A strategic approach to incorporating non-cereal crops in low rainfall regions of southern Australia: A preliminary analysis of probable yields

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Abstract

We evaluate low rainfall (<350mm annual rainfall) agriculture in southern Australia and strategies for incorporating non-cereal crops into these regions. Less than 5% of farmers in the SE Australian Mallee grow pulses and oilseeds. Desktop studies suggest that in many locations with <350mm annual rainfall it is unlikely that yields of ≥1 t/ha can be achieved with grain legumes or oilseeds in most years. Furthermore, an examination of seasonal longevity /suitability (using precipitation/evaporation ratios) and the probability of clear seasonal breaks (Σ 25mm rain/3days from April 1) indicates that growing season length and probability of a clear sowing opportunity do not favour non-cereal crops. We are thus investigating novel options to assist in the integration of non-cereal crops in the region. These include dry sowing, reducing input costs, growing multipurpose crops (grain/forage/graze) to reduce the reliance on cash grain yields, and the use of crop mixtures to increase rotational benefits to following cereal crops. A successful grazing enterprise would be key to capitalising on such an approach. Gross income and gross margin probabilities will also be used to determine which crops and rotations are more likely to be provide a return on investment across the region. Such systems might be suited to variable, low rainfall climates and help overcome barriers to adoption of non-cereal cash crops in low rainfall agriculture.

Media summary

Searching for new and novel farming systems for low rainfall agriculture.

Key words

Yield probability, growing season rainfall, pulses, grain legumes, oilseeds

Introduction

Although Hamblin and Kyneur (1993) highlighted the need for more non-cereal crop options in low rainfall areas of southern Australia there has been little change in the adoption of grain legumes and oilseeds in this region. For example, in the survey of Latta (2002), which also highlighted the slow adoption of conservation farming practices in the low rainfall SE Australian Mallee, <5% of farmers grew grain legumes or oilseeds, even though cereal yields tend to be higher following grain legumes than the long fallow (Sadras *et al.* 2002) that precedes almost 70% of cereals in the region (Latta 2002). We assume the principal reasons for the low adoption of non-cereal crops are profitability and risk. Compared to cereals, oilseeds and grain legumes have higher input costs, and more variable yields and grain prices. Our strategic approach to incorporation of non-cereals in this region includes an examination of this low rainfall environment, the crops that are currently grown and probable yields. New farming system opportunities to solve the risk:return dilemma are thus being explored.

Methods

Taking low rainfall agriculture as <350mm annual rainfall (Perry 1992; Stephens and Lyons 1998) we identified the low rainfall cropping area of southern Australia based on Australian Bureau of Statistics (ABS) "statistical local areas" (SLAs) and a rainfall dataset from the National Land and Water Resources Audit (www.nlwra.gov.au). We have defined the lower limit for arable agriculture as where the ABS 1996 agricultural census crop area statistics sum >100ha for a given <350mm annual rainfall SLA. Crop types were aggregated into grain legumes, oilseeds, and cereals. To estimate the likelihood of profitable yield, we developed correlations between crop yield and GSR and then used historical rainfall to estimate probability of yield. Yield data from the last 20 years was obtained from field trials at specific sites or nearby stations, and combined with growing season rainfall (April-Oct) data to provide a means (regression) to estimate yield from GSR. This was combined with long-term rainfall data (SILO Database, Jeffrey *et al.* 2001) for 11 sites in low rainfall southern Australia to estimate probable grain yields. In this paper we present results for 4 of the sites Balranald/Euston (NSW), Merredin (WA), Minnipa (SA) and Walpeup (Victoria) and 3 out of 7 crops viz. wheat, canola and field peas.

Results and discussions

The 1996 ABS Agstats (Table 1) record some 4.6 mill. ha of cereals, 638,000 ha of pulses and 29,439 ha of oilseeds for the area. These crops are however not spread evenly across this low rainfall zone (Table 1), with about 16% of the WA low rainfall area devoted to pulses, 12% in Victoria, 2% in NSW and only 1% in SA. Some if this difference may be due to soil types, but nuances of climate are also likely to play a part in marginal environments (e.g. O'Connell *et al.* 2002).

Table 1. Area (ha) of cereals, pulses and oilseeds grown in areas with <350mm annual rainfall in southern and western Australia, as a percentage of the total crop area, and as a percentage of the low rainfall crop area. Data from 1996 Australian Bureau Statistics Agstats.

	NSW	SA	Vic	WA
Cereals <350mm (ha)	203,352	551,097	640,282	2,719,003
% of state total cereal area	4	20	35	49
% of state <350mm area	97	99	87	83
Pulses (ha)	4234	5793	88504	533565
% of state total pulse area	3	2	21	46
% of state <350mm area	2	1.0	12	16
Oilseeds (ha)	2961	1936	5713	16893
% of state total oilseed area	1.2	5	5	16
% of state <350mm area	1.4	0.3	0.8	0.5

Annual and GSR variability, and hence farmer uncertainty, decreases from east to west. For example, although Balranald, Walpeup and Merredin have closely similar annual and GSR (Table 2), the coefficients of variation are much greater for Balranald (35% and 39%), and Walpeup (27% and 31%) than for Merredin in WA (25% and 24%). This decreased uncertainty may partially account for approximately 14% of the cropped area in the Merredin in WA being pulses and oilseeds, but <1% around Balranald and 2% in the Mildura regions, notwithstanding lupin being more suited to WA soils.

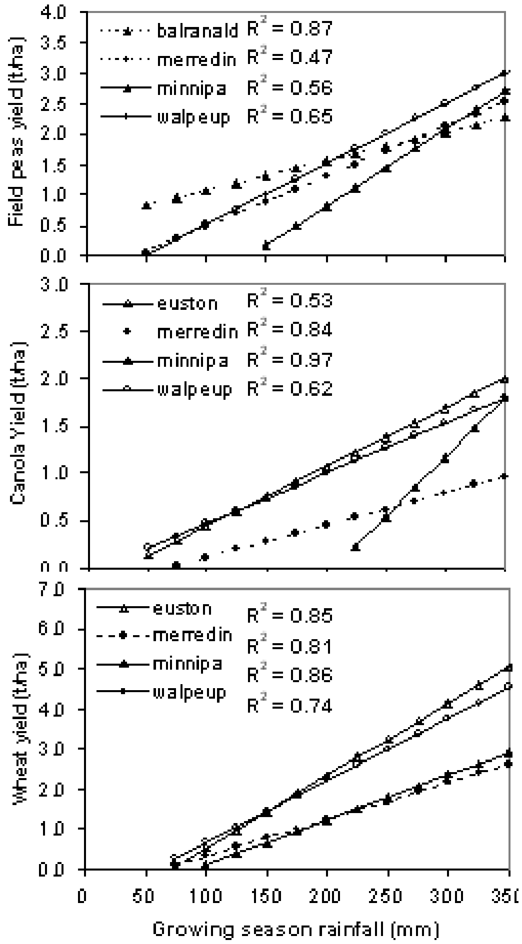
Table 2. Annual, GSR (mm) and the probability of receiving 25mm rain/3days from April 1 for selected southern Australian low rainfall stations (from 1902-2002). cv=coefficient of variation.

						Σ 25mm/3days from April 1(% of years)	
Location	State	Annual rainfall	cv	April- Oct. rainfall	cv	1st week May (day 121-127)	1st week June (day 152-158)
Balranald	NSW	323	35	203	39	30	45
Walpeup	Vic.	329	27	225	31	25	42
Minnipa	SA	328	28	246	30	11	36
Merredin	WA	326	25	249	24	27	49

We found strong relationships between GSR and crop yields for some crops and sites (Figure 1). A high correlation coefficient (R^2) indicates that much of the variation in crop yields can be accommodated by GSR alone. Other factors such as stored soil water at sowing, sowing time, crop disease, frost, weed competition are, not surprisingly, less important in low rainfall areas. Figure 1 indicates that for sites such as Minnipa in SA and Merredin in WA, little oilseed or grain legume yield appears to be achieved with <150mm GSR, while at some other locations (e.g. Walpeup in Victoria and Balranald in NSW) some yield can be produced when GSR is relatively low. This may reflect the influence of effective summer rainfall and soil type. Regressions derived from these correlations have been combined with historical rainfall data (last 100 years) to estimate probable yields for a range of pulse and oilseeds crops.

Based on this simple analysis an indicative most probable yield for canola at Merredin in WA is only 0.5 t/ha (Figure 2) and yields of ≥1 t/ha are unlikely (<10% of years), while at Walpeup in Victoria, which has a very similar GSR, yields of ≥1 t/ha are indicated in >60% of years. For canola at Balranald a yield of >1 t/ha is only indicated in 10% of years. At Minnipa in SA yields of >1 t/ha are only predicted in 20% of years. For places like Minnipa or Merredin the probability of profitable canola yields appear to be low whereas for field pea the prospects are more encouraging, although at Merredin yields of >1 t/ha are still only indicated in 25% of years. In contrast field pea yields of >1 t/ha are indicated in 83% of years at Walpeup. Yield of wheat in most sites of ≥2 t/ha is indicated close to 25% of years, except for Walpeup where it reached 61% of years. We are currently checking these indicative yields against independent data sets of observed yields to see if they are realistic.

A critical factor in achieving profitable yields of non-cereals within low rainfall environments is early sowing (Siddique *et al.* 1999) to provide some growth before the cold of winter and a platform for rapid spring growth prior to soil water deficits which invariably limit grain yield (O'Connell *et al.* 2002). Penalties for delayed sowing are suggested to be 14 kg/ha, for each day sowing is delayed in canola (Farre *et al.* 2001), and 13.3 kg/ha for field pea for each day sowing is delayed past the break (Pritchard and Carpenter 1993). One possibility to assist in early sowing is to dry sow such that crops emerge at the earliest possible break. Another advantage of dry sowing is that sowing of non-cereals will be completed prior to cereal sowing which will remain the highest priority for farmers once the season breaks. Our analysis in Table 2 indicates that the greatest opportunities for early dry sowing are at Balranald, Merredin and Walpeup where there is a >25% probability of a seasonal break (Σ25mm ≤3 days) by the first week of May (Table 2). By June 7 the probability of such a rainfall event does not significantly increase for most sites, indicating that a later break is no more likely. However, at Minnipa the probability of a clear seasonal break (Σ 25mm ≤3 days) increases to 36% in June but this may be too late for grain legume and oilseed sowing (Sadras *et al.* 2003). In low rainfall Western Australia, Σ 15mm over 5 days from April 15 is considered sufficient to sow lupins (Farre *et al.* 2003) and for cereal sowing on the Eyre Peninsula in South Australia 10mm rain over 3 days (Coventry *et al.* 1998) after April 20 may constitute a break and so our analysis in Table 2 may be conservative.



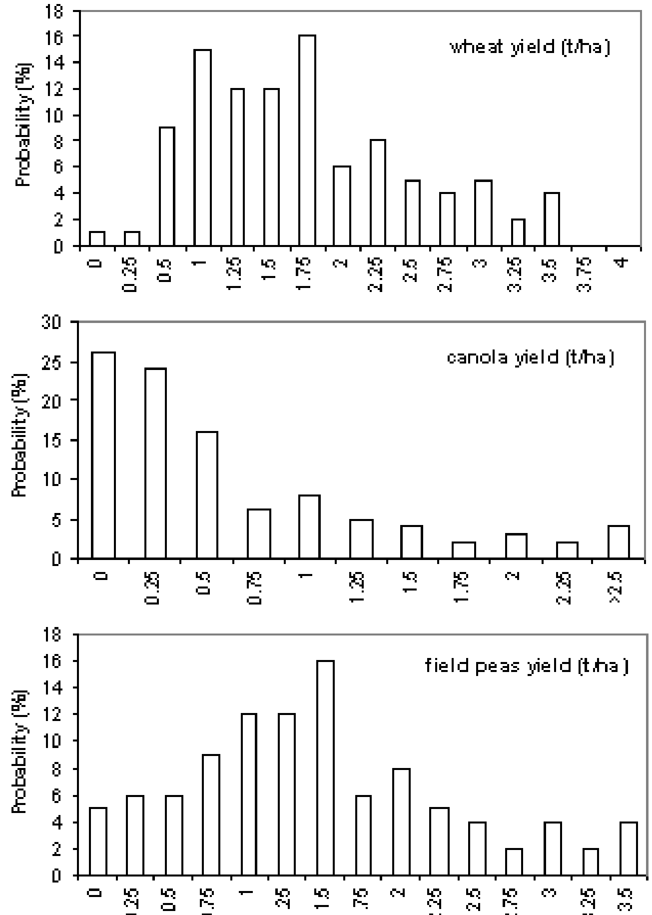


Figure 1 Rainfall:yield relationships for selected crops and sites.

Figure 2 Indicative yield probabilities for wheat, canola and field peas at Minnipa.

To increase the likelihood of a return on the investment in the lowest rainfall years multi-purpose (grain, fodder and graze) species such as vetch and other *Vicia* species provide further options by providing animal feed when it is short supply and when low, non-profitable, grain yields are likely. Further opportunities for improving prospects for non-cereals include using smaller seeded species to reduce input costs, crop mixtures to reduce risk of complete failure and increase rotational benefit, and possibly developing self-regenerating grain legume crops to replace pasture systems. We are examining these in companion field studies.

Conclusion

The study has used simple relationships between rainfall and yield to improve our understanding of likely yields of non-cereals in low rainfall environments. Yields of ≥1 t/ha are unlikely for oilseeds and grain legumes at many sites across southern Australia where annual rainfall <350mm. As there is still a great need for suitable break crops novel options need to be contemplated. We intend to estimate gross margin probabilities for a range of non-cereal crops to ascertain which crops are more likely to be provide a return on investment. We hope to examine the potential of a number of strategic options that could be used in unpredictable, low rainfall environments, which growers might adapt to their farming enterprise depending on seasonal and critical management considerations.

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