



Department of  
Primary Industries and  
Regional Development

# Journal of the Department of Agriculture, Western Australia, Series 4

---

Volume 3  
Number 7 July, 1962

Article 2


---

1-1-1962

## Loss of structure in wheatbelt soils

T C. Stoneman

Follow this and additional works at: [https://researchlibrary.agric.wa.gov.au/journal\\_agriculture4](https://researchlibrary.agric.wa.gov.au/journal_agriculture4)

 Part of the [Environmental Indicators and Impact Assessment Commons](#), [Sedimentology Commons](#), and the [Soil Science Commons](#)

---

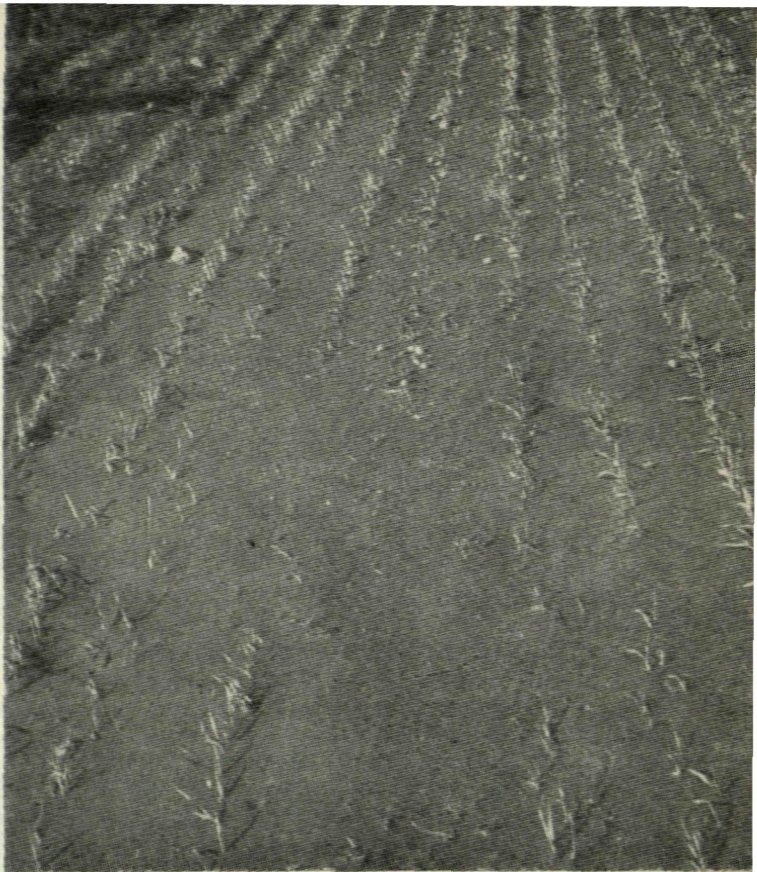
### Recommended Citation

Stoneman, T C. (1962) "Loss of structure in wheatbelt soils," *Journal of the Department of Agriculture, Western Australia, Series 4: Vol. 3 : No. 7 , Article 2.*  
Available at: [https://researchlibrary.agric.wa.gov.au/journal\\_agriculture4/vol3/iss7/2](https://researchlibrary.agric.wa.gov.au/journal_agriculture4/vol3/iss7/2)

This article is brought to you for free and open access by Research Library. It has been accepted for inclusion in Journal of the Department of Agriculture, Western Australia, Series 4 by an authorized administrator of Research Library. For more information, please contact [jennifer.heathcote@agric.wa.gov.au](mailto:jennifer.heathcote@agric.wa.gov.au), [sandra.papenfus@agric.wa.gov.au](mailto:sandra.papenfus@agric.wa.gov.au), [paul.orange@dpird.wa.gov.au](mailto:paul.orange@dpird.wa.gov.au).

Survey Shows . . .

# LOSS OF STRUCTURE IN WHEATBELT SOILS



One of the signs of loss of soil structure—a patch where germinating wheat plants failed to break through a hard surface crust. Water tends to run off instead of soaking in, so creating an erosion hazard. Drainage is also poor, and root growth may be limited

*(Picture from South Australian Journal of Agriculture.)*

By T. C. STONEMAN, B.Sc. (Agric.), Research Officer, Soils Division

**M**ANY of the heavy soils of the West Australian wheatbelt have been farmed for 30 or 40 years, and farmers now frequently complain that these soils are becoming more difficult to handle, that greater power is needed to break up the soil, and the time that it remains in a workable condition after rains is shorter.

These may be indications that the structure of the soil has suffered as a result of years of cultivation.

Soil structure—the physical condition of the soil—refers to the way in which the organic matter and separate particles of sand, silt and clay are bonded together into soil crumbs or aggregates.

A soil with a good crumbly structure has good drainage, is easily penetrated by plant roots, and is much more easily (and successfully) worked by farm implements.

A heavy soil loses these desirable properties as its structure is broken down by poor soil management or excessive cultivation. This is what may have happened to some of the older wheatbelt soils.

Soil structure investigations were undertaken in the years 1958-1960 to try to gather evidence either supporting or discounting these views. Field experiments were also carried out to assess the effect of soil structure on wheat yield, and, the role of periods of pasture ley in soil structure build-up.

## SOILS STUDIED IN STRUCTURE SURVEY

For the purposes of this article, the six soils studied can be described by their local names, which are dependent on the original dominant tree cover. They are:—

### **"Salmon Gum and Gimlet" Soil at Merredin**

This soil is representative of the soils of the broad flat valleys of the outer wheat-belt. The surface soil here sampled was clay loam in texture.

### **"Tamma Scrub" Sandplain Soil at Merredin**

This soil is typical of much of the high level sandplain country in the lower rainfall parts of the wheatgrowing areas. Soils of this type are brownish yellow in colour and their texture becomes gradually finer below the sand or loamy sand surface. Moderate to large amounts of ferruginous gravel occur in the subsoils.

### **"Morrel" Silt Loam at Corrigin**

This is a "fluffy" surfaced calcareous soil, usually about 12 inches of grey-brown loam to silt loam over a light brown clay loam subsoil containing small and large nodules of calcium carbonate.

### **"Jam" Soil at Yealering**

This is a shallow podzolized granitic soil, with a sandy loam surface.

### **"Salmon Gum" Soil near Quairading**

The profile of this soil has six inches of light brown sandy loam over yellowish brown clay to 12 inches at which depth calcareous nodules appear.

### **"Mallee" Soil near Quairading**

This soil has a sandy loam surface over clay at about six inches.

## **METHOD OF SURVEY**

At each site soil in the virgin condition was compared with adjacent cultivated soil. None of these soils, where sampled,

had at any stage carried a leguminous pasture.

Many hundreds of samples were collected and a variety of tests applied both in the paddock and in the laboratory. The various tests used assess the many different aspects of the structure of soil and so arrive at a meaningful overall picture of its physical condition. The characteristics which were assessed are discussed and results given below.

## **TECHNIQUES AND RESULTS**

### **Apparent Density:**

Compaction by machinery and stock may cause changes in the soil structure which are readily evaluated by measuring soil apparent density. This is the weight of solid dry soil material occupying a fixed volume. In all six soils this value had increased in the cleared soil, thereby providing evidence of compaction.

### **Penetrability:**

This is the relative ease with which soil can be penetrated by a pointed probe.

By inference it gives an indication of the relative resistances different soils would offer to penetration and disruption by cultivating implements. It also provides a useful comparison of the effect of different management practices on the same soil type.

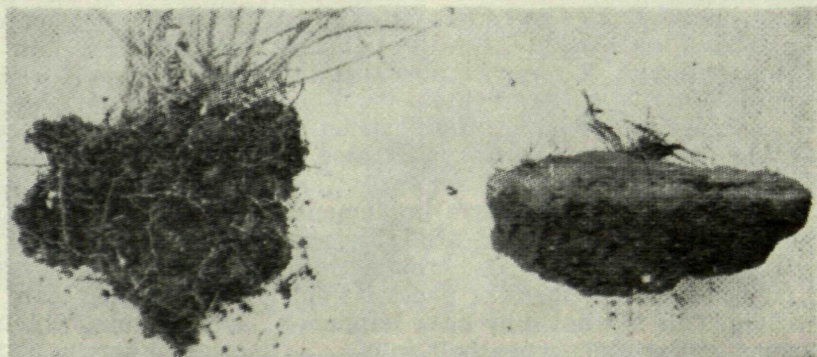
The results indicated that for four of the six soils examined, the cleared soil was much more difficult to penetrate (i.e., compacted) than the virgin soil.

### **Pore Space Analysis:**

This term describes the technique used for measuring the different sized pores or spaces occurring in soils between the individual soil particles. Large pore spaces

Contrast in soil structure. The sample on the left was taken from under the fence, where it has missed cultivation; the one on the right came from the cultivated part of the paddock. Note the crumbly nature and good root penetration of the first sample, and the cloddy, compacted condition of the second

(Picture from *South Australian Journal of Agriculture*.)



are important in providing rapid drainage and satisfactory aeration; small pore spaces are necessary to provide water storage in the soil.

The large pore space in five of the six cleared soils had suffered severely over the years. In four soils, aeration of cultivated soil had been reduced to less than half the aeration in the virgin state.

#### Soil Aggregation:

A soil is said to have good soil structure when most of the primary particles of clay, silt and sand are held together into small clumps or crumbs, and these crumbs are water-stable; that is, on wetting they do not readily collapse or disperse.

When a soil has a good crumb structure, it has good drainage and aeration, good water intake and retention properties, and does not "melt" during rain and so lead to unnecessary run-off and consequent erosion. The range of sizes of these crumbs as they occur in the field and their stability to wetting can be measured in the laboratory.

Again, in all but one soil, the stability of the aggregates occurring in the cleared

soils was markedly less than in the soils in the virgin condition.

#### Organic Carbon and Nitrogen:

The maintenance of reasonable levels of organic carbon (organic matter) is important in maintaining good soil structure and fertility. The changes in organic carbon and total soil nitrogen as a result of management can be chemically assessed.

Agricultural development of four of these soils has resulted in a reduction in the levels of organic carbon and nitrogen.

Assuming that the above measurements are a reasonable estimate of physical condition, the data obtained indicate clearly that the soils examined have suffered considerably in physical condition since clearing. In nearly every case, there has been a considerable drop in the organic carbon content, an increase in density, and a lowering of pore space, particularly of the large pores. Penetration has become very difficult and the stability of soil crumbs has deteriorated.

These results are detailed in the table below.

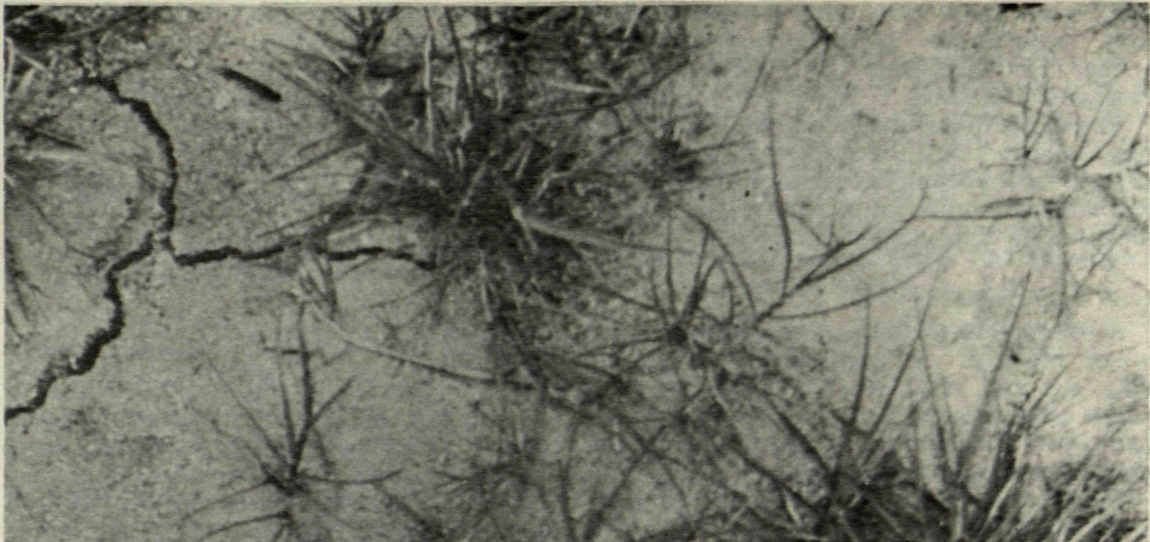
### STRUCTURE MEASUREMENTS ON WHEATBELT SOILS

Soil Type	Condition	Organic Carbon (%)	Water Stable Aggregates (% > 1 m.m.)	Bulk Density (g/c.c.)	Non-Capillary Pore Space c.c./c.c.	Penetrometer Readings (inches)
Salmon Gum—Gimlet soil, Merredin (Loam)	Virgin	1.33†	19.64	1.24†	20.3†	5.07‡
	cleared 40 years	0.85	18.50	1.68	9.3	3.18
Tamma Scrub Sandplain, Merredin (Sandy Loam)	Virgin	0.85	56.48‡	1.25‡	23.6†	4.93‡
	cleared 9 years	1.01*	16.47	1.39	21.4	4.58
Morrel soil, Corrigin (Silt Loam)	Virgin	2.79‡	40.40‡	1.05‡	18.53‡	4.10‡
	cleared 37 years	1.19	11.29	1.38	8.25	3.58
Jam soil, Yealering (Sandy Loam)	Virgin	1.51†	51.20‡	1.46‡	19.76	3.56
	cleared 36 years	0.88	34.29	1.53	19.59	4.03‡
Salmon Gum soil, Quairading (Sandy Loam)	Virgin	0.88	33.73†	1.52‡	14.39‡	1.99*
	cleared	1.06‡	15.79	1.67	6.22	1.73
Mallee soil, Quairading (Sandy Loam)	Virgin	1.34‡	37.66‡	1.57‡	9.82‡	2.23
	cleared 44 years	0.99	15.54	1.78	4.03	3.25‡

\* Denotes significant differences at 5% level.

† Denotes significant differences at 1% level.

‡ Denotes significant differences at 0.1% level.



Poor structure of a heavy soil near Qualtrading. The surface is crusted, and large cracks have formed on drying out

## EFFECT OF STRUCTURE DETERIORATION ON YIELD

The work carried out provides direct evidence of an actual deterioration in the physical condition on some wheatbelt soils. However, this does not, in itself, show that this decline has any influence on plant production.

As a means of assessing the effect of soil structure on crop yields an experiment was conducted at the Merredin Research Station during 1959. The soil used was "salmon gum-gimlet" country fallowed in 1958.

By experimental treatment, two levels of soil structure were obtained, "normal" and "improved" both of which were sown to wheat.

The "improved" soil structure treatment was obtained by incorporating in the soil



Crumbly structure of the same soil treated with a soil conditioner in an experiment to assess the effect of structure on crop yield. Improving the structure resulted in a 25 per cent. higher wheat yield in an experiment on Merredin Research Station

a synthetic chemical soil conditioner (Krilium Loamaker) which has been reported to have the ability to maintain a good structure in most soils containing reasonable amounts of clay.

The growing season was abnormally dry during 1959 at Merredin. To maintain growth and achieve a reasonable yield level, artificial watering was therefore used on two occasions during the spring, all plots receiving equal amounts of water.

Harvest results showed a 25 per cent. increase in yield of wheat on the "improved" soil structure treatment. Also, the grain weights from the "improved" struc-

ture treatment were significantly greater than for the "normal" treatment.

Thus improved soil structure gave a higher yield of grain due to

- (a) heavier grain and
- (b) a greater number of wheat grains per plot than the untreated soil.

Treatment	Mean Yield Grams/plot	Mean Wt. of 1000 grains of Wheat (Grams)
Soil conditioner ...	2552	36.05
No soil conditioner	2031	34.89

Differences significant at the 5 per cent. level

## EFFECT OF PASTURES ON SOIL STRUCTURE

On the fine textured soils in the lower rainfall areas of the wheatbelt, some soil samplings have been carried out to assess the effect of a number of years under pasture, both volunteer and barrel medic, on soil structures.

These assessments have been made on the surface few inches of soil only and have used a wet sieving method to determine soil aggregate stability.

These results suggest that after five or six years under pasture, either volunteer pasture (mainly barley grass) or barrel medic pasture, water stable aggregation had more than doubled compared with the paddock soil outside the plot. The paddock had been worked under a three or four year rotation, including fallow, and showed signs of poor soil structure.

The build-up of soil structure under various pastures over a number of years and the effects of soil compaction by grazing stock in the winter months are aspects which are to be studied in the drier wheatbelt during the next few years.

More detailed results are available of the effect of subterranean clover pasture and volunteer pasture on soil structure in a higher rainfall area. This information was obtained from an experiment which ran for five years on a medium textured soil west of Brookton.

In this study, both forms of continuous pasture produced significantly better soil aggregation than a three year rotation of volunteer pasture-fallow-wheat.

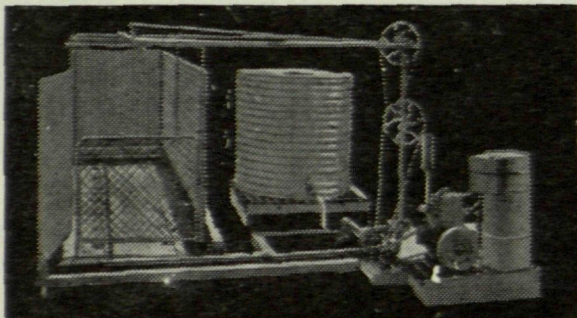
The results also suggest that most of the improvement in soil aggregation took place in the first three years of the five year period.

### IN BRIEF

- A soil structure survey of six commonly occurring wheatbelt soils provided evidence of a decline in the physical condition of these soils.
- Results of a soil structure experiment at Merredin Research Station suggested that if soil structure could be improved higher grain yields would result. This indicates that soil structure deterioration in wheatbelt soils is playing a part in restricting wheat yields.
- There is some evidence that the structure of fine textured soils in the lower rainfall districts under pasture for five or six years improves considerably. Further work in this field is outlined.
- In a high rainfall district, five years under continuous subterranean clover or volunteer pasture considerably increased soil aggregation.

# Sunbeam COOPER 'ANTI-STRIP'

(TRADE MARK)



This revolutionary new sheepshowering method gives you:

- ★ A clean, effective, evenly distributed ash from the first sheep to the very last!
- ★ Whatever dip you prefer, you can use at original effective strength, without wasteful stripping or reinforcement.
- ★ Over 50% saving in installation costs.
- ★ Over 30% saving in dip costs by completely eliminating the necessity to reinforce.

Made in Australia by Sunbeam Corporation Limited  
(Formerly Cooper Engineering Co. Pty. Ltd.)

CONTACT YOUR W.A. DISTRIBUTORS NOW . . . .

for further details

## DALGETY & NEW ZEALAND LOAN LTD.

OR THEIR AGENTS

The "ANTI-STRIP" method of sheepshower was discovered by the C.I.S.R.O., and today can be practically applied by means of this "ANTI-STRIP" Sheepshower



EASY TO INSTAL . . . . OR  
SERVICES OF CONTRACTOR  
AVAILABLE TO COMPLETE THE  
INSTALLATION



*Ask for a representative  
to call, to select yard site with  
no obligations*

