

Soil Enhancement versus Maintenance of Yield

Case Study: Broad Acre Grain and Silage

Soil enhancement processes have long been plagued by early-term yield losses as lower nutrient application and changes in land management practices are adopted. Prior studies have shown that low microbial counts and low microbial diversity are a feature of depleted soils and in particular of intensively farmed regions which have a strong reliance on applied nutrient. There is evidence to suggest that continued reliance on high rates of chemical fertiliser prevents regeneration of the microbial elements which are critical to the in-soil processing of these same nutrients. This fosters a cycle of increasing need for more nutrient in order to maintain yields. In an attempt to address this nexus, many landholders are seeking soil enhancement products which aim to help rebuild microbial diversity and biomass in soils. However, in most cases, farmers have been faced with accepting several seasons of lower yield or leaving land fallow altogether in order to promote microbial recovery in the soil.

This situation creates a commercial barrier for entry for most soil enhancement products, including those which involve the re-cycling or re-application of organic matter as a stimulant or a catalyst for in-soil biomass development.

In 2005 a solution was developed in North Queensland whereby highly adapted sets of organisms were pre-grown on conventional fertilisers allowing a reduction of the environmental shock load faced by soil organisms when concentrated nutrients are applied to the soil. These formulations were then specifically adapted to allow the processing of key nutrients (N, P and Ca) and it was found that the introduction of formulations containing these key sets of organisms were able to supply a much faster development of soil biomass than had previously been possible. In addition, the sensitivity to concentrated nutrient was reduced, allowing farmers to manage reductions in the application of fertiliser over time rather than removing chemical inputs altogether in the early years of transition.

A simultaneous improvement in soil biomass and diversity of microbial development while in transition to lower fertiliser application and the use of organic inputs without the attendant yield losses provided an attractive solution for those landholders wanting to move to a platform of improved soil. Further impetus has been added to the discussion with the growing need for soil structure management (to prevent erosion and wind-blown losses) and for moisture retention. It has long been observed that soils which contain higher levels of humus – the result of microbial diversity and higher levels of microbial biomass – are better structured and retain water and nutrients longer in the zones where plants need them.

In recent times this discussion has become even more pertinent given the focus on re-deployment of Soil Carbon reservoirs which occur naturally as a result of increased biomass development. It became clear in 2005 that the process of adapted microbial re-deployment was by proxy a process which rapidly sequestered atmospheric Carbon.

In this study, a prominent farmer in the Riverina area of Australia sought to make the transition to lower fertiliser input and improved soil. The objective was to maintain yield by managing the input of both organic (soil enhancement) products and conventional nutrients such that improvements in soil health were achieved without yield decrease.

Property Details

Land Owner: Ken Hughes

Land Size: 800 ha broad acre cropping and grazing

Land Usage: Cereal crops (Barley and Wheat), Silage & sheep

'Treated areas' Fertiliser: MicroGrowth (a fermented soil inoculant aimed at early Phosphorous processing) & MicroNutrient (a bio fertiliser containing 7%N, 1%P and 4%K from conventional sources)

'Untreated areas' Fertiliser: Urea and DAP

Dilution: MicroGrowth 1:10 (water). MicroNutrient 1:10 (water)

Application Rates to Treated Areas (excl water):

MicroGrowth	4 Litres per ha
MicroNutrient	20 Litres per ha
Cost	\$70 per ha

Application Rates to Untreated Areas:

Urea	50 Kg per ha
DAP	100 Kg per ha
Cost	\$170 per ha

NB: ½ Bio Fertiliser applied in Spring & ½ in Autumn.

Method

Over the course of the **2005 to 2008 growing seasons**, whole paddocks of land were segregated to allow treatment of discrete blocks of grain (refer 'Production Data'). On this farm, during better years, grain is harvested while during poorer years, silage is harvested from the same ground. Accordingly, the overall tonnage of production is an important indicator of yield. Production levels were measured to highlight the effects following the adoption of a lower nutrient (fertiliser) regimen combined with selected soil enhancement products. Products were applied in late autumn to broad acre Barley fields prior to seedling emergence and again in spring.

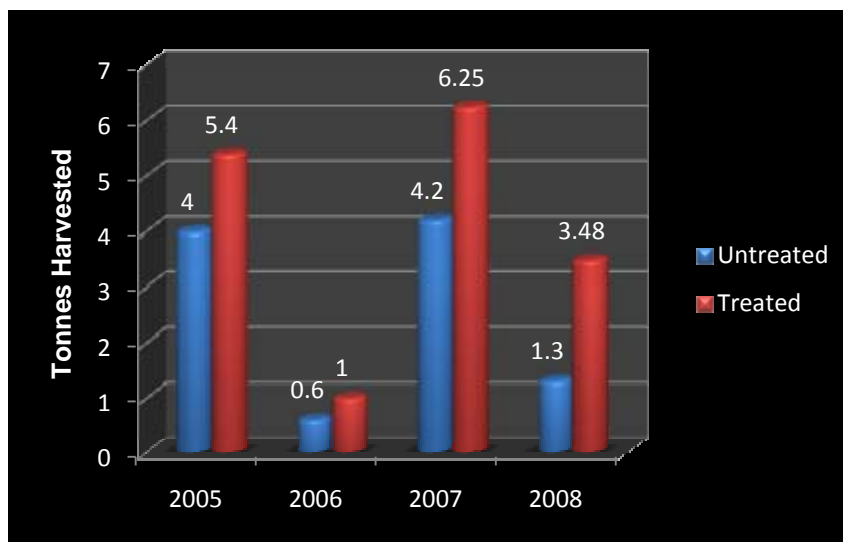
During 2006 and 2007 the farm experienced severe drought conditions in line with lower and poorly timed rainfall across the entire region. In 2007 the farm produced silage rather than harvest a poor grain crop. Improved soil structure and moisture retention led to impressive increases in 2008 yields.

Comparisons are made between treated and untreated areas of the farm, being areas where biological products were applied (treated) versus those where chemical inputs only were applied (untreated). Buffer areas were left around the treated areas to ensure separation of treated and untreated zones.



Production Data

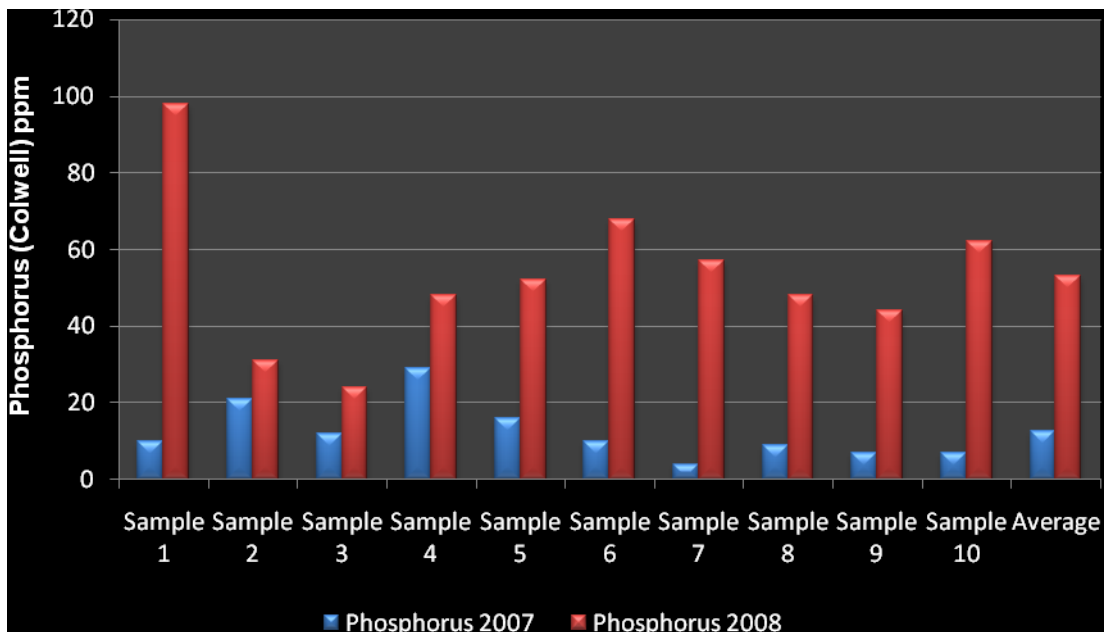
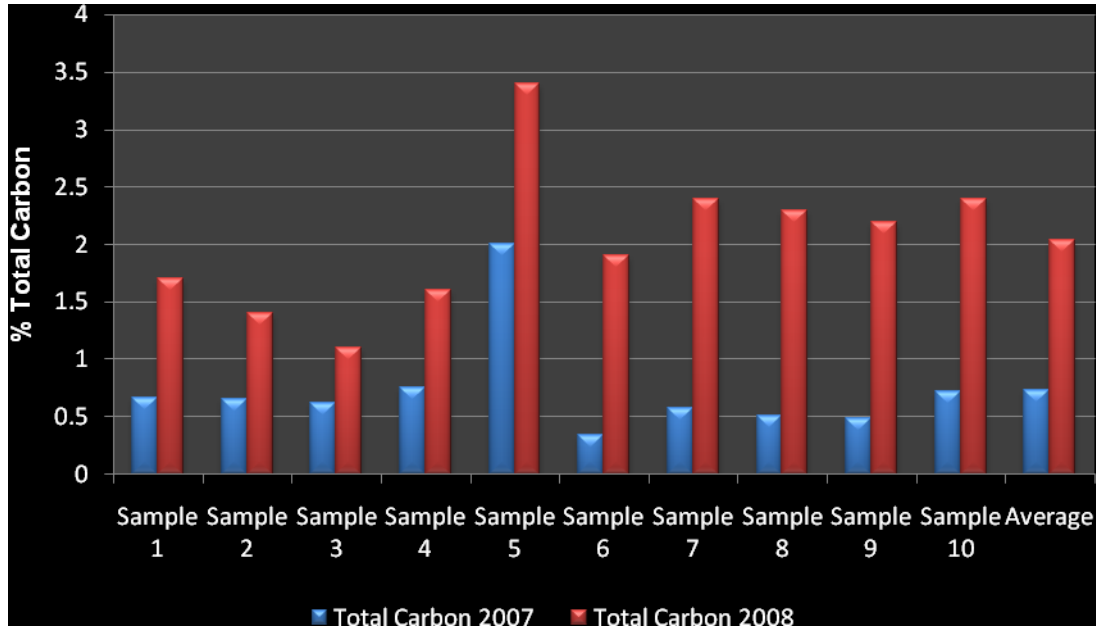
		UNTREATED AREAS			TREATED AREAS			TREATED
YEAR	RAINFALL - mm	PADDOCK SIZE - ha	YIELD TONNES/ha	BRIX % READING	PADDOCK SIZE - ha	YIELD TONNES/ha	BRIX % READING	INCREASED TONNES %
2005 (Barley)	581	30	4.0	-	50	5.4	-	35
2006 (Barley)	183	30	0.6	-	50	1.0	-	67
2007 (Silage)	455	200	4.2	-	40	6.25	-	49
2008 (Barley)	TBC	100	1.3	5.8	300	3.48	11.8	168



Yields verified by Peter McLaughlin, Riverina Co-op, Wagga Wagga.

Improved soil structure and significantly increased moisture retention were observed in treated areas as shown in the photographs following. Soil on this farm is predominately a gravel loam/clay which over time had become relatively structureless and which held moisture poorly. The soil typically dries out to a fine light dust in dry periods and forms a structureless clay in wet periods. In the treated areas a rapid re-development of structure was observed over the three years with concurrent extended plant root development and higher levels of organic carbon measured. BRIX (sugar) readings in the treated areas were measured at or near 11.8% compared to 5.8% in untreated areas testifying to a higher nutrient uptake and greater pest and disease resilience in treated areas.

The clear benefits outlined by these trials have been the catalyst for the property to adopt a lower nutrient regimen combined with selected soil enhancement products over the entire property for the **2009 growing season**. Recent widespread soil tests conducted by Charles Sturt University have highlighted significant improvements in the soil's biology, particularly in relation to Total Carbon and Phosphorus levels achieved as per the following charts:



Note: these results are backed up by a 2005 NSW DPI report 'Microbes & Minerals' stating *"Building soil organic matter helps to build the organic pool of Phosphorus"*. Phosphorus and other minerals are then made available to the plants via the microbes contained in the soil enhancement products.

Samples taken in late winter showed strong increases in levels of available Phosphorous, despite low rainfall and cold weather. This higher nutrient availability is mirrored in significant increases in soil organic matter and in Total Carbon fractions.

Total Carbon increases in excess of 1.3% have been recorded in treated areas during the 2008 growing season. While areas of lower background carbon had proportionately higher rates of increase in both available Phosphorous and Total Carbon following treatment, it is important to note that the trend of increased biological activity is consistent across the property.



Examples of improved soil structure and moisture retention in treated versus untreated Barley crops. The higher Organic Carbon levels have transformed the previously structureless loam/clay. Greater levels of nutrient have been delivered to the treated plants via the significantly improved root structure.

Outcomes

Overall production tonnages were consistently and significantly higher in the areas treated with bio-products over those left untreated. This result was pleasing given the adverse growing conditions experienced throughout the period and the much lower nutrient regime employed on treated areas. Input costs of the biological soil enhancing products were less than half that of the chemical fertiliser inputs.

Similarly, a significant growth in soil organic matter and a commensurate improvement in soil organic carbon and moisture retention were noted in treated areas despite the farm experiencing severe drought. Dramatic improvements in available Phosphorous were observed in treated areas. This was particularly pertinent in the farm's region as landholders typically struggle to maintain levels of available Phosphorous despite high levels of applied P (as seen in untreated areas of this study). In this case, treated areas had applied P of approximately 0.2 kg per hectare. Untreated areas received applied P of approximately 20 kg per hectare. Despite the large disparity in applied nutrient, treated areas showed much higher available P levels throughout the growing season. Soil tests will confirm if a small amount of DAP, or similar, is to be applied prior to the biological fertiliser in following years.

Improvements in soil structure and friability have also been noted. This mirrors an increasing pool of Organic Carbon measured in treated soil over the period. Further measurement of these factors is anticipated for following seasons with the Soil Enhancement Program being applied to the entire property.