Waterspreading to restore native grasslands

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Abstract

Waterspreading is a land rehabilitation technique that targets the variability of rainfall and runoff in semi-arid systems to initiate long term changes in ground cover. This study outlines the effect of waterspreading at 'Florida' in western NSW, which has been steadily implementing waterspreading systems for the last 30 years. By combining recent pasture measurements, on-farm observations, and soil surface carbon and nitrogen measurements, this study outlines the dramatic changes in pasture condition and diversity, and long term changes in surface soil properties, that occur following waterspreading. These dramatic yet persistent changes exemplify the benefits of implementing rehabilitation that is based upon the processes that govern resource movement and productivity within semi-arid systems, namely, recognition of variability in rainfall and runoff, and management of this.

Introduction

Before European settlement, the Western New South Wales Peneplain landscape was a mosaic of open grasslands with patches of scrub and open woodlands – now Invasive Native Scrub (INS) dominates much of the landscape which has led to reduced carring capacity (Gardiner et al. 1998) and changes in soil condition (Tighe et al. 2009). Many methods have been tried to bring these degraded areas of the peneplain back to production. Waterspreading is one method that is very successful.

Waterspreading is a land management technique used to evenly spread and disperse rainwater flows over country with gentle slopes less then three percent. It is based on the recognition of the patchiness of semi-arid landscapes and the source-sink operation of different soil surface conditions (Tongway and Ludwig 1996). The driving mechanism behind the success of waterspreading is the reduction of the energy of water flow, meaning a large reduction in soil erosion and an increase in water infiltration.

Waterspreading involves creating a series of small banks to direct water away from eroding drainage lines to areas where it would normally not flow (Central West and Western CMA 2008). Each bank is designed to slow and spread water as it continues downslope, increasing infiltration. Restoring native grassland from an INS site in this way is a long-term exercise and can take five to seven years (Central West & Western CMA 2008). Firstly the invasive scrub area is thinned or cleared through chaining, raking and burning, followed by ploughing if necessary where regeneration of turpentine and bimble box has occurred. Waterspreading banks are surveyed and constructed. Pioneer plants such as yellow burr daisy and galvanised burr establish first, eventually being replaced by other native/naturalised grasses after around two years. While such changes are visually obvious, there has been little documentation of pasture changes, or co-comitant changes in soil condition following waterspreading. This paper presents a summary of initial visual responses of a grazing system to waterspreading, and surface soil measurements within this system that is indicative of soil condition.

Methods

Study site, survey and construction

Measurements and observations were undertaken on ‘Florida’, Canbelego, NSW, approximately 50 km east of Cobar. Over the last 30 years 500 kilometres of waterspreading banks have been constructed covering 3400 hectares on Florida. The general method of construction is as follows: the paddock is surveyed with a spectra-physics laser leveller mounted on and within a dual cab 4WD vehicle. Following marking, roadgraders are used to construct waterspreading banks – preferably to a height of 60cm and basal width of over 2.0 metres – which are then rolled to account for stock trampling, tunnelling, flooding and settlement of bank. Maintence of the waterspreading system is ongoing in keeping new INS out.

Monitoring

Herbage mass and ground cover were documented in 2008 on an area untreated and treated north of the Florida homestead by Higgins and Theakston (2008). Changes in species diversity and composition and stocking rates are a summary of visual observations since the beginning of waterspreading trials on this property over 30 years ago (K. Mitchell, pers. obs.).

For soil analysis, three waterspreading systems were selected on 'Florida', 2, 15 and 30 years since watespreading implementation, and matching site conditions as closely as possible. An adjacent patch of scrub (dominated by Turpentine – Eremophila sturtii) taken to be representative of pre-spreading conditions was also sampled. Surface (0-5cm) soil sampling for carbon (C), nitrogen (N), and available N (the sum of NH_4^+ N and NO_3^- N) and statistical analysis followed the approach of Tighe et al. (2009), with Tukey's posthoc comparisons undertaken where significant differences ($P<0.05$) were detected.

Results

Pasture dynamics

Table 1. Average herbage dry weight and ground cover within a 6 year old waterspreading system and at an adjacent untreated site. In the waterspreading system samples were taken in 2008, following chaininng (2002), raking and waterspreading (2006)

Variable	Adjacent untreated site	6 year old waterspreading system
Herbage dry weight (units)Kg/Ha	146	5,061
Ground cover (%)	26	98
Visual change in pasture species across whole waterspreading system	80% No9 Wiregrass & Corkscrew	5% No9 Wiregrass & Corkscrew
Soft palatable grasses & herbage	5%	80%
Estimated sustainable stocking rate	1 cow to 50 hectares	1 cow to 9 hectares
Species diversity	47	+ 350

Table 1 shows a pronounced increase in both average herbage dry weight and ground cover following water spreading. Similarly, there has been a very obvious shift away from the dominance of undesirable pasture species, and an increase in pasture species diversity. These changes have resulted in a notable improvement in the on-farm stocking rate.

Soil C and N

Total C, and available N showed similar trends across the different ages of waterspreading systems sampled, compared with the scrub patch (Fig. 1). Total N followed C very closely and is not reported here. The 2 year old waterspreader had higher C, N, and available N compared with the scrub patch. This difference was not evident in the 15 year old system, but was present in the oldest (30 year old) system. In the 30 year old system the available N was significantly higher compared to all other systems.

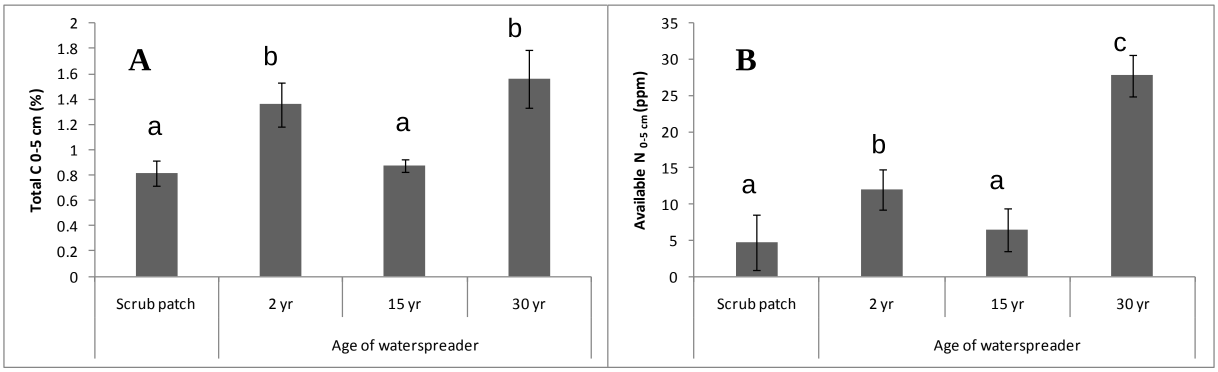

Fig. 1. Total carbon (A) and available N (B) in 0-5 cm soil of three waterspreading systems of different ages, and one adjacent patch of Turpentine (E. sturtii) mixed scrub. Different lowercase letter denote differences between sites at P<0.05.

Discussion

There are complex processes operating in semi-arid systems, processes that waterspreading capitalises on. By building upon an understanding of how runoff interacts with soil condition, waterspreading targets the source-sink functioning of the soil surface over a timeframe that is relevant to the boom-bust cycles of the semi-arid zone. The difference between waterspread treated and non-treated INS sites is clear cut. The implementation of waterspreading banks combined with the removal of the INS is restoring grasslands on the landscape, improving pasture biodiversity, increasing carrying capacity and ensuring farm viability.

There is large potential for waterspreading to not only improve pasture stability, productivity and diversity, but to beneficially alter surface soil condition over a long time period. The higher C and available N in surface soils in the young water spreading system compared with the patch of scrub probably reflects the short term release of nutrients into the soil from biomass following the management of scrub (and burning of material) during waterspreader implementation. Similarly, the lower nutrient values in the 15 year old system may be indicative of this nutrient loss in the longer term, as the system utilises these new found, relatively available resources, or resources are removed via grazing or leaching. If this is the case, then the much higher values found in the 30 year old system may indicate the progression of the waterspreaders into a new stable state, in which nutrients accure and cycle at higher levels. The doubling of surface soil C when the scrub patch is compared with the 30 year old waterspreader is a large change compared with other post-INS grazing systems in the region (Tighe et al. 2009). These trends reflect the potential of waterspreading to alter soil condition over a long time period, but a more comprehensive sampling regime is required to confirm this.

This study shows waterspreading can produce dramatic changes in a degraded system, and it does so by targeting the processes that govern resource movement within semi-arid systems. Such changes occurr over a long time period (5-7 years for initial pasture changes, up to 30 years for soil nutrient changes) which match the long term variability of such semi-arid systems.

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