

Changes in land management practices have reduced wind erosion on the cropping country of south-western NSW

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Abstract

Since the mid-1970s, a conversion of ~250,000 ha of rangelands to cropping in semi-arid south-west NSW has resulted in substantial wind erosion. Over recent decades, multi-faceted extension programs have promoted sustainable land management practices to reduce wind erosion. To determine which practices control wind erosion and if the practices are changing through time, repeated biannual paddock surveys were undertaken between 2003 and 2021. These data show the adoption of practices that maintain ground cover, reduce wind erosion. Best management practices (BMP) included using chemical fallow, maintaining standing stubble and having perennial pastures. The proportion of sites with BMP increased from 14% to 72%, equating to an increase of 3.2% per year. Conversely, practices that reduced ground cover to below target levels, including tilled pasture, tilled stubble, grazed stubble, or grazed perennial legume pastures, were associated with higher levels of wind erosion. In drier years, livestock grazing crop stubble is a key cause of erosion. In 2020, the Western Local Land Services (LLS) conducted a social benchmarking survey that indicated >80% of respondents sourced their information for practice change from neighbours, stock agents, land services, farmer and community groups, and industry bodies. New programs that highlight feed-budgeting and grazing methods to avoid erosion are currently being implemented.

Key Words: roadside survey, practice change, grazing management

Introduction

Since the 1970s, ~250,000 ha of rangelands in the semi-arid south-west of NSW have converted from pastoral to cropping land use. This conversion, done under licence and permit on the predominantly Western Lands Leasehold tenements, has at times, resulted in substantial wind erosion occurring on the aeolian landscape (Leys *et al.* 1994). Specifically, traditional cultivation practices used during fallow to prepare paddocks for sowing, exposed soils to a high risk of wind erosion (French 1993). However, minimum tillage and direct drilling techniques have greater capacity to retain crop residues, minimise soil disturbance and maintain ground cover to prevent erosion.

The Australian government has widely invested to change land management practice over the last 30 years (e.g., Australian Government 1995, 2008). These investments aim to encourage land management practices that protect and enhance soil, water and biological resources, thereby sustaining and benefiting the community now and into the future. Therefore, quantifying firstly current land management practice and secondly, any change in practices are worthwhile to identify successes and prioritise future investments.

Tracking land management practice change through time is a challenge. The Australian Bureau of Statistics has taken various approaches to collect such data, including its agricultural census (1995-96 and 2000-01) and the Agricultural Resource Management Survey (2007-08 and 2009-10). These data showed that the success of programs like Caring for our Country depended upon land management practices that improved ground cover to reduce wind and water erosion (ACLUMP 2010). Further, the data provided information on how various land management practices influenced ground cover in local, state and national Natural Resource Management (NRM) regions (ABS 2008). But the data did not report on the erosion outcomes, and in the south-west of NSW the management practices seemed to differ from what field officers observed. To fill this gap, the local NRM region used the example of Anderson *et al.* (1992) to develop a preliminary roadside survey (RoS) method. Since 2003, the Western Local Land Services (LLS) region has refined the RoS methodology and used it to gather local data that report against its management targets. In this paper, using data from 2003 to 2020, we determine which land management practices were associated with wind erosion, evaluate whether land management practice has changed, and if these changes resulted in improved erosion outcome. The understanding gained from this process is used to suggest areas for future investment that might further reduce wind erosion in the region.

Methods

We used a roadside survey (RoS) methodology to observe land management practice and erosion outcome at 260 geo-located sites in the Balranald and Wentworth Shires of the Western LLS region in south-west NSW. The method is based on similar rapid observational surveys used in other Australian states (Anderson *et al.* 1992; Forward 2009; Laycock 2010; McCord & Payne 2004). The key difference being that our observations were made from a stationary vehicle which enabled us to; 1) assess multiple attributes, and 2) focus on a small sample site which aids in repeatability. Each site (20 m x 20 m), located on land permitted for cropping, was 20-100 m inside paddocks adjacent to public roads and stratified by the endemic vegetation community (Val 1999). For example, if 30% of the cultivation area in the Western LLS is in the Mallee Mosaic community, then 30% of the 260 sites were in that community. For each site, 13 static biophysical attributes were documented (e.g., vegetation community, soil type, soil landform), and 18 dynamic variables (e.g., land management practice, ground cover level, erosion level) were observed through time.

Sites were surveyed twice a year in summer and autumn, from 2003 to 2021, to identify key land management practices and their changes, and erosion outcomes. For example, the summer survey identified plant type, crop species, fallow method and duration. The autumn survey identified any subsequent change in land management practices, and their impacts on groundcover level and erosion outcome. Data capture, quality assurance and graphical interpretation were managed in a database that used GPS guidance to locate each site (Murphy 2009).

Land management practices were defined in four groups: crop, fallow, pasture, stubble. These groups were further divided into sub-types, e.g., 'cereal' crop, 'tilled' fallow, 'perennial' pasture, or 'grazed' stubble. This sub-division resulted in 29 unique practices. Local agronomists, then grouped the unique practices into four 'Best Management Practices (BMPs)':

- Crop - e.g., cereal crop,
- Chemical fallow - e.g., sprayed pasture or crop residues,
- Perennial pasture - e.g., chenopod shrubs, copper burrs, spear grass, lucerne,
- Standing stubble - e.g., Crop residue has greater than 50% standing.

For this study we used autumn survey data, as this is the time of year when plant dry matter and ground cover are at their lowest, and erosion is most observable. We recorded 25 unique land management practices over the 19 years in a total of 4,940 observations. To determine the impact of the land management practices, we determined the percentage of sites that erosion was observed for each land management practice and used regression to determine change through time.

Results / Discussion

Which land management practices resulted in or controlled wind erosion?

Analysing the frequency of sites having erosion per BMP showed those with <15% erosion were: standing stubble, crop, chemical fallow, and perennial pasture (1, 3, 7 and 9% of sites, respectively). However, the highest frequency of erosion was detected on several unique land management practices: grazed stubble, perennial legume pasture, and tillage (20, 40 and 43% of sites, respectively).

How have the practices changed over time?

The percentage of sites in each BMP and for all BMP's combined, together with the total proportion of sites with erosion each year is shown in Figure 1. There has been an increase in the percentage of sites with a BMP (from 14 to 72%, Figure 1a), and a decrease in the percentage of sites with erosion (from 23 to 9%, Figure 1b). The drivers for improvement have been the increased proportions of chemical fallow and standing stubble. In certain years stubble management becomes an issue. When standing stubble declines, e.g., 2019 erosion increases.

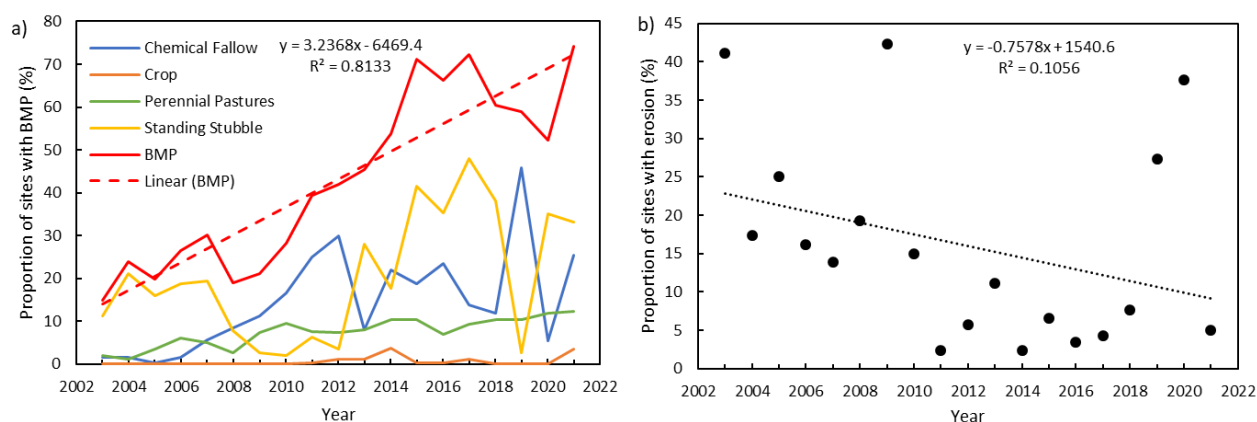


Figure 1. The percentage of sites observed in autumn each year with a) Best Management Practices (BMP), and b) erosion.

Which practices can we target to further reduce erosion?

Sites where stubble is grazed or sown to perennial legume pastures (i.e., lucerne), tend to have high frequency of erosion. Over the last three years, the frequency of erosion on grazed stubbles has increased to above 35% of sites, which is higher than the previous 15 years of observations. We suggest that high stock prices and dry conditions in recent years have been a contributing factor to the over utilisation of stubble.

French (1993) noted, with a change from rangelands to cropping, having livestock in the system would increase pressure, particularly in drier years, on maintaining crop stubbles. Our data indeed shows that grazing of crop stubbles frequently leads to higher rates of wind

erosion. Hence, we conclude there is a need for targeted programs to address grazing management and forage budgeting to avoid over utilisation.

Where do landholders get their land management practice information?

Landholders sourced >80% of practice change information from five sources, neighbours and other landholders, stock and station agents, Western LLS, farming groups and industry bodies (Local Land Services 2021). When examining the linkages between sources of information and subsequent decision making, often we see trends, rather than deterministic relationships, as the decision-making process is imperfect and influenced by a range of circumstances (Pannell *et al.* 2006). Whilst the Western LLS survey presents the sources of information, specific detail on south-west NSW cropping areas is needed to establish a causal link between extension programs and reported practice change. This will allow future extension programs to be tailored to ensure the adoption of BMP continues to increase.

Conclusions

The land management practices associated with wind erosion were tilled pasture, tilled stubble, grazed stubble, or grazed perennial legume pastures. BMPs all had low levels of erosion. Adoption of BMPs has increased from 14 to 72%, while erosion decreased from 23 to 9%. This suggests that extension messages on minimum tillage and direct drilling have been adopted. However, there is an opportunity to target future extension activities on grazing management of stubbles and pastures to reduce erosion.

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Conflicts of Interest

The authors identify no conflict of interest.

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Summary text for newsletter

Long-term paddock surveys in south-west NSW from 2003 to 2021 show that the increased adoption of best management practices (from 15 to 75% of sites) has reduced wind erosion (from 23 to 9% of sites). To further reduce erosion, we suggest there is an opportunity to target future extension activities on grazing management of stubbles and pastures.