

Zero-tilling to renovate buffel grass and ‘the tip of the iceberg’ – carbon sequestration under pastures

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Echo Hills is our 4000 hectare property, about 80 km north-east of Roma on the eastern fall of the Great Dividing Range and so in the Dawson River catchment. Echo Hills has been in the family since 1949, when my father bought it as an undeveloped scrub block. Nikki and I took over full management in 1987. The undulating country, steep around the watercourses, was originally 80% brigalow (*Acacia harpophylla*)–belah (*Casuarina cristata*), with poplar box (*Eucalyptus populnea*) on Slatehill Creek. The land was cleared between 1960 and 1978, and we now have 25% cropping land and 75% grazing, although up to 85% of this has been offset ploughed at some time with short-term farming for regrowth control. The grazing land carries 1200–1500 background cattle. Our long-term average annual rainfall is 650 mm but this has varied from 310 to 750 mm over the last 10 years.

Buffel grass (*Cenchrus ciliaris*) and other grasses have been established into brigalow country in a number of different ways since development started.

The first pastures were planted after the brigalow scrub was pulled. The dried timber was burned and seed broadcast from the air or ground into the ash. The seed fell into several centimetres of ash, the soil beneath was friable and the fertility high. Establishment was usually reliable and growth of the grasses [buffel, rhodes grass (*Chloris gayana*) and green panic (*Panicum maximum* var. *trichoglume*)] was excellent. Less dense stands of scrub and timber might have been pulled and then stickraked. Pasture seed was planted into the stickraked rough surface using a variety of seeders that could handle the fluffy buffel seed.

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Once brigalow regrowth thickened and created problems with mustering, blade ploughs were used on country that was not suitable for cropping. Large crawler tractors (D8+ sized) pulled blade ploughs up to 5 m wide, cutting off roots of the regrowth and leaving a very rough soil surface. Seed of pasture grasses and forage sorghum (*Sorghum* spp., especially Silk sorghum) were dropped onto the rough surface from rolling drum seeders on the back of the dozer. Establishment of grasses was variable but the larger seed of Silk usually established and gave early feed. In addition to plants resulting from the pasture seed sown at this time, existing plants of buffel often recovered and grew vigorously on the mineralised nitrogen, and seed set by the old grass plants would also establish. Seed had to be dropped during the dry months, when blade ploughing was possible. While timber control was effective at this time, the pasture seed could not germinate until the subsequent wet season.

On previous cropping land, pastures have been planted into a prepared seed-bed with a cover crop. Reliable establishment of the pastures depended on good crop management, such as planting on a good profile of soil moisture and not burying seed too deep. The larger-seeded cover crop established more reliably and provided earlier feed. Other techniques included undersowing pastures of temperate legumes (medics) and tropical grasses in a wheat crop.

Our ‘minimal time loss’ establishment

We have developed a forage–pasture establishment technique, which is proving reliable and cuts down the time before feed is available.

- A mixture of summer and winter forage cereals plus legumes and grasses is planted ideally in early March following a wheat crop. The ground is zero-till prepared as for an oats crop.

- The mix we usually sow is: 1 kg Silk sorghum or Superdan; 20 kg oats; 330 g lucerne; 150 g Kelson medic; 600 g green panic; 1 kg coated USA buffel.
- The principle is that, in this district, oats-planting rain falling in autumn germinates and establishes all seeds.
- The forage sorghum and oats grow rapidly and are ready to graze by late May. The cattle eat the sorghum down first, which allows the oats a little more time to bulk up. This heavy grazing also allows the sorghum to withstand any frosts through winter, while the oats protects the grasses and legumes that have established.
- When the oats starts to cut out in September, the paddock is locked up for 4–5 weeks, by which time the sorghum has tillered profusely and is ready to graze again. The sorghum protects the seedlings of buffel and green panic, and these are well grown by the time the sorghum is consumed.

The over-all result is a maximum of 10 weeks 'downtime' for the paddock within a 12-month period, while the pasture establishes.

Managing the pasture

- Stocking rates. We generally use a program of '6 weeks annual rest' for all pasture paddocks at some time between November and May (peak growth period) and a stocking rate of 1

(250–400 kg) dry beast/1.5 ha for the balance of the year.

- Quality. Tissue testing has shown old buffel grass pasture to have as little as 0.3% protein in the leaf by late winter.
- Fertiliser. We experimented by broadcasting urea at up to 100 kg/ha over small trial areas but deemed it too expensive to adopt as standard management.
- Companion legumes. We have tried many legumes (from lucerne to lablab to medics) but none has persisted well. Currently, we have 200 ha in year 2 of companion leucaena (*Leucaena leucocephala*).
- Soil tests. Data for soils established with buffel for 25+ years, virgin soils and soils under wheat are shown in table below:

On these soils, buffel grass becomes dominant with time and then starts to lose productivity. We prefer more productivity and better biodiversity than under a mono-specific pasture. There are a number of options for restoring this biodiversity and productivity.

Deep ripping and blade ploughing

Deep ripping and blade ploughing mineralise nitrogen, making it available to the pasture. This gives a huge initial boost in growth and establishment of other plant species, but the pasture runs down within 4–5 years to return to the previous stunted, lowly productive pasture (and the rough

Parameter	Virgin brigalow	Buffel 25+ years	Cereals after 2 years	Cereals after 8 years
N shallow (ppm)	10	14.9	14.5	2.4
N mid (ppm)				8.8
N deep (ppm)	20	1.1	5.3	4.7
TOTAL N (ppm)	92.6	17.4	34.7	79.0
P (ppm)	40	10	18	22
K (ppm)	1.67	0.69	0.95	1.08
Z (ppm)		0.5	1	1.47
S (ppm)		5	7	6.8
EC shallow	0.3	0.8	0.5	0.18
Na shallow (ppm)		1.08	0.66	0.74
Cl shallow (ppm)	80	15	10	57
EC deep		3.1	2	1.29
Na deep (ppm)				
Cl deep (ppm)		950	115	210
Organic C (%)	2.1	1.8	2	3
pH	8	7.9	7.8	8.2 – 8.4
CEC		33.45	36.79	32.72

cultivation leaves a surface that is usually too rough to drive over). Not all land is accessible or suitable for mechanical intervention, and this practice using high-powered tractors is expensive (AUD 60+/ha) and extremely energy-intensive.

Burning

Burning is also effective at mineralising nitrogen and it also controls various shrubby weeds, allowing some short-term improvement in flora diversity. Burning costs only cents per hectare, so is very cost-effective. It provides an excellent disease and pest break but unfortunately is rather environmentally unfriendly (Remember the smoke haze for months in the 1960s and 70s).

Spraying with glyphosate

Spraying is an option that we ‘stumbled on’ when converting a 30-year-old buffel pasture into wheat cropping land. The first time, we stick-raked a paddock, then aerially sprayed with 1.5 L/ha Roundup CT (540 g/L active ingredient) after the first spring rains. This was followed some 6 weeks later by a 150 mm chisel ploughing with a Trashworker, then another spraying with 1.2 L/ha Roundup CT in February to control the vast number of new buffel seedlings which emerged.

We observed two things:

- In steep or stony areas which received the initial spray but no other treatment, much of the buffel growth was from new plants with some old plants knee high by January.
- Spraying these areas again gave a total kill of both the new and old buffel plants but the huge reservoir of buffel seed that had built up over the years germinated and established subsequently. By late April, the buffel was lush green and as high as the bonnet of the Toyota utility.

Welcome to the world of zero-till pasture management!!

Treat it like a crop and ‘zero-till’ it

We now accept that an improved pasture (especially buffel) is not a permanent pasture and, like any other ‘crop’, it needs to be managed by means other than varying stocking pressure.

- If the pasture is treated like a crop and managed in 5–7-year cycles, productivity is enhanced, while the plants grow for long enough to store significant organic matter at depth.
- Spraying with glyphosate by plane or helicopter is quick, easy and economical and can be employed on virtually all land forms.
- By spraying, there is opportunity for judicious use of fire to control woody weeds, if necessary, and this can be done even during wet seasons, when everything else is too green to burn.

Storing carbon

Soil cores that we have taken have shown that, after 25 years of buffel grass, there is a huge mass of live and dead root matter (organic carbon) down to at least 1200 mm in our brigalow–belah soils. This is at a time when the grass is stunted, runs to seed easily and has minimal above-ground bulk—hence the analogy of the iceberg.

- The top 600 mm holds about 25% root matter (as assessed visually).
- We have also observed proportionally similar amounts in 5–7-year-old buffel pasture.

Future research

There are some topics that we consider warrant further investigation. These include:

- Quantifying the benefits of zero-till management of buffel (and other pastures).
- Optimum timing and application rates of glyphosate.
- Accurate measurements of stored organic material under permanent pastures.
- Accurate measurements of carbon sequestration.