Sabbatical Fallowing for Healthy Soil

Resting Pasture Boosts Productivity

by JOHN KING

Walking across Tim Gow's pastures, the many benefits of sabbatical fallowing are clear. Underfoot is soft, like walking on a cushion; a deep mat of litter protects soil from climatic events and provides a bed and breakfast for many different life-forms. In fact, visiting scientists found insects they have yet to identify on his land.

Sabbatical fallowing of pastures involves removing grazing livestock from one-seventh of a property for 12 months, usually from early spring to late winter, to improve soil fertility and function. Pasture grows and accumulates biomass without livestock present to feed soil with litter, exudates and sloughing root hairs. The Bible and other texts mention the practice, and it was common in the United Kingdom until World War II.

Tim and his wife Helen have spent a lifetime challenging conventional New Zealand pastoral farming, often attracting criticism that has proven unfounded. As pioneering organic farmers they began sabbatical fallowing in 1988 after seeing many examples while traveling in Asia and the Middle East. This also coincided with a deep interest in genetics, resulting in stud Shire sheep and Tufty cattle that thrive in pastures of greater maturity while reducing handling and production costs; a classic example of creating pasture first and then finding livestock to graze it. They said that if they were starting again they wouldn't waste time using conventional livestock breeds because older, better-adapted breeds like Wiltshire and German Marsh sheep and Highland cattle are better suited to organic production and fallowed pastures.

The Gows' 1,159-acre property Mangapiri Downs Organicstud Farm is located deep in southern South Island, New Zealand. The property is split between red tussock alpine pastures and semi-developed flat pasture country and includes 173 acres of trees. Surrounded by Takitimu Mountains, it is unlike most neighboring sheep and beef properties; pastures aren't grazed short or dotted with bales of baylage – nor is Tim a fan of electric fencing and intensive grazing practices common in New Zealand. The property is able to run more than its current 200 cattle and 2,000 sheep as Tim continues recovering from a severe head concussion.

The common New Zealand farming practice of intensive winter grazing on wet soils and lush pastures with 800-2,000 sheep/ha using electric fencing significantly impacts soil structure by reducing porosity and inducing compaction. Soil scientists concerned about soil degradation from grazing practices were amazed at what they found at Mangapiri Downs.

Tim says soil benefits from sabbatical fallow include better soil life, improved water-holding capacity, porosity and tilth and deeper and greater root density. Earthworm numbers also improve, along with trace elements and nitrogen accumulation, supporting more efficient nutrient cycling. Decomposing litter creates a deep humus layer that is rich and biologically

Farmer Tim Gow at Mangapiri Downs.

Table 1. Possible Benefits of Pastoral Fallow in Different Pastoral Farming Systems (Mackay et al, 1991).

Farm System	Sward Vigour		Nitrogen		Improved fertiliser use[5]	Pasture Control [6]	Pest Control [7]	Soil fauna[8]	Soil physical properties[9]
	Re-seeding[1]	Re-generation[2]	Accumulation[3]	Conservation[4]					
1. Low Fertility Hill Country	1	4	5	2	5	5	?	+	+
2. Hill Country	2	4	3	3	5	5	?	+	+
3. Intensive Sheep/Beef	3	4	2	2	2	4	?	+	+
4. Mixed Crop/ Stock finishing	0	0	2	5	1	1	?	+	+
5. Dairying	4	4	2	2	2	3	?	+	+

1 **Re-seeding**. 1 = little or no re-seeding; 5 = extensive re-seeding
2 **Re-generation**. Reduce tiller density, increase tiller size and individual plant size and vigour. Increased rooting depth. 1 = minor; 5 = major effect
3 **Nitrogen accumulation**. Return of N as plant litter to site of fixation. 1 = minor improvement; 5 = significant
4 **Nitrogen conservation**. Reduce losses of N by providing a carbon source. 1 = minor role; 5 = significant
5 **Improved fertilizer use**. Reduce S and P losses by transfer in dung and urine. 1 = minor role; 5 = significant
6 **Pasture control**. Management tool for maintaining pasture quality. 1 = minor role; 5 = significant
7 **Pest management**. Impact on porina and grass grub populations. + Positive; - Negative effect
8 **Soil fauna**. Increase in earthworm and Enchyt numbers. + Positive; - Negative effect
9 **Soil physical properties**. Impact on soil surface bearing strength, infiltration rates, etc. + Positive; - Negative effects

Time for Fallow

- For systems 1,2,3,and 5 a traditional spring to autumn or summer only (mini-fallow) , although in drier areas an autumn to summer fallow might be more effective
- For system 4, a summer to spring fallow maybe more appropriate

active with a new seed base, all of which increases topsoil. Biomass also provides a great feed bank for winter grazing.

In 28 years the whole farm has experienced sabbatical three times, and in many areas four. The Gows tend to fallow paddocks together across the length or width of the farm. They have not used any fertilizer since 1988, organic or otherwise, including lime, and they don't make hay, reducing input costs.

The Gows originally reduced stock numbers when they started out but have found productivity has increased and keep numbers steady through winter – and more critically through dry spells and droughts. The critical period is a feed pinch at the end of winter when cleaning up the last fallow and shutting gates. Tim is becoming more relaxed about grazing fallowed pasture into spring rather than sticking to a strict timetable.

RESEARCH & RESULTS

Manawatu couple James and Barbara Wilson farmed 593 acres, of which 260 acres was cropped with small grains, vegetables and trees. The remainder was grazed by up to 450 dairy beef cattle, 500 ewes and 200 goats. They enjoyed 10 years without fertilizer and were producing at their district average without the major cost of importing fertility. They were also running a sabbatical consultancy service.

The Wilsons observed a number of changes including up to 5 cm of earthworm castings. Pasture pests like porina (*Wiseana* species) and grass grub (*Costelytra zealandica*) also increased, but heavy trampling over winter crushed most of them. Deeper root systems also lifted production by another 1,000 kgDM/ha/year over control site of 13,000 kgDM/ha/yr. Animal health improved due to deeper root systems and a better balance of species, eliminating bloat and reducing ryegrass staggers. The Wilsons said their mutton lost its traditional strong chemical smell, an advantage for exporting to Japan.

To make sabbatical fallow work, they suggest dropping livestock numbers by 20 percent, which is similar to strategies farmers use to cash in on spring livestock premiums. However, in their experience stocking rates recover almost to what they were as fallow is integrated into management.

So what might that look like in the first year? The main limiting factor is how many livestock can overwinter. For example, a 400 ha farm divided by seven is 57 ha. Assuming this area normally produces 11,000 kgDM/ha/yr and 6,500 kg is lost through composting, that leaves 4,500 kg for livestock feed. Also assume 500 kgDM is lost through trampling, leaving 4,000 kgDM/ha. If the property normally carries 10 sheep/ha (4,000 sheep annually), then 57 ha at 4,000 kgDM/ha would provide enough feed for 57 days during the winter months. If you drop sheep numbers by 20 percent to 3,200, that would push out 71 days.

SOIL IMPACTS

During the 1990s, scientists explored sabbatical fallow and documented a number of interesting characteristics for improving productivity on southern faces of low fertility North Island hill country.

Root biomass changes seasonally with fallowed plots having higher root mass in spring as bulk biomass exceeds grazed areas and less in fall, reflecting senescence and decay of aboveground biomass. Porosity increased under fallow due to larger pores from increased soil life activity, decay of dead roots and lack of compression from livestock. This reduces soil bulk density without drying soil like cultivation. Higher organic matter increases water-holding capacity, a phenomenon that also occurs in stock camps and established livestock trails.

No significant changes in soil minerals emerged between fallow and grazing plots. There were slightly lower K and N levels with fallow possibly due to lack of fresh dung and urine, which contain rapidly available forms of N and K, high total growth rate of fallowed pasture depleting N and K reserves and declining N fixation by legumes shaded by grasses.

Improvements in soil structure, breakdown of plant residues and release of soil organic nitrogen lifted pasture production for two years after fallowing. Trampling by cattle helped carbon to mineralize, but mineralization of nitrogen took much longer to initiate. Pasture and legume growth rates were higher the year after fallowing, particularly greater legume biomass later summer into fall.

SPECIES & PLANT DYNAMICS

Concurring with farmer observations mentioned earlier, aboveground pasture mass during an annual fallow on hill country peaks over 11,000 kgDM/ha over mid-summer (January) but by early winter (May) it declined to 5,000 kgDM/ha as grass and legumes decomposed.

Fallowing reduces plant density per meter, but those plants are bigger with deeper roots than grazed swards, a useful phenomenon called self-thinning. It occurs when increasing plant biomass reduces plants per meter and also reduces tillering, producing a sward that is taller and more erect. As plant density decreases it creates opportunities to introduce new sward species.

Sabbatical fallow is an ideal tool to introduce species by oversowing where direct drilling is impossible or difficult. What is also significant is moisture content is higher under fallow, which is a dominating factor in seed germination and seedling establishment.

TIMING OF FALLOW

Length and timing of fallow can also bring useful benefits depending on desired sward characteristics for several farming systems (Table 1).

Spring-fall fallow allows for natural seeding of all species in the sward, especially grass species. Fallows starting from January onward checked natural reseeding whereas fallows from December produced a great natural reseeding. If sward grasses are not desirable, fallows from January onward are the best option. For intensive pasture-based dairy, a mini fallow from October to February ensures reseeding of dominant grass species. This also coincided with improved regrowth of recovering sward, litter breakdown and decomposition and survival of seedlings compared to a traditional fallow.

Mini fallows from December onward do not produce as greater biomass because the majority of growth occurs in spring months. Nitrogen fertilizer can help address this, but only if there is enough soil moisture to ensure growth, which may be an issue mid- to late-summer.

Farmer concerns about losing clover when fallowing prove false as fallows starting from December and January onward increases white clover presence through elongated internodes.

IMPACT OF FERTILIZER

While grass tiller densities decline and swards become open and upright, white clover growth was low over winter, and yet clover stolons overran and established in bare patches of decomposing litter in late winter/early spring, thereby strengthening clover content. Overall biomass accumulation does not appear to differ between fertilized (North Carolina RPR and elemental sulphur) and non-fertilized plots. Both fertilized and unfertilized fallow plots had 56 percent higher root biomass to 220 mm verses grazed plots and C and N mineralization rates between treatments were essentially the same.

However, biomass of clovers on plots fertilized two years running then fallowed was 1,000 kgDM/ha above plots fertilized and grazed throughout the trial. An interesting observation was that when clovers are not grazed, recycling of N inside the legume reduced nitrogen fixation. It was suggested if organic N accumulated in soil during the fallow period it would also inhibit nitrogen fixation by clovers.

Nitrogen determines pasture decomposition rates, often a reflection of sward leaf maturity but also plant type. Timothy has a greater carbon/nitrogen ratio than clover and therefore takes longer to decompose. When herbage compounds are simple and decomposition is bacterial, nitrate nitrogen is released. When material is high in cellulose, fungi dominate and little nitrogen is released. Its percentage of carbon in any compound lowers its decomposition rate, which is why proteins decompose faster than lignin.


PHOTOS COURTESY OF MANGAPIRI DOWNS

Tufty cattle at Mangapiri Downs.

Lignin is the greatest contributor to soil carbon and because it favors fungi, it very likely contributes to lowering soil pH.

Giving pastures a vacation from livestock for a year stimulates benefits for soils and pasture species alike. Tim and Helen Gow demonstrate how fallowing regenerates soil properties and highlight that changing livestock genetics assists in making it viable. The Wilsons didn't take this path, but also experienced benefits from a low-input system. Gains in both instances illustrate how this age-old practice regenerates grassland function.

Editor's Note: For a complete list of sources referenced and/or used in the article, please email *editor@acresusa.com*. View this article with additional information at Acres U.S.A.'s *ecofarmingdaily.com*.

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