Case studies — sustainable farming systems[1]
1. A dairying enterprise

D. GENRICH

MS 26, Crows Nest, Queensland, Australia.

Description of the enterprise

General

Effective area being used for dairying: 140ha
Stock numbers: 80 medium-sized Friesian cows
70 heifers
Annual production: approx. 450 000 litres
Average per cow production: approx. 5000 litres
Peak production: spring/early summer
Calving pattern: 2/5 herd — April, May, June
3/5 herd — August, September, October, November
Breeding: AI 85%
Embryo transplant 15%
Age of farm: 80 years

Physical aspects

Soils — Sand: generally infertile
Loams: medium fertility
Alluvial clays: medium fertility
Scrub soils: medium-high fertility

There are more structural problems with the first three soils than with the scrub soils.

Water — Creek, saline at most times
1 well and 4 stock dams
1 small irrigation dam

General — A 60 ha eucalypt forest is part of the farm.
Saline outbreak affects about 4 ha.
All cultivation areas have been contoured.

Land use

Pasture areas		*Soil Type*
Rhodes grass		Sand and sandy loams
Callide	11 ha	
Katambora	7 ha	
Kikuyu/African Star grass	8 ha	All types
Lucerne/clover	6 ha	Clay loam
Other (Paspalum, Pioneer rhodes, green panic etc)	40 ha	All types
Native (undeveloped)	38 ha	

The above areas include: 32 ha have Haifa white clover and rye grass, 8 ha have woolly-pod vetch, and 5 ha of irrigated Callide rhodes/Haifa white clover/rye grass.

Cropping area

Oats/vetch	30 ha	More fertile soils
Lab-lab bean	15 ha	

Pasture and crop management

Soil tests are taken on all pasture and cropping areas every 2-3 years. P, K and S are added according to soil test result, pasture or crop type and available funds. N (as urea) is added to oats, rye grass and rhodes grass. The use of urea has increased the amount of dry matter available in pastures and crops; this has contributed to a rise in stocking rates, and per cow production.

More legumes have been used in pastures over the past 5 years; notably Haifa white clover and woolly-pod vetch, with an increase in natural burr medic where pastures are fertilized. Higher milk production is obtained from legume pastures. A conscious attempt is made not to overgraze pastures; better milk production is obtained from the more nutritious 'leaf'. Pastures respond quicker to rainfall when plenty of stem is retained. Crops and pastures are strip grazed 90% of the time.

Hay is used in the autumn and winter period at night time. 1.5 tonne of grain per cow per lactation is fed. This is supplemented with Fermaphos and cottonseed meal is also fed when pastures are poor. Heifers are fed grain daily.

[1]Talks presented at the Fourth Australian Conference on Tropical Pastures, held at Toowoomba, Queensland, in November 1990.

Sustainability of the enterprise

Relevant problems and proposed solutions.

Problem 1. How to be 'efficient': matching genetic potential with environmental conditions.

Solution

(i) Cows produce more milk off legumes than grasses. More legumes are proposed — Haifa white clover, vetch and medics, as well as an increase in lucerne areas where the soil is suitable.
(ii) Cows need to consume feeds of high energy value. Grain is necessary in the system to sustain milk production. Minerals are increasingly important as cow production rises — for reproduction and general health as well as for milk production.
(iii) Cows need 15-20 kg of dry matter per day. Growing legumes decreases dry matter production compared with grasses, so grasses on a dry land farm are very important. Rhodes grass and kikuyu on the soil not suitable for permanent cultivation provides green feed in the late spring, summer and autumn periods, and hay for the winter-early spring period. That is, a balance of pasture species is needed.

Problem 2. How to cultivate without causing erosion.

Solution

(i) Contouring cultivated paddocks.
(ii) Using a minimum tillage system.
(iii) Planting more pastures.

Problem 3. How to fertilise without affecting soil structure, pH, and erosion of waterways.

Solution

If fertilising was stopped immediately, stocking rate would have to be reduced and production (both per cow and per farm) would decrease. In the short term, this would be economically unviable. However, increasing temperate legume content in tropical pasture areas enables N input to be decreased. Use of lab-lab bean sod-seeded into minimally-tilled oats paddocks provides good quality feed for late summer and autumn without the need for N fertilizer.

On poorer soils where rhodes grass grows well, P, K and S (and other elements) levels need to be maintained.

The sustainability of the enterprise depends on many factors, not the least being the economic ones. If fixed costs such as debt servicing were lower, then the production needed to service the debts need not be as high. This would place less stress on the whole system with lower stocking rates, no over-grazing of pastures, cows selectively grazing higher quality pastures and lower work loads. The tropical grasses in our system play a vital role in achieving our production. As urea usage is decreased, they will become less important on their own, but more so as a component in grass-legume combinations. As the legumes increase in area on the farm, I expect stocking rates to decline, milk production per cow to increase, and total farm production to fall slightly. By moving in this direction, I feel dairying in our environment will be sustainable.

2. Ley farming on heavy clay soils

B. VON PEIN

'Hereward', Dalby, Queensland, Australia.

Background

As a young man travelling in southern Australia, Bernie Von Pein was impressed with ley farming systems which improved soil fertility and made wheat growing possible on poor soils. Under a wheat, fire, short fallow and wheat rotation, the soil was 'tightening' and becoming less workable. Water would not infiltrate as it had previously done. Yields were down and the grain was mottled. He asked himself the question — 'Could the southern ley philosophy work in Queensland where nitrogen fertiliser was being used on rundown wheat soils?'

Mr Von Pein made two observations which were to prove critical in developing his system of farming.

(i) Excellent growth by snail medic and oats when intercropped, showed that two different species growing together could enhance the growth of each other. This led to wheat-snail medic plantings, at first with some caution, as the concept was contrary to the conventional wisdom of weed competition.

(ii) Summer fallowing for moisture conservation was a most inefficient practice. A legume could be introduced into a fallow immediately after a wheat crop with minimal effects on the efficiency of moisture storage in that fallow. Where introduced into wheat straw, the legume also enhanced the decomposition of the straw.

The system he developed incorporates the objectives of grain production without fertiliser, and animal production without supplement. It replaces the old system of winter cereal production, firing of stubbles and short fallow.

The rotations

The rotations take into account crop plants, forage plants and animals organised into variable systems. They are planned on a paddock basis depending on the fertility and other needs of each paddock. The combinations of crop options employed are limitless — there is no fixed system. Nevertheless, there are a number of key rules that are followed. After a grass cereal crop, grown either for grain or forage, a legume is used immediately in the rotation to build soil fertility and to break disease cycles associated with the grass crop. Similarly, the philosophy is to break repeated legume crops with grass crops except in badly rundown soils which need rejuvenation. Some examples of the rotations used are set out, together with traditional grain farming systems, in Table 1. Lab lab, snail medic and stubbles are grazed by sheep and/or cattle which are an integral part of the system.

Up to 1990, Bernie Von Pein rarely included lucerne in his rotations because the property is on flat land adjacent to the Condamine River, the majority of which is prone to flooding. In 1990, lucerne was sown under the winter crop in paddocks on the highest land on the property. He considers that ley farmers on non-flooded land with more slope would benefit from the incorporation of lucerne in the farming system.

Table 1. Rotations used at 'Hereward' and on traditional grain farms.

	Year															
	1		2		3		4		5		6		7		8	
'Hereward'																
Rotation 1	F	So	SM	MB	F	So	SM	F	W+SM	F	B+SM	L	SM	F	W+SM	
Rotation 2	W+SM	L	SM	F	W+SM	F	B+SM	MB	SM	F	W+SM	F	O+SM	L	F	
Rotation 3	B+SM	L	SM	MB	F	So	SM	MB	F	So	SM	F	O+SM	L	SM	
Rotation 4	B+SM	L	SM	F	W+SM	MB	F	So	SM	F	B+SM	L	SM	F	W+SM	
Traditional																
Rotation 1	W	F	F	S	F	F	W	F	B	F	B	F	F	S	F	
Rotation 2	B	Su	F	F	W	F	B	F	B	F	F	So	F	Su	F	

Key: W = Wheat
B = Barley
SM = Snail Medic/Barrel Medic
L = Lab lab
MB = Mung Beans
So = Sorghum (grain/forage)
Su = Sunflowers
O = Oats
F = Fallow

For the past 15 years, he has also included chickpea in his rotation systems.

In any five years of the rotation, Mr Von Pein claims to have reduced the number of cultivations by half. Yields of 2.75 t/ha of wheat, 3 t/ha of barley, 3.7 t/ha of sorghum and 0.82 t/ha of mung beans are commonly obtained from this system of dryland ley farming.

Land preparation and fallow management

Primary tillage on 'Hereward' is performed with a Yeomans plough with the shakaerator removed. This implement does not appear to produce any 'bottom' and gently lifts and opens the soil leaving it in a receptive condition for rain and yet at the same time, it prepares a soil mulch which effectively retains accumulated moisture. Clods appear to break down readily under this system and the implement has a low draught requirement.

Secondary tillage is performed by a Gyral spring-release cultivator. This is used for all operations after the initial tillage through to planting. Planting is carried out with a conventional combine.

Treatment of straw

Mr Von Pein does not believe that stubbles are essential to the system. In going directly from winter cereals to summer grain legume (usually mung bean) crops, he has no hesitation in burning the stubble. Incorporation of large quantities of straw is considered unnecessary and often produces undesirable consequences such as N immobilisation and a proliferation of insects, and diseases such as yellow spot. However, stubble is retained when the summer grazing legume lab lab is direct seeded into winter crop straw. This occurs at least once in the rotation period. Sorghum stubbles are always grazed through into the subsequent regenerating crop of medic.

Chemicals

No insecticides, herbicides of fertilisers are used on 'Hereward'. Grazing animals control many weeds in the forage crop and crop stubble segments of the rotation. This is facilitated by the judicious planning of the winter and summer crop components of the rotation.

However, at some point in the future, fertilisers may be needed. Soil tests indicate that N is in good supply following legume crops, but it is likely that P will be required in the future. The evidence for this is a low soil analysis for P. Despite this, yields of legumes with high phosphate reqirements have been maintained and grain yields are excellent. This system of ley farming is conducive to development of mycorrhizas, fungal organisms which grow on and effectively extend the root systems of some plants, resulting in their better foraging for soil P and Zn.

3. Cropping and pasture production from lighter soils

C. CAMERON

'Rockwood', Chinchilla, Queensland, Australia.

Our 2250 ha property, 'Rockwood', lies approximately 200 km north west of Toowoomba, on the western edge of the Darling Downs, in a 625 mm variable rainfall zone. The land is quite variable, from brigalow (*Acacia harpophylla*)/belah (*Casuarina cristata*) on good quality soil at one extreme to narrow-leaved ironbark (*Eucalyptus drepanophylla*) on rocky, sandstone hills at the other. The good soil represents only 10% of the property; the major part is light soil with varying proportions of sand and clay, that originally carried poplar box (*Eucalyptus populnea*) with some bulloak (*Casuarina luehmannii*) and cypress pine (*Callitris columellaris*).

'Rockwood' in 1982 when it was run down and overgrown, carrying only 300 sheep and 40 cattle with some difficulty, and with 120 ha of cultivation. We set about implementing a farm development plan as funds would allow.

We had about 800 ha cleared, including most of the brigalow/belah, some box and a smaller proportion of bulloak/cypress pine. We were careful to leave an interlocking pattern of shelter belts at least five chains wide, with cover in every paddock. Previous experience had

shown that isolated clumps die out in time and do not provide wildlife habitats. Some much larger areas were left, the ironbark country as a timber resource because of its very shallow soil, and one particularly attractive patch of sugar gum (*Angophora costata*). These areas provide space for even the shyest bird species to live and breed, that is, cicada birds and crested hawks. Our property bird list covers approximately 227 species, some 140 of which have been recorded breeding. In addition to being stock shelter and crop windbreaks, the paddock shelter belts provide homes for many of the useful mouse and grasshopper predators, that is, kestrel, black-shouldered kite, spotted harrier, brown hawk, boobook, barn and barking owls, tawny frogmouth, crow, raven, butcherbird and magpie which play a significant role in keeping the base populations of mice at a low level.

We began development on the heaviest soils, aiming for a quick return from grain and lambs to finance development of the lighter country which posed the greater problem. In their naturally timbered state, the lighter soils never carry much grass, and allow rapid runoff of storm water causing heavy erosion.

Most of the box country is rapidly re-colonised after clearing by suckers and seedlings of box and false sandalwood (*Eremophila mitchellii*). The soil is hard setting, making grass growth fairly sparse. This pattern of continuing aridity can be broken, and the earth transformed into healthy and fertile soil. An examination of the soil reveals a shallow 'A' horizon, only 10-20 cm deep, with most plant roots restricted to this zone. Below is a brick-like clayey mass with little root penetration, and little sign of earthworms or other soil fauna. The sandier soils have a deeper 'A' horizon but still have the hard and near impervious 'B' horizon. A pattern of 'on the contour' ripping, beginning with a shallow breaking of the 'B' horizon has given immediate response; water is held and allowed to soak in, and a cloddy surface affords protection from sun and wind to germinating plants. Annual deep ripping intensifies the effect and rejuvenates old worn-out cultivation. We recently bought a subsoiler and have had spectacular results with it breaking hard ground and allowing water to infiltrate. Having been to 'Carisbrooke' near Winton and seen the 'Keyline' project operating there, I have begun work with the subsoiler following these ideas to maximise water absorption into my land. I am also renovating some of the older pasture country.

We have ploughed a large area to remove suckers, then sown grass either aerially or by roller-drum, primarily Callide rhodes grass. This has been an astounding success, grass growing 2 metres high in a few months and producing a dense mat on the ground which greatly slows the storm runoff. This, coupled with our gully stabilisation has effectively halted soil erosion. Underneath this pasture the ground itself has changed after four years. It is now soft, dark, moist and smells 'alive'. After four years' pasture, the organic carbon level had increased from 0.5% to 1% and soil total N had increased from 0.13% to 0.18% although no legume had been used.

We have had a little success in establishing legumes on these poor soils. We have tried Hunter River and Trifecta lucernes, snail and Cyprus barrel medics; all grow well in heavier soils but not on the sands. In the winter of 1990 we planted Languedoc vetch which performed well with oats as a cover crop. In autumn 1991, we will sow serradella for the first time. It may be the best legume for the light soils providing it can compete with Rhodes grass.

We have proved, to ourselves at least, that our very poor country can be made fertile, and at an acceptable price. The stock-carrying capacity has increased tenfold and our development is not yet half completed. With the current concerns about greenhouse gases and degraded land there is much to gain through large scale programs of soil improvement.

4. Pastoral production from a mixture of land classes

R. CARLYLE

'Wonga Hills', Chinchilla, Queensland, Australia.

Wonga Hills is situated 90 km north of Chinchilla on the eastern slope of the Great Dividing Range. Comprising 4900 ha it consists of 3000 ha of brigalow/belah/bottletree/vine scrub with the remainder being various classes of poorer eucalypt forest country. It lies in a 26 inch (650 mm) rainfall zone and is run as a beef cattle breeding and fattening property.

Most of the pasture development undertaken has been in the scrub country with the main species being Pioneer rhodes grass and green panic. All seeding was done from the air as the country was progressively cleared between 1960 and 1984. One large area of scrub country has been left in its natural state; covering 600 ha, it is quite mountainous and a good remnant of the original scrub in the district.

The oldest pastures are now approaching 30 years old and in the better soils have persisted very well. Only in the poorer marginal soils has the improved pasture reverted back to native grasses. Even then it has been mainly due to over-grazing from wallabies.

The main management strategy for pastures has been not to overstock, occasional spelling and the use of fire to control regrowth. In terms of pasture quality it is evident that there has been some decline in soil fertility. With no legumes in most paddocks and the seeming necessity to burn overgrown dry rhodes grass, soil nitrogen will decline.

In some paddocks, which have been cultivated, Callide rhodes grass has been sown with lucerne. One paddock sown in 1987 still has a good content of lucerne after three years. It is hoped that with spelling the legume can be maintained. The main difficulty with sowing lucerne is the need to cultivate the land. Most of the country on Wonga Hills is steep and many areas are so stony that mechanical cultivation is impracticable.

Over the past 16 years most of the scrub country has been used for bullock fattening. Young steers have been bought and kept for two years and turned off as bullocks. Breeders were reduced to about 150 head after the beef slump in the mid 70s, but these are now being increased again. Because of feedlot demand, the margins in buying and selling steers have been reduced. It is planned to continue to increase breeder numbers from the current 250 head. Traditionally, many people only run breeders on forest country but with the higher weaning weights and weaning percentages off scrub country, breeders are more profitable than fattening bought steers.

The forest country on Wonga Hills consists of mixed areas of silverleaf ironbark, narrowleaf ironbark, gum-top box and spotted gum. Much of this country, particularly the spotted gum, is of little grazing value and is retained for timber production. The better forest paddocks were ringbarked in the early days and have since been cultivated and sown to improved pasture. This included Callide and Katambora rhodes grass, creeping blue grass, Bambatsi panic, purple pigeon grass, Gayndah buffel and Biloela buffel. Legumes planted were Siratro, fine stem stylo, Fitzroy stylo and Jemalong barrel medic. Of the grasses, Callide and Katambora rhodes grass have been the best species due to their ability to spread with runners. The creeping blue grass is a slow starter but is now well established. The only concern with it is its palatability due to the strong odour after it seeds. Siratro has been the best legume, while the only other legume remaining after five years has been fine stem stylo which is confined to small areas of sandy loam.

For the future, the only way to maintain the productivity of our pastures will be by the planting of legumes to prevent a continuing rundown in soil nitrogen levels. This will be easier in the forest soils as there are more suitable legumes available. On the scrub soils which are still very fertile, it is still probably uneconomic to attempt to incorporate legumes in the pasture on a wide scale. In any case, the steepness and rockiness of many of our scrub paddocks would make this difficult. If we could order an ideal legume, it would be a small leucaena type shrub with good fire and frost resistance and suited to the heavier scrub soils.