Soil conservation in the paddock - keeping a full plate into the future effects of farming practices on red soils in central West NSW.

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Summary. In the 1991/92 cropping season, a study was made of 61 paddocks from 30 farms in a region roughly bound by the towns of Trangie, Nyngan, Lake Cargelligo. and Condobolin in central west NSW. The study collected data on each paddock's cropping history and general farming practices. soils and crops and aimed to evaluate the effect of different management systems on soil physical and chemical fertility. Inherent soil factors have the highest correlation with soil strength. The management practices which had the highest association with soil strength were the number of cultivations before sowing and the number of consecutive years of cropping.

Introduction

Australia-wide it is estimated that there are 8.4 million ha of fragile and potentially hardsetting red soils (9) occupying approximately 1/5 of our country's land used for wheat production. The hardsetting nature of soils is a structural problem that is perceived to considerably limit the yield capability of soils for cropping. Problems associated with these soils revolve around the rapid development of high soil strength on drying and in a deterioration in soil hydraulic properties. Specific agronomic problems include poor establishment of sown crops and pastures. restricted root growth, poor aeration in wet conditions, lowered infiltration rates and a soil's vulnerability to structural damage by cultivation outside a narrow range of moisture contents. Evidence that these problems are related to cultivation and cropping include decreasing aggregate stability and soil organic matter, which have been well documented in the past in the cropping zones of NSW, SA, and WA (1,3,10,12).

This paper will discuss some of the results from a NSCP-funded project on the management of hardsetting red soils. Preliminary results from a farm monitoring project which covered 61 paddocks from 30 farms in the Nyngan and Condobolin regions of central west NSW will be presented. This region is considered to be a marginal cropping area with average annual rainfall ranging from 420 mm near Lake Cargelligo to 480 mm at Trangic and having a co-efficient of variation exceeding 40%. A mixed wheat/sheep enterprise is the most common farming system. The soils in this study ranged in texture from sandy loam *to* silty loam with clay contents between 10-30% in the surface 0-0.1 m.

The project was undertaken in the 1991/92 cropping season and aimed to investigate. using survey and questionnaire techniques and laboratory analyses of soils:

- the effects of different farming practices on soil physical and chemical properties, especially soil strength. and
- what factors account for most of the variability in these soil properties.

Methods

Site selection

Sites were selected using the following procedure:

- sites had to be on red soil
- sites had to cover a range of cropping intensities over the last 10 years
- properties satisfying the selection criteria were chosen *with the* help of the local District Agronomists and other NSW Agriculture personnel who had knowledge of the study area.

Survey methodology

Once properties were selected all the landholders were interviewed individually in order to complete an initial questionnaire on their farming practices. Soil samples were taken from selected monitoring sites on each farm and a cropping history for each site for at least the last 10 years was also obtained. Fifty-one variables covering general farming practices (e.g. fertiliser use. fallowing. stubble burning. tillage implements, cropping frequency and intensity) and soil variables were recorded or determined from each site.

Results and discussion

Table I summarises the major differences in soil properties between adjacent cropped and uncropped paddocks in this study.

Table I Differences in some soil properties between cropped and uncropped soils. with maximum and minimum values shown in parentheses.

Soil property	Uncropped soils		Cropped soils	
	(0-2.5 cm)	(2.5-10 cm)	(0-2.5 cm)	(2.5-10 cm)
Organic carbon (%)	2.81 (1.17, 9.32)	1.36 (0.70, 3.18)	1.38 (0.87, 2.32)	1.21 (0.67, 1.75)
Total nitrogen (%)	0.200 (0.113,0.550)	0.106 (0.053, 0.199)	0.127 (0.047, 0.210)	0.098 (0.052, 0.138)
C/N ratio	13.3 (10.36, 19.14)	12.7 (10.0, 16.0)	11.13 (7.03, 18.50)	12.59 (9.63, 17.82).
Ec	0.116 (0.020, 0.405)	0.057 (0.030, 0.130)	0.095 (0.020, 0.355)	0.055 (0.020, 0.105)
p H	5.45 (4.97, 6.17)	5.27 (4.53, 6.28)	5.06 (4.40, 6.52)	4.84 (4.10, 7.28)
% Water stable aggregates (>250μm)	82 (77, 97)	69 (38, 93)	62 (20, 97)	46 (14, 63)
Soil strength (kg/cm^2)	0.32 (0.10, 0.70)	0.89 (0.10, 2.97)	1.18 (0.01, 3.89)	1.92 (0.10, 5.75).

Preliminary results show significant (P<0.001) declines in organic carbon, nitrogen and structural stability (as measured by wet sieving), but increases in soil strength and acidity of the cropped soils when compared to soils in the virgin (i.e., uncropped) state. The data also showed that soil strength and aggregate stability varied significantly with depth, with soil in the top 2.5 cm having significantly (P<0.001) lower strengths and higher aggregate stabilities than soil in the 2.5-10 cm layer.

The data from the farm monitoring project has so far been analysed using three statistical techniques:

- a correlation analysis - to remove variables that are highly correlated with each other
- a stepwise regression - to identify the best set of predictive variables that relate to air dry soil strength
- a tree regression - to identify the interaction and relationships between variables which are associated with soil strength.

Because farm management variables were overridden by soil variables in the original tree regression analysis, the data was split into two groups and separate analyses were done for each group. Models predicting soil strength using separate tree regressions for farm management variables and soil variables are shown in Figs. I and 2 respectively.

The results in Fig. I show that of the 20 management variables that were measured, the number of cultivations before sowing and the number of crops sown in a row have the greatest effect on soil strength.

The preliminary results show that the amount of coarse sand in the soil accounts for over 50% of the variation in air dry soil strength. In the soils of the study region, coarse sand is highly correlated with the collective amount of fine sand and silt (r=-0.91). Therefore air dry soil strength is also related to the fine sand plus silt content.

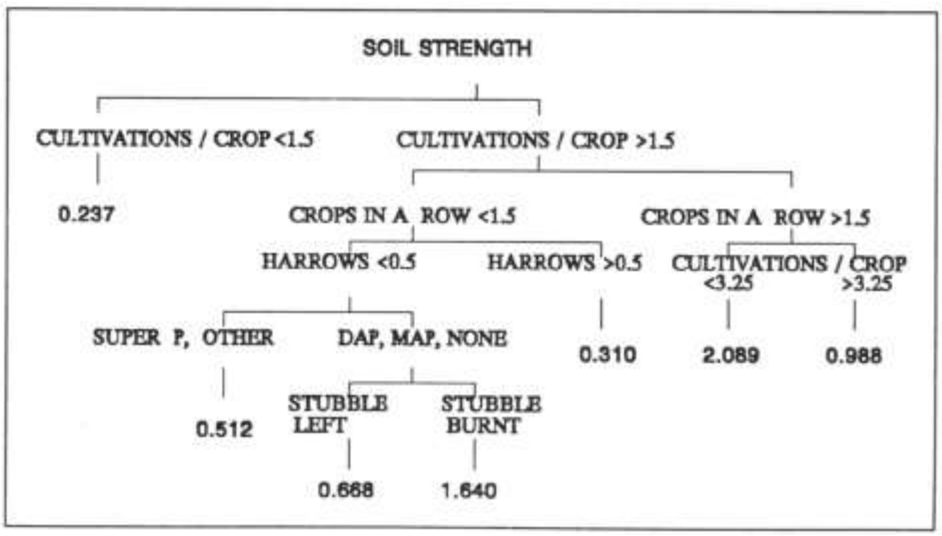

Figure 1. Tree regression predicting values of soil strength (kg/cm^2) based on management variables.

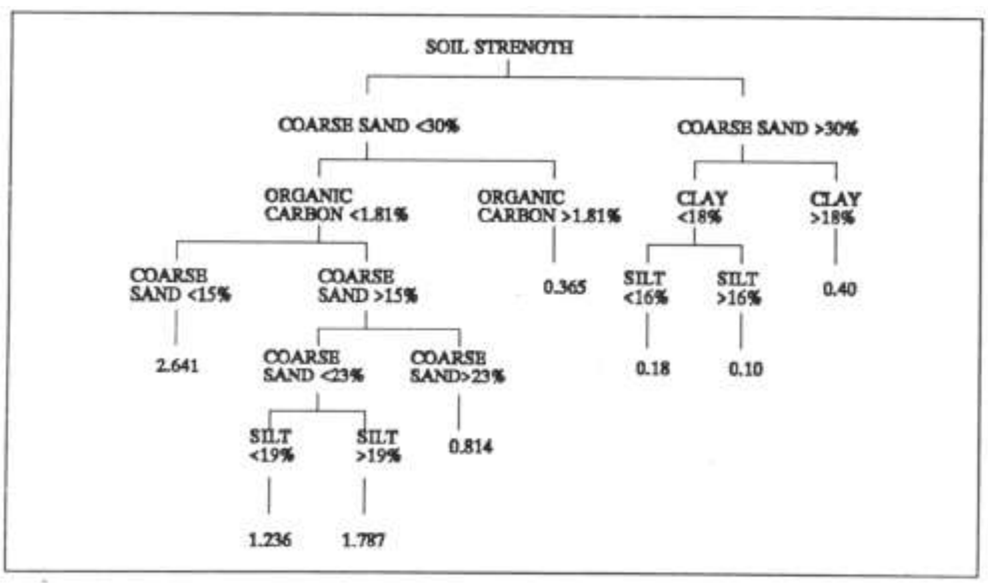

Figure 2. Tree regression predicting values of soil strength (kg/cm^2) based on soil variables.

From the results shown in Fig. 2, it can be seen that the highest soil strength is found when the coarse sand content is less than 15% and organic carbon is less than 1.81%. For soils with less than 30% coarse sand, organic carbon plays a dominant role in controlling soil strength. The significant boundary of 1.81%

for a soil's organic carbon level as obtained in this study is higher than the 1% commonly associated with critical organic carbon levels below which soils exhibit structural problems. This highlights the fragile nature of the soils in the study region.

Data from this project (Table I and Fig. 2) supports the results of previous research, that if certain textural criteria are satisfied (i.e., critical limits of coarse sand, fine sand and silt), the soil will have the *potential* to develop high strength (2,4,5,6,7,8.11) and farm management. through its influence on organic carbon, then plays an important role.

Acknowledgements

Many thanks to Mr. Gavin Melville for the statistical analyses, to Mr. Warren Smith for assistance in the field and to the National Soil Conservation Program for funding this research.

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