Preliminary Investigation of effects of Natural Sequence Farming (NSF) on soil organic matter levels and nutrient uptake at Baramul

By
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Introduction

Before European settlement, many of the smaller waterways in Australia were discontinuous "chain of ponds" or pool-riffle systems which flowed intermittently. Loss of riparian vegetation and adverse changes in soil stability have led to wide spread erosion of these waterways resulting in more deeply incised waterways which flow rapidly (Boulton 1999; Erskine 1999; Erskine and Webb 2003)

Natural Sequence Farming (NSF) is designed to re-establish a pool and riffle or chain of ponds system, to improve stream and floodplain sustainability and to mitigate both the impacts of salinity on productivity and its discharge into streams. NSF practices may have effects on soils which are likely to significantly increase the production of crops or pasture. If NSF results in improved soil hydration, plant growth and soil microflora there are likely to be flow on effects on soil organic matter levels, structure and nutrient cycling.

There are numerous instances documented of improving soil properties through organic amendments and subsequent increases in yield with no additional water requirement e.g. in lettuce (McGiffen, Lebron *et al.* 2004); melons (Faria, Costa *et al.* 2003); rice (Krishnakumar, Saravanan *et al.* 2005); pasture (Sangha, Midmore *et al.* 2005); and mango (Musvoto and Campbell 1995; Christanty, Mailly et al. 1996).

Soil organic matter is a reliable index of crop productivity in semi-arid regions because it positively affects soil water-holding capacity (Diaz-Zorita, Buschiazzo *et al.* 1999). Increasing soil organic matter has been shown to increase crop productivity over a range of crops including vegetables, fruit, cereals and pastures (Diaz-Zorita, Buschiazzo et al. 1999; Zebarth, Neilsen et al. 1999; Lorenzo Dominguez, Badia Villas et al. 2001; Poudel, Ferris et al. 2001; Carter 2002; Vestberg, Kukkonen et al. 2002; Carter, Sanderson et al. 2004).

One main features of NSF is an approach to stream rehabilitation involving the installation of stream structures. Such structures are currently installed on "Baramul Stud" in the Widden Valley and the effectiveness of these NSF structures and approach is being monitored through an ARC-Linkage project (LP0455080) led by Dr Richard. Bush (Southern Cross University); Prof. Ian White (ANU), and Prof. Wayen Erskine (University of Newcastle) and involving the Hunter-Central Rivers Catchment Management Authority and the NSW Department of Natural Resources.

The objective of this study was to collect some preliminary data on the effects of NSF on soil and plant nutrient levels and soil organic matter.

Materials and Methods

Three sites were selected in the Widden Valley, part of the Hunter Valley, NSW Australia. The first NSF site was an area of pasture on the bank of Widden Brook near an NSF weir known as the ***Bride Site*** (GPS coordinates S 32˚ 33.193', E 150˚ 21.573' , Fig. 1). The second NSF site was also on the banks of Widden Brook, near and NSF pool, and was known as the ***Pool Site*** (GPS coordinates S 32˚ 33.193', E 150˚ 21.573', Fig. 2) The control site was an intensively farmed pasture also on the banks of Widden Brook, and similar in nature to the NSF sites, but without NSF interventions (GPS coordinates S 32˚ 33.783', E 150˚ 21.922', Fig. 3).

Soil type at all sites was a sandy loam. At each of these sub-sites, 15 soils sampled were collected from 0-15cm on the pasture area, surface vegetation and leaf litter removed. The sub-samples were then pooled and sub samples sent to a NATA accredited lab for analysis of physical and chemical properties using standard soil testing methods.

15 whole shoot pasture samples shoot samples were collected over a $400m^2$ in the same area that the soil samples taken and nutrient concentrations measured on oven dried samples. Water samples collected from the upstream side of weir at NSF sites and below creek bed at control site. Three water samples were collected from the upstream side of weir at NSF sites and below creek bed at control site and EC measured on each sampling using a standard laboratory EC meter.

Results and Discussion

The results in this preliminary study must be taken as a guide only. While there was replication in soil and plant sampling and between NSF sites, chemical analysis of soil and plant samples were carried out on single pooled samples. This means while that the values presented are correct, there is no measure of variability in the data presented. Water samples were replicated (n=3).

Soil organic matter was higher at both NSF pasture and creek flat sites compared to the control sites (Fig. 4) suggesting that something to do with the NSF modifications are affecting the level of organic matter present. This OM could have come from plant reside or from soil micro flora. The soil moisture at the time of sampling was also higher at NSF sites compared to the control site (data not shown).

A significant finding was that the cation exchange capacity (CEC) was also generally higher at the NSF sites compared to the control site. The NSF bridge and NSF pond pasture soils CECS were 65% and 80 % higher respectively than the control pasture soil (Fig. 5). This increase in CEC was probably due to higher soil OM levels.

The pasture soil nitrate levels in the control site were high (18 mg/kg) compared to the two NSF sites (2-3 mg/kg) (Fig. 6). Despite the discrepancy in soil nitrate levels, the shoot N concentration on all the sites however all ranged between 1.8 and 2.4% which were all within the normal range. This result may be due to higher soil organism activity making soil N more available to plants in NSF sites despite lower soil nitrate levels.

The exchangeable soil potassium concentration was higher in the NSF sites (Fig. 8) and this was reflected by pasture shoot potassium concentrations (Fig. 9). The water salinity (EC) was much higher at control site compared to NSF sites 1 and 2 (Fig. 10).

In summary, this preliminary data suggests that soil organic matter and CEC levels were enhanced by NSF activities. This may have resulted in more soil micro-organism activity which could explain better utilization of available sol nitrate and possible potassium. These aspects should be further investigated in future studies.

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Figures

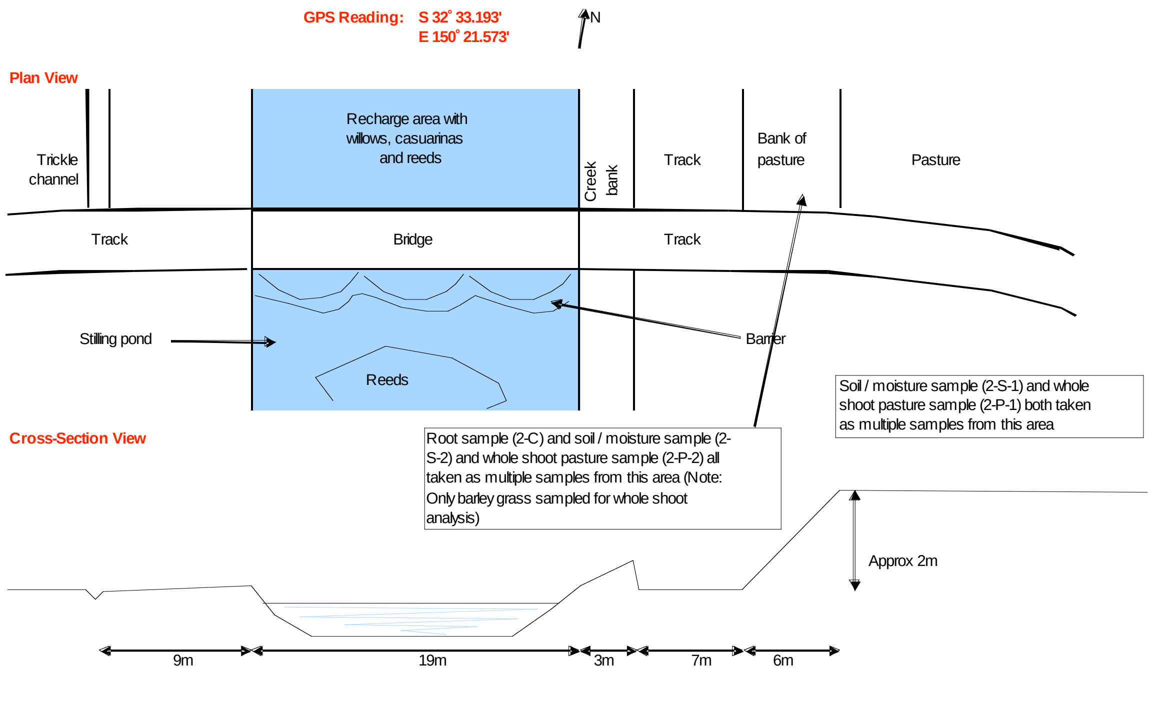

Figure 1. Bridge NSF site

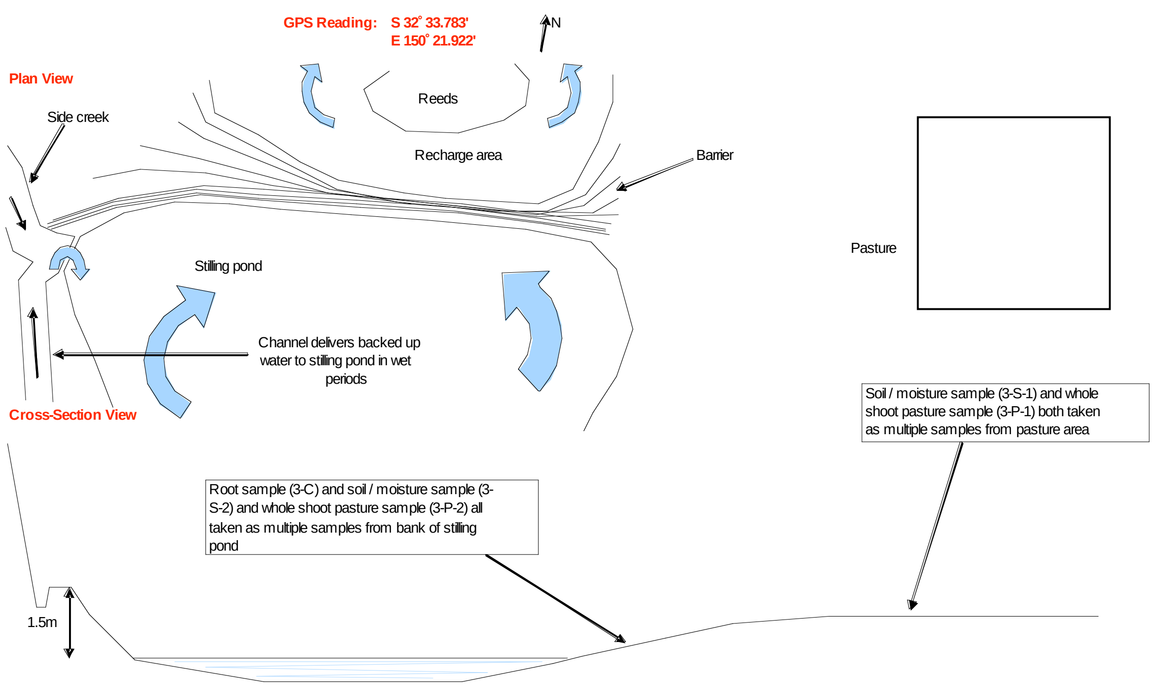

Figure 2 – Large Pool NFS site

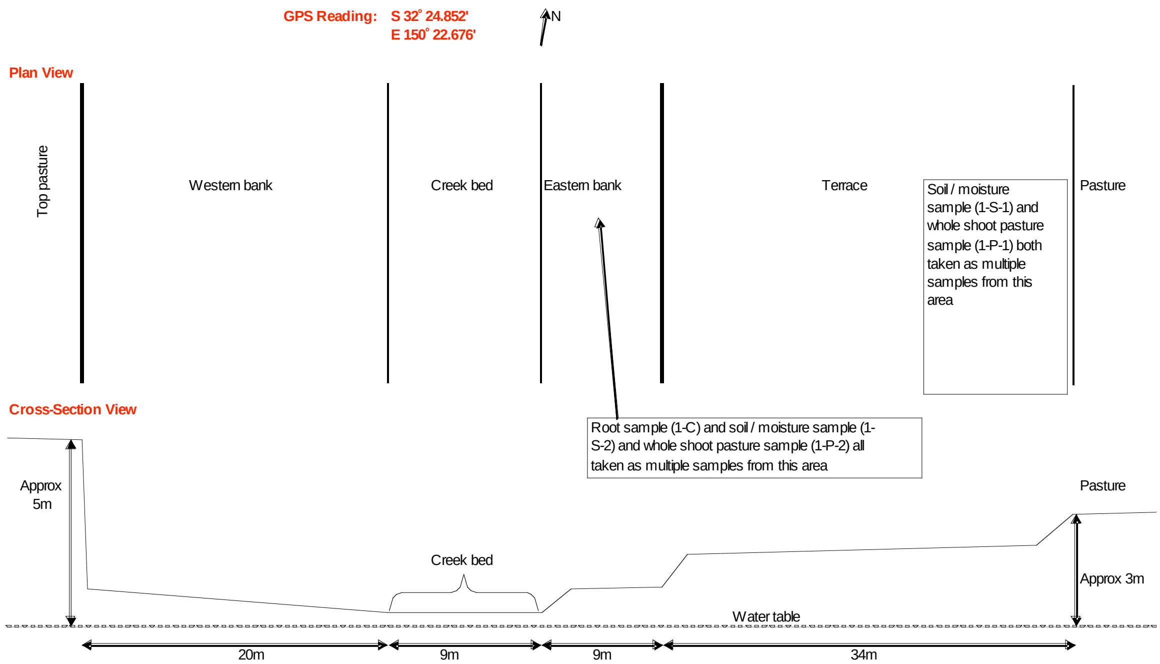

Figure 3 Control site.

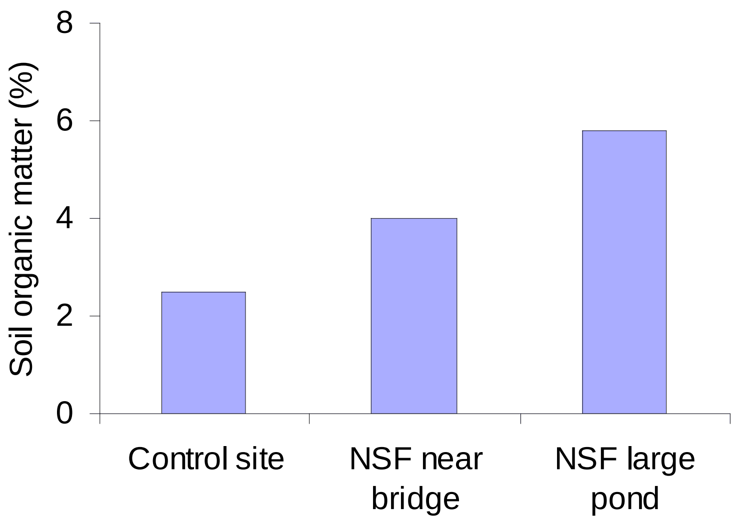

Figure 4. Soil organic matter from the 0-15cm topsoil at each site.

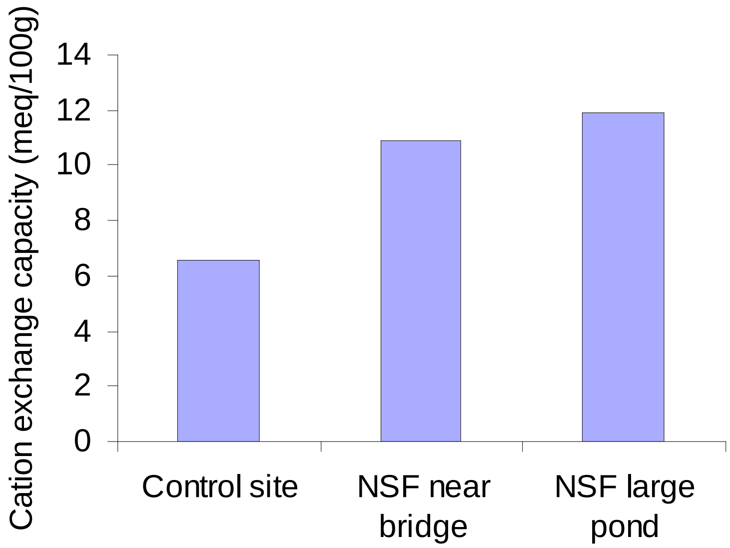

Figure 5. Cation exchange capacity from the 0-15cm topsoil at each site.

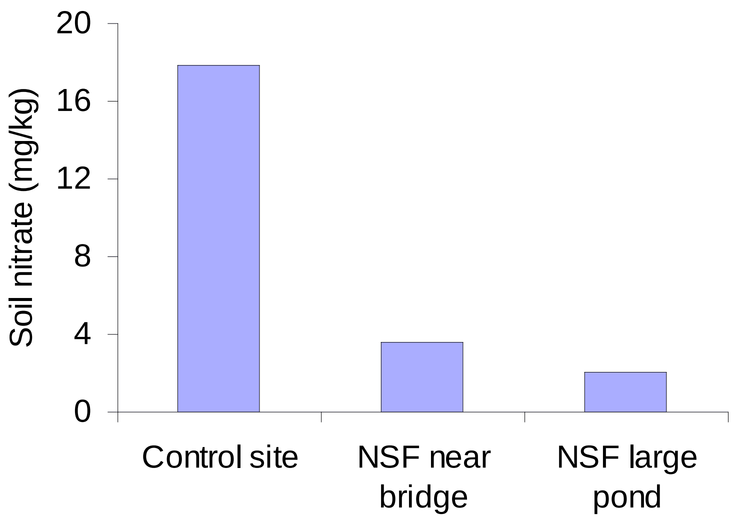

Figure 6. Pasture shoot nitrate concentration.

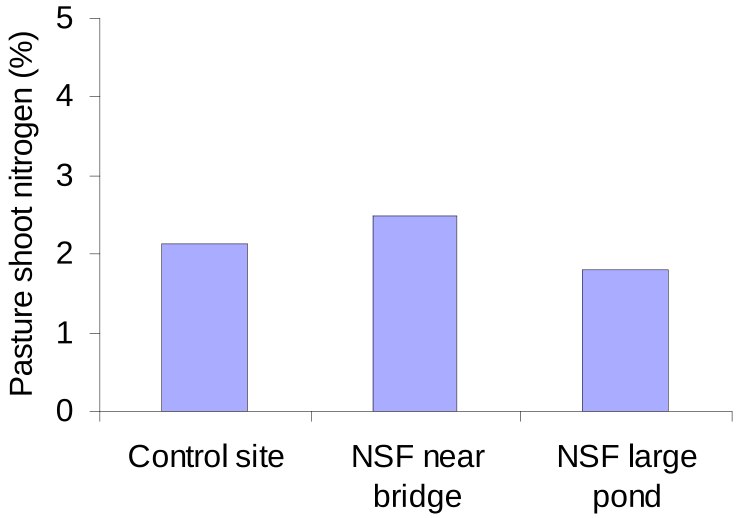

Figure 7. Pasture shoot nitrogen concentration

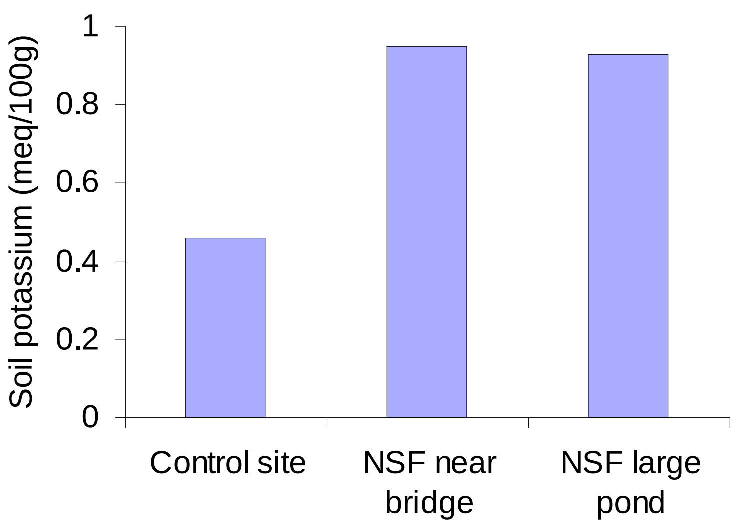

Figure 8. Exchangeable potassium in the topsoil of the pasture soils.

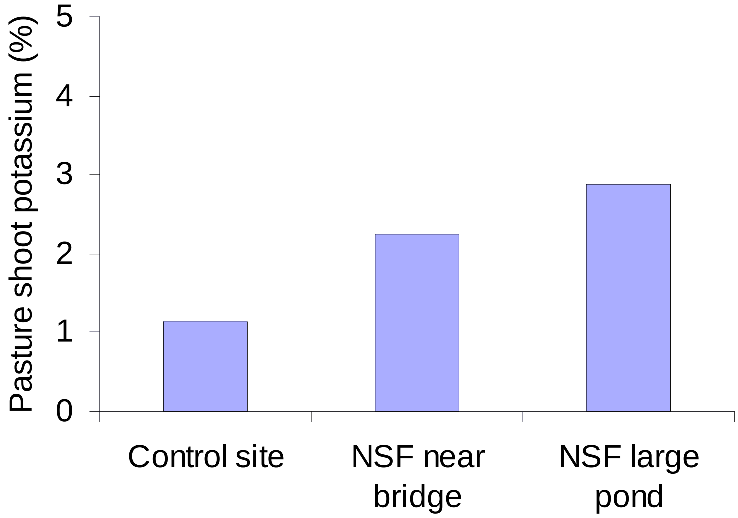

Figure 9. Pasture shoot potassium concentration.

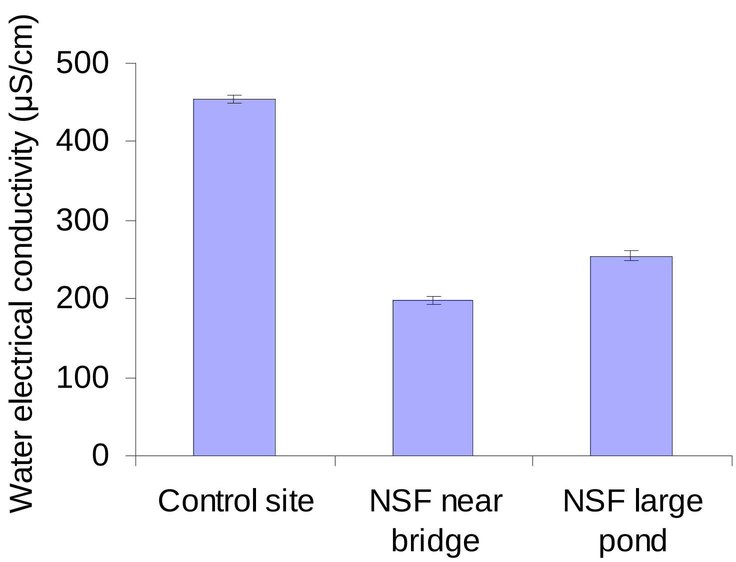

Figure 10. Water salinity near each site.