starting with a herd of 3730 animals, of which 1000 were breeders. They calculated how much farmers would earn from the sale of various classes of cattle and allowed for costs such as freight and supplementary feed, as well as the costs of development of the property — for example, clearing, seed, and fertiliser. Profit and tax liability were also included in the model.

The three alternatives for this imaginary property were: clearing 1000 ha annually for 4 years, but with no other development; clearing 500 ha annually for 4 years, and improving the pasture by sowing legumes and applying superphosphate; and no clearing, but improving the pastures underneath the woodland with legumes and superphosphate over 1000 ha every year for 4 years.

Clearing alone increased the carrying capacity of the property, but, with taxation taken into account, it actually reduced the business's profit, as well severely reducing income in the first year because of the cost of the clearing. The other two scenarios produced much healthier cash flows and after-tax profits than did tree-clearing alone or leaving the property undeveloped. On economic grounds, no clear winner emerged, as the two options involving pasture improvement provided very similar returns.

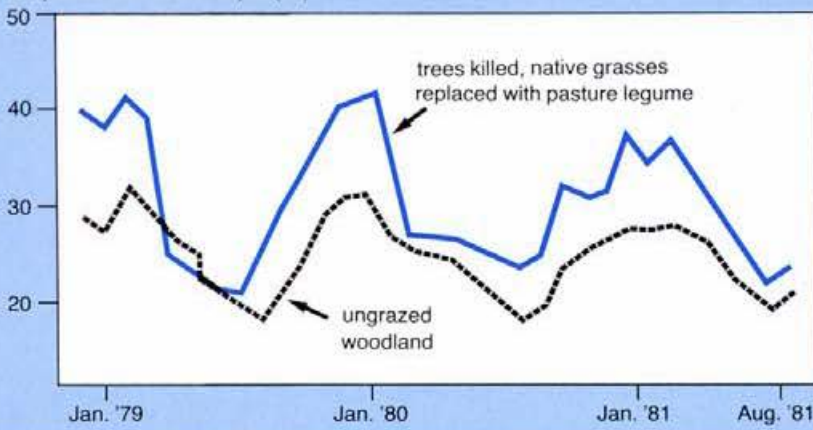
Clearing 500 ha a year and improving the pasture increased the available stocking rate, but also cost more than pasture improvement alone, as the tree-clearing expenses no longer carry a tax concession. However, the researchers noticed that some pastoralists still appear to believe that they do. In fact, only the clearing of regrowth now counts as a genuinely tax-deductible development expense.

The land

But, looking beyond the immediate economic time scale, what of the changes in the land wrought by the three regimes? Removing trees means that the water they had used becomes available to support a lush growth of grass. Whether or not the grass uses up water to the same extent as the

Hotter earth

temperature at 10 cm depth (°C)



woodland will partly determine how much the water table rises. A number of other factors also impinge on this, such as the soil nutrient status, the daily balance between rainfall and evaporation, the soil's hydraulic properties, and the rooting behaviour of the grass type. Many of these vary from region to region.

To date, tree-clearing in Queensland has not produced salinity problems comparable with those that have arisen in southern Australia. This is partly because much of it has occurred in regions with fertile basalt soils that contain little salt; clearing incurs less risk of salinity on these soils than where salt is abundant beneath the surface. However, around Bowen and Ayr saline seeps can occur naturally in untouched eucalypt woodland in certain soil types at the base of slopes during wet years. This shows just how fine is the balance between incipient salinity and the full-blown problem in some areas. Tree-clearing can easily tip the scales there.

And just because salt has not appeared in places decades after clearing does not mean that it never will. For example, the water table moves up more slowly following the removal of acacias in our semi-arid tropics than it does when eucalypts are cleared elsewhere. In part this is because of the hyd-

rology of the areas in which the acacias are growing, but also because acacias remove less water anyway, so their sudden loss makes less of an immediate impact on the level of the water table than the disappearance of eucalypt woodland.

The other main worry about clearing native vegetation is the loss of topsoil. In the semi-arid tropics, work by Dr Williams, Dr McIvor, and Dr Gardiner has shown that increased grass growth will bind the soil effectively, compensating for the lost trees. However, if the grass is grazed then erosion can occur, the extent depending on the stocking rate. In the area of Queensland that Dr Williams has been investigating, eroded topsoil is likely to end up — via the Burdekin River — deposited in the sea around the Great Barrier Reef.

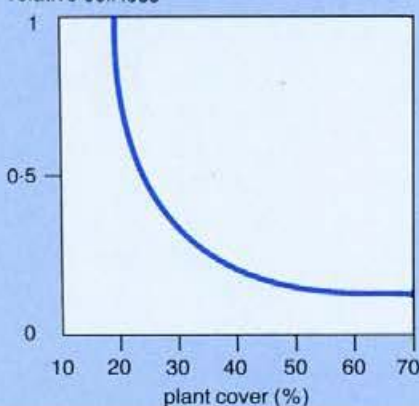
Measurements by Mr Warren Hicks, a chemist also with the Division of Soils, have revealed that up to 1 kg of phosphorus per ha and up to 8 kg of nitrogen are lost to the Burdekin River system every year from heavily grazed areas. Whether the input of nutrients is having any effect on the Reef remains to be determined, but we do know that phosphorus interferes with the deposition of the calcium carbonate skeleton of coral. In the absence of any evidence to the contrary, it seems wise to assume that it is detrimental to the marine ecosystem.

Dr Williams and Dr Gillard also identified another concern about clearing — its effect on the temperature of the soil, which can be considerable in the tropics. The scientists carried out measurements showing that tree-killing and the replacement of native grasses with legume pastures can indeed increase soil temperatures 10 cm below the surface, compared with ungrazed-woodland soil measured at the same depth and time. The increase was

Data collected by Dr Williams and his collaborators on a property near Cardigan, Qld, show how reduced ground cover can mean dramatically increased erosion.

Lose cover, lose soil

relative soil loss



Soil temperature measurements were made on a property near Charters Towers. Implications of the substantially higher temperatures in areas where the trees have been killed and legume pastures established are not yet clear.

small during the dry season, but substantial — 10°C or more — during the Wet (see the adjacent graph).

The implications of this are uncertain. Presumably the high temperatures may affect soil organisms. In the tropics, ants, termites, and other soil insects are the main sources of soil permeability, important for aeration and water infiltration. If their activities are substantially inhibited by high temperatures, the consequences could be serious.

To clear or not to clear

Determining in advance what will happen is not easy. Routine methods that allow the farmer to predict consequences simply do not exist. The scientists stress that decisions must be made on a patch-by-patch basis, after detailed surveys, as the hydrological and soil conditions can vary considerably over small distances. Hence, any clearing on a large scale is especially undesirable.

They conclude that tree-clearing in the semi-arid tropics can only be economically worth while if combined with pasture improvement and, most importantly, if it does not involve any risk of land degradation. Landscapes prone to suffer from salinisation should never be cleared; land with steep slopes and unstable soils should not be deforested because of the danger of erosion; and if uncontrollable regrowth of trees is likely it makes little economic sense to try to clear in the first place.

Although the researchers agree that areas exist that can be cleared and the pasture improved with no adverse long-term degradation or economic effect, they feel that, because of the doubt involved in identifying those areas and the need to maintain species diversity and ecological balance, it's best to practise pasture improvement underneath a woodland. Clearing is risky both economically and ecologically.

Roger Beckmann

More about the topic

Dry tropical rangelands: solving one problem and creating another. C.J. Gardener, J.G. McIvor, and J. Williams. *Proceedings of the Ecological Society of Australia*, 1990, **16**, 279–86.

Clearing trees from Australia's semi-arid tropics. P. Gillard, J. Williams, and R. Monypenny. *Agricultural Science*, 1989, **2**, 34–9.