CSIRO Land and Water

# Reaping the Rewards of Intensive, Flexible Cropping in the Mallee

In the semiarid environment of the Mallee, farmers tend to deal with the risks of low and highly variable rainfall through low input cropping. But there is a downside to this approach: farmers often miss opportunities to make higher returns during wetter seasons, because rainfall is actually underused in grain production.

Previous research has shown that many crops yield well below their potential. Limited by the availability of nitrogen and other constraints, these crops are unable to make use of extra rain, which will evaporate, run off or drain beyond the root zone - potentially driving soil erosion and dryland salinity.

The development of a forecasting tool for more accurate predictions of seasonal rainfall (Sheet No. 24) was the first step towards better risk-management in the Mallee. On the basis of this information, farmers can now select opportunistic combinations of crops (such as wheat, canola and legumes) and provide just the right amount of nitrogen to match soil and seasonal conditions.

CSIRO Land and Water has explored the potential for this flexible, intensive cropping approach, in collaboration with farmers in South Australia, Victoria and New South Wales. The approach is a viable alternative to current practices, which promises to increase farm profits, stabilise seasonal variations in income and improve water-use efficiency.

Greater yield, associated with improved efficiency in the use of resources, is essential to ensure the long-term viability of Australian farms.

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## The right combination of crops

The opportunistic selection of crops is based on the risk of critical biological stresses for cereals and the timing of the rainfall break (Fig. 1a).

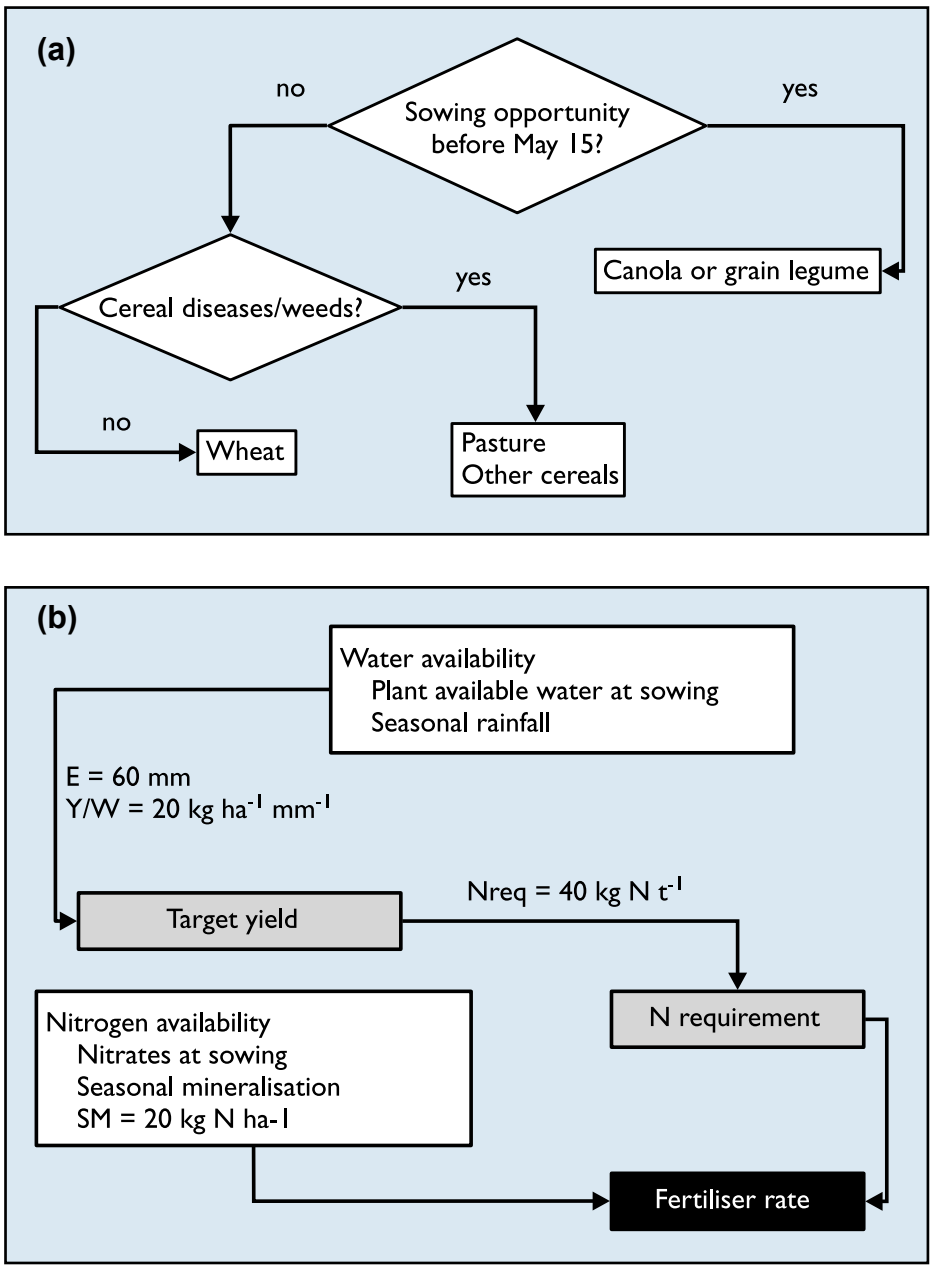
Early rains increase the likelihood of profitable yields, so canola or legumes may be selected. These 'break crops' tend to generate high profits in good seasons, but they are more risky, with greater production costs in comparison to cereals. The risk is further reduced if there is a good amount of stored water available in the soil at sowing.

Otherwise wheat is the preferred option, provided there are no major biological constraints (like wheat root diseases or grass weeds), which will switch the decision towards the other, more tolerant cereals, such as rye, or volunteer pasture.

## Matching of nitrogen input to soil and seasonal conditions

Estimates of the availability of water and nitrogen can be used to calculate the optimal dose of nitrogen fertiliser for canola and cereals (Fig. 1b). Two sources of water availability are considered: plant available water in the soil at sowing, and seasonal rainfall.

Available soil water can be estimated by sampling the top one metre of the soil profile. Upper and lower limits can be gathered from paddock measurements or soil texture. As seasonal rainfall is an unknown at the time of decision-making, the CSIRO forecasting rule is used where April is taken as an indication of seasonal conditions (refer to Sheet No. 24).




Target cereal yield is calculated assuming seasonal evaporation between 60–110mm and an ideal productivity of 20kg of grain per hectare per millimetre of seasonal rainfall and soil-available water (Fig. 1b). Two sources of available nitrogen are considered: soil inorganic nitrogen at sowing, derived from sampling of soil profiles, and a fixed amount of nitrogen mineralisation, derived from local measurements. Fertiliser rate is calculated as the difference between crop requirement and supply from these two sources.

***Figure 1: Framework for decision-making including (a) crop choice and (b) nitrogen fertiliser rate. In (b), key parameters for wheat are shown, including soil evaporation (E), attainable yield per unit available water (Y/W), nitrogen requirement per unit grain yield (NReq) and seasonal nitrogen mineralisation (SM).***

## Test of the concept

### *In the field:*

The feasibility of a more flexible, intensive cropping strategy for low-rainfall areas was assessed in collaboration with farmers involved in the Mallee Sustainable Farming Project.

In Waikerie SA, where average annual rainfall is 267mm with 66 per cent falling in the growing season (April to October), wheat/pasture with low inputs is common practice. But under flexible, intensive cropping, profits doubled and the variation between seasons was halved (Table 1).

Benefits of the intensive cropping approach included the possibility of growing successive wheat crops provided there are no major biological constraints (1998-99), the opportunistic use of canola as a break crop in the case of an early onset of seasonal rainfall (2000), and the high yield of wheat following canola (2001).

The fixed wheat/pulse approach also illustrated the high risk of untimely sown grain legumes (1999), and the benefits of growing wheat after a legume crop (2000).

### *On the computer:*

The impact of more intensive cropping on both nitrogen leaching and deep drainage was also investigated. A locally tested computer simulation model was used together with 44-year climatic records, which involved seasonal rainfall in the range of 53-334 mm.

Fig. 2 illustrates the long-term simulated yield response of crops managed with a fixed input of nitrogen (5kg per hectare) as opposed to a flexible nitrogen input aiming at matching fertiliser dose to soil and seasonal conditions. Crops with a fixed, low amount of nitrogen did not respond to higher soil moisture, whereas a variable rate of fertiliser accounted for a steady yield increase with increasing soil water content at sowing.

| Year | Cropping Strategy<br>Intensive | Wheat/Pasture | Wheat/Pulse |
|---|---|---|---|
| 1998 | $232 (wheat, 2.5) | $221 (wheat, 2.2) | $232 (wheat, 2.5) |
| 1999 | $110 (wheat, 1.6) | $40 (pasture) | -$87 (vetch, 0) |
| 2000 | $234 (canola, 1.2) | $143 (wheat, 1.5) | $222 (wheat, 2.3) |
| 2001 | $306 (wheat, 3.1) | $40 (pasture) | $162 (field pea, 1.3) |
| | | | |
| TOTAL | $882 | $444 | $529 |
| GMCV | 36% | 71% | 102% |

***Table 1. Gross margins ($ per hectare) and grain yields (tonnes per hectare) of three cropping strategies in a field trial at Waikerie (SA). The coefficient of variation of gross margins (GMCV, %) is also shown.***

Simulations also indicated a moderate decrease in drainage beyond the root zone (Table 2) with no significant increase in nitrogen leaching under the more intensive approach, despite a substantial increase in fertiliser dose. Effectively tuned to water availability, the higher nitrogen dose enhances crop growth, and also leaves less opportunity for deep drainage and associated nitrogen leaching beyond the root zone.

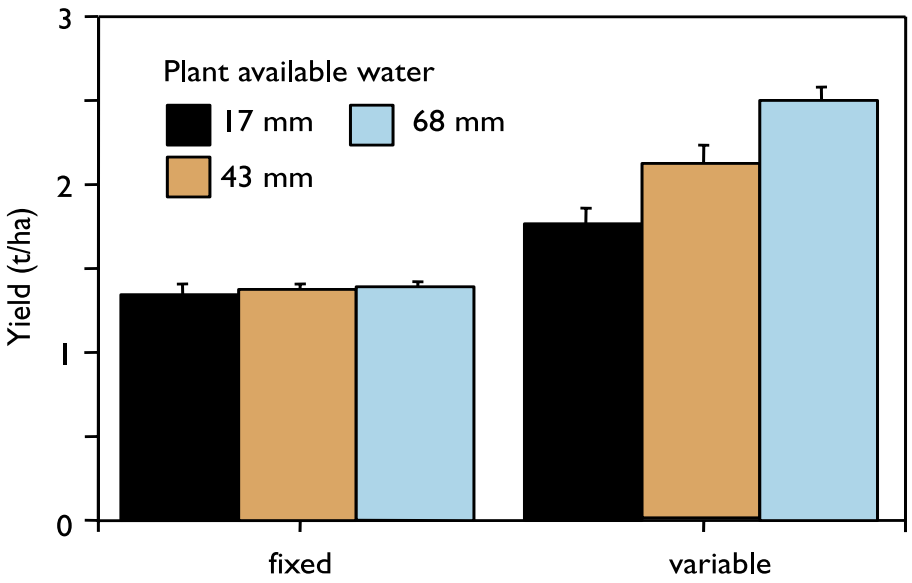



*Figure 2. Nitrogen fertiliser strategy*

| Cropping Strategy | Probability (percentage) of drainage events more than:<br>10mm | 20mm | 30mm |
|---|---|---|---|
| Intensive | 21 | 2 | 0 |
| Wheat-canola | 26 | 12 | 7 |
| Wheat-fallow | 30 | 16 | 7 |
| Wheat-pulse | 21 | 7 | 5 |

***Table 2. Intensive cropping approach can reduce deep drainage***

## Industry participation

With the support of the Grains Research and Development Corporation (GRDC) and the National Heritage Trust, the research team from CSIRO Land and Water studied the feasibility of opportunity cropping in the Mallee region, using both paddock trials and computer modelling experiments.

Victor Sadras, David Roget, Jeff Baldock and their team have worked closely with the farming community through the Mallee Sustainable Farming Project. The move to more intensive systems has been made easier through the establishment of farmer groups to help work through the adoption process.

A successful switch to more flexible, intensive cropping systems will require greater input from agronomic and financial management, with increased monitoring. User-friendly software is currently in development to facilitate the decision-making process. Farmers are invited to participate in this trial: the package is freely available through CSIRO Land and Water (see contact details below).

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## Embracing the Opportunity

**The flexible, intensive cropping approach is largely based on concepts that some growers already use in decision-making, but now, these decisions can be made with confidence. The key elements are:**

- **select crop type based on timing of rainfall break and risk of disease/ grassy weeds**
- **estimate seasonal rain using the CSIRO forecasting tool, or alternative forecasting tools as they became available**
- **calculate target yield**
- **measure the availability of nitrogen and water in the soil at sowing so as to provide just the right amount of fertiliser**

**Field trials and modelling experiments have shown that this approach is feasible, both in terms of the techniques used (e.g. soil sampling and analyses) and the timelines necessary for on-farm decision-making.**