Tactical fallows for the Victorian Mallee?

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ABSTRACT

Short (6 month) and long (18 month) fallows were simulated for the period 1939 to 2000 using the O'Leary-Connor fallow-wheat model. In the short-fallow, soil-water storage increased by 46 mm per 100 mm of fallow rainfall in excess of 55 mm (55 < fallow rainfall < 320 mm). Conversely, after a long-fallow, in the range of long-fallow rainfall to 760 mm, stored water increased by 28 mm per 100 mm of fallow rainfall in excess of 200 mm.

Short-fallow rainfall afforded adequate soil water at sowing to justify an immediate crop in ≈12% of years. These crops may warrant increased inputs to exploit the seasonal conditions. Otherwise, summer rainfall had an indeterminate bearing on fallow-crop strategy.

Summer rainfall may provide for a flexible fallow-crop strategy that maximises soil-water benefits for crops and minimise adverse environmental impacts in the Victorian Mallee.

KEY WORDS

Short-fallow, long-fallow, semi-arid, soil water, summer rainfall, fallow efficiency.

INTRODUCTION

A flexible crop strategy is advocated for cropping enterprises in the Great Plains Canada and USA (1). The region is semi-arid and subject to dryland salinity. The decision to fallow is based on profile soil water at sowing.

A similar situation arises in the Victorian Mallee where long-fallows are commonly used to supplement in-crop rainfall. Stubble and volunteer weeds dominate the first 9 months of the long-fallow after harvest after which weeds are actively controlled (tillage/herbicide) prior to sowing. Stubble and volunteer weeds dominate in the summer period prior to seedbed preparation in the short fallows between crops. Environmental (wind erosion and dryland salinity: 3, 6) and economic (sacrificed crop) penalties attributable to long fallow necessitate measures to balance soil-water benefits and environmental impacts.

This study questions the long-fallow/wheat rotation and investigates the scope for strategies that lessen the reliance on long fallow in the Victorian Mallee using a fallow-wheat simulation model.

MATERIAL AND METHODS

Site

This study was conducted at Walpeup (35^{o} 07' S., 142^{o} 00' E., 105 m elev.: mean annual rainfall = 337 mm) in Mallee region of north-west Victoria. Approximately 90 % of rainfall occurs in events up to 10 mm and larger storms (≥40 mm) dominate in summer and autumn.

Fallow-wheat model

The O'Leary-Connor fallow-wheat model (4), which was developed and validated for the Mallee environment (5), was used to examine soil-stored water after short and long fallows.

The analysis compared water conservation between harvest and sowing, under short and long fallow, for the period, 1939-2000.

Soil data appropriate to a sandy loam (Gc 1.2 (2)) were obtained from O'Leary and Connor (5). The model was initialised assuming a typical dry soil profile at harvest (soil-water deficit = 150 mm). Daily meteorological data, were obtained for Walpeup for the period, 1939 to 2000, from the Bureau of Meteorology (Station 076064). Data described screen air and soil surface minimum and maximum temperature; 0900 and 1500 h screen, air and wet bulb temperature; minimum, maximum, daily mean, 0900 and 1500 h relative humidity; rainfall; solar radiation and wind run.

RESULTS

Mean soil water content of long fallow was 212 mm at sowing (range 142-285 mm). By contrast, mean soil-water content after short fallow was 176 mm (range 139-259 mm). Figure 1 shows effects of short and long fallow on soil water accrued between harvest and sowing.

Short fallow storage (S) was described by the relationship

$$S = 0.46(RF - 55)$$

in the range of rainfall, $55 < RF < 320$ mm. That is, soil-water increased by 46 mm per 100 mm of fallow rainfall in excess of 55 mm in the short fallow.

Long-fallow storage (L) was described by

$$L = 0.28(RF - 200)$$

in the range of rainfall, $RF < 760$ mm. That is, soil-water increased by 28 mm per 100 mm of fallow rainfall in excess of 200 mm. In the range, $RF \geq 760$ mm, long-fallow storage verged on 155 mm (Fig. 1). By contrast, estimates of fallow storage failed to reach the upper limit in short fallows.

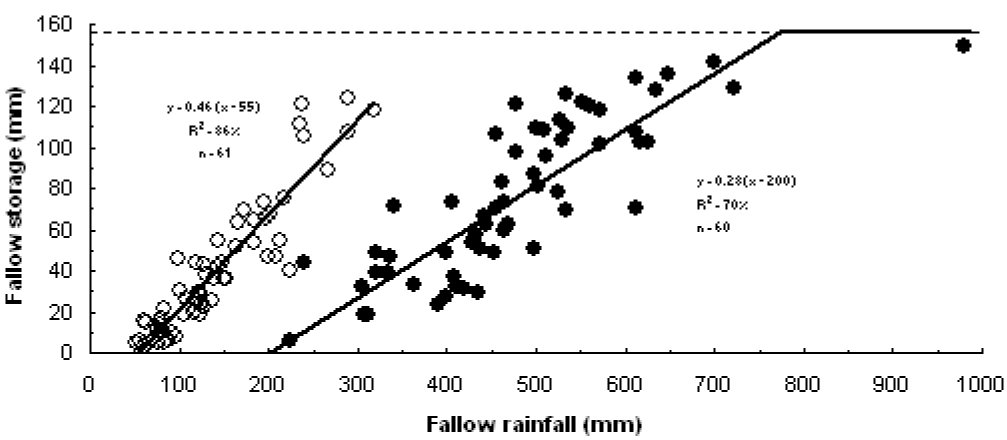

Figure 1. Simulated relationship between fallow rainfall and fallow soil-water storage at sowing after short-(O) and long-fallow (●) at Walpeup for the period 1939 to 2000. Note: simulations used a root zone soil-water holding capacity of 155 mm (sandy loam), represented by the dashed line.

DISCUSSION

High soil-water content at sowing predisposes soils to in-crop drainage. Soil water stored by long fallow exceeded that of short fallow (mean = 212 and 176 mm, respectively) and verged on the soil-water holding capacity more frequently than short fallow. Short fallow was therefore less conducive to in-crop drainage.

Root zone soil water holding capacity was taken as 155 mm in this work. Soil chemical and physical characteristics affect root zone soil water holding capacity with potential important effects on drainage.

A large soil water holding capacity confers a greater storage capability, a larger storage of rainfall, improved crop yield potential, and decreased in-crop drainage. Conversely, a lower soil water holding capacity than 155 mm reduces the storage of rainfall by soil, with negative effects on both yield and drainage outcomes. The sandy loam, simulated here, represents the upper spectrum of soil water holding capacity for the Mallee. The upper limit to storage is less in light soils and soils with root zone constraints. Therefore, the lower the water holding capacity of a soil the greater the hydrologic justification to substitute a crop for long fallow.

Long fallow appears unjustified in ca. 12 % of years when summer rainfall exceeds a threshold of 230 mm. Under those conditions, rainfall stored by short fallows equated with the upper half of responses elucidated by long fallow. The additional soil water conferred by long fallow was marginal and long fallow does not seem to be justified on economic and hyrological grounds.

By contrast, long fallow is justified in most years when summer rainfall fails to replenish harvest soil water. Low soil water content at sowing decreases the likelihood of drainage in both the crop and long fallow, but compromises crop yield potential.

CONCLUSION

In common with the ‘flexible cropping’ approach adopted in the northern Great Plains of Canada and USA (1), these data suggest the need to adopt a more strategic approach to fallow-cropping in the Victorian Mallee. Strategic cropping places a greater emphasis on cropping at the expense of long fallows under conditions of high summer rainfall.

Cropping is justified after wet short-fallow periods (≈12 % of years). These crops may warrant increased inputs to exploit the seasonal conditions. Long-fallow is justified for soil-water conservation due to the risk of drought. There appears to be potential for the reduction of long–fallow cropping in the Mallee. Further analyses are required to elucidate the threshold short-fallow rainfall below which long fallow is profitable.

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