Fast-tracking the adaptation of grain production systems to a changing climate using a participatory action research, development and extension (PARD&E) process

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Abstract

The last decade has produced poor seasonal conditions for cropping, with low rainfall across north-west Victoria. Whether these current climatic conditions are due to short term climate variability or longer term climate change matters little to farmers. While many farmers have suffered poor crops, other growers have maintained production. This raises the question: Is this due to good luck or good management? A benchmarking survey was conducted with two farmer groups in the central and northern Wimmera as part of a Participatory Action Research Development & Extension (PARD&E) project designed to improve agronomic management under variable seasonal conditions. Both groups identified the utility of various stubble management strategies on protecting soil water reserves from evaporation as high priority. A benchmark survey of the two farmer groups revealed that although overall crop yields between 1995 and 2008 have decreased, the rainfall use efficiency (WUE) of some crops has been maintained. In 1995 and 2008, wheat WUE was 9.1 and 8.8 kg/ha/mm respectively, while barley increased from 9.1 to 10.0 kg/ha/mm respectively. For high risk crops such as canola, current average WUE was 3.9 kg/ha/mm, whereas the highest WUE achieved was 7.9 kg/ha/mm. Average WUE of lentils was 2.8 kg/ha/mm, although up to 10 kg/ha/mm was achieved by some growers. The conclusion was made that that there is capacity for improved productivity through better agronomic management. The Central Wimmera group, 'Horsham East' perceived that successful farming was due to both luck and good management, where as the Northern Wimmera group 'Sheep Hills' were of the strong opinion good crops were delivered through good management. Both groups were strongly polarized in their opinion that natural climate variability was occurring and that previous dry seasonal conditions were not related to anthropogenic climate change.

Key Words

Climate change, wheat, barley, canola, lentil, water use efficiency

Introduction

Persistently low growing season rainfall across south-eastern Australia over the last 10 years has increased the incidence of crop failure, suppressed yields and limited the diversity of crop choice within the farming system. The Victorian Wimmera has a Mediterranean-type environment and produces approximately 40% of Victoria's grain production. The growing season rainfall (April to October) and long-term (1873 to 2008) annual rainfall of Horsham is 313 mm and 445 mm respectively. Over the last 8 years there has been 17% less annual rainfall and 21% less growing season rainfall (GSR). Similarly for the Sheep Hills district the long term annual rainfall of 391 mm has diminished 18% and the GSR of 271 mm had dropped on average 26% in the last 8 years (Bureau of Meteorology 2009).

Two farmer groups, denoted Horsham East and Sheep Hills, were engaged in a participatory action research (PARD&E), development and extension pilot study for the fast-tracking of adaptation of their farming enterprise to an uncertain climate. This PARD&E process attempts to identify those agronomic management practices where profitability has been maintained (or increased), despite the current run of dry seasonal conditions, so as to assist growers to develop best management practices for use in future climates. It is envisioned that effective adoption of robust practice by growers will be improved by the PARD&E methodology (Carberry 2001; Robertson et al. 2000).

As a precursor to on farm activity, a desktop analysis was conducted using results from a farmer survey, which characterize land use, farm management practices and farm enterprise trends over the last decade for the respective groups. Australian Bureau of Statistics (ABS) data were also used for broader context. These analyses will also provide a basis for future evaluation of practice change. This paper presents results from the farmer benchmark survey and in particular highlight the shift in farming practices over the last 10 years and pattern of adoption of various farming practices.

Methods

Farmer survey

The farmer benchmark survey was conducted (based on a mailed questionnaire with a follow-up telephone contact) across Horsham East and Sheep Hills farmer groups to define specific attributes of the farm enterprise. Within the survey there were 21 and 30 farmer participants for Horsham East and Sheep Hills respectively, out of a total of 110 growers' approached (46% participation). A transcript of the questionnaire can be obtained on request to the authors. WUE calculations were derived from whole farm estimates of yield for the various crop types as a ratio of estimated growing season rainfall (April to October). It does not account for available soil water. Rainfall figures were taken from closest Bureau of Meteorology site.

Results and Discussion

Average wheat yields in 1995 were substantially more than that in 2008 (lower growing season rainfall) for both Horsham East and Sheep Hills (Fig 1*a*). Despite this the rainfall use efficiency (WUE) of 9.4 kg/ha/mm in 1995 was similar to that of 9.0 kg/ha/mm recorded in 2008 for Horsham East. Similarly for Sheep Hills, WUE was 8.7 and 8.5 kg/ha/mm in 1995 and 2008, respectively. We recognized that the calculation of WUE does not take into account contribution from stored soil water accrued either through long fallow or summer rainfall. In the period Oct 2004 to Mar 2005, summer rainfall at Horsham East and Sheep Hills was 79 mm, where as for the same months in 2007/08 summer rainfall was 165 and 140 mm for Horsham East and Sheep Hills respectively. This highlights that in 2008, yield and our estimate of WUE may be inflated. Barley crops across both regions also yielded substantially less in 2008 compared with 1995 (Fig 1*b*) Horsham East, although the average WUE at both locations was higher in 2008 (drier) compared with 1995 where at Horsham East this ratio increased from 9.4 to 9.6 kg/ha/mm and for Sheep Hills from 8.9 to 10.4 kg/ha/mm. Canola yield averages at Horsham East decreased from 1.9 to 0.7 t/ha and in Sheep Hills 1.5 to 0.3 t/ha between 1995 and 2008. In contrast with cereal crops the average WUE decreased across this period for Horsham East (5.0 kg/ha/mm in 1995 versus 3.6 kg/ha/mm in 2008) and Sheep Hills, WUE (4.1 kg/ha/mm in 1995 versus 2.3 kg/ha/mm in 2008). Highest WUE was 7.9 kg/ha/mm, which was recorded in 1995 and 2008. Lentil yields and WUE also dropped substantially in 2008 compared with 1995 across both regions (Fig 1*d*). Lentil WUE dropped from 5.1 and 3.8 kg/ha/mm for Horsham East and Sheep Hills respectively in 1995 to 3.3 and 1.7 kg/ha/mm in 2008. The highest lentil WUE was 10.0 kg/ha/mm in both regions. Overall, the WUE of cereal crops were either maintained (wheat) or increased (barley) where as for pulse and canola crops WUE fell substantially when comparing 1995 to 2008. Irrespective, some growers did maintain WUE of oilseed and pulse crops across this time period, which suggests that the agronomic management tactics/strategies such as long fallow, good summer weed control and stubble management may contribute to maintaining productivity under dry growing season conditions. For both districts the proportion of farm sown to cereal crops has increased from 64% in 2005 to 72% at the expense of area sown to oilseed crops (9% to 2%). Proportion of farm sown to pulse crops is consistent over both district and time (ca. 28%) shift in proportion although in 1995 chickpea was the predominant pulse species grown, where as in 2008 this change to lentil.

Crop stubble management had shifted towards maintaining standing stubble in 2008 compared with 1995, (Fig 2) although a high proportion of farmers grazed stubbles at Sheep Hills, whereas for Horsham East farmers increasingly avoided grazing stubbles. Incorporation of stubbles was not a common practice in the Horsham East district in either 1995 or 2008, whereas over 50% of farmers at Sheep Hills either incorporated some or all of their stubbles in 1995, although there has been a trend away from this practice in recent years. The burning of at least some stubble was common practice in 1995 where 85%

and 62% of growers burnt stubble in Horsham East and Sheep Hills districts, respectively (Fig 2). Since 1995 there has been a shift away from burning stubble, with only 30% and 4% of farmers now burning stubbles in the Horsham East and Sheep Hills districts respectively.

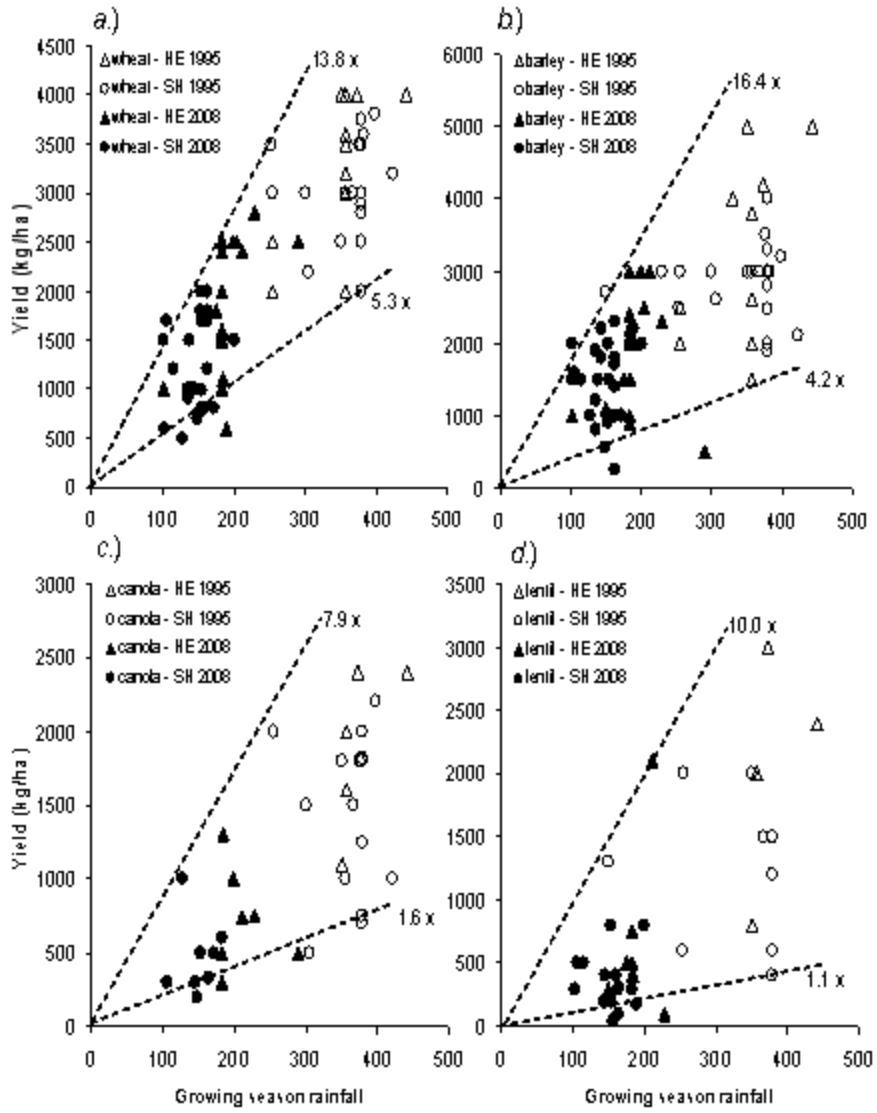

Figure 1. Relationship between grain yield (kg/ha) and growing season rainfall (April – October) for wheat, barley and canola grown in 1995 and 2008. Data is for the Horsham East (HE) and Sheep Hills (SH) growers. Broken lines define the effective range in rainfall use efficiency (slope x).

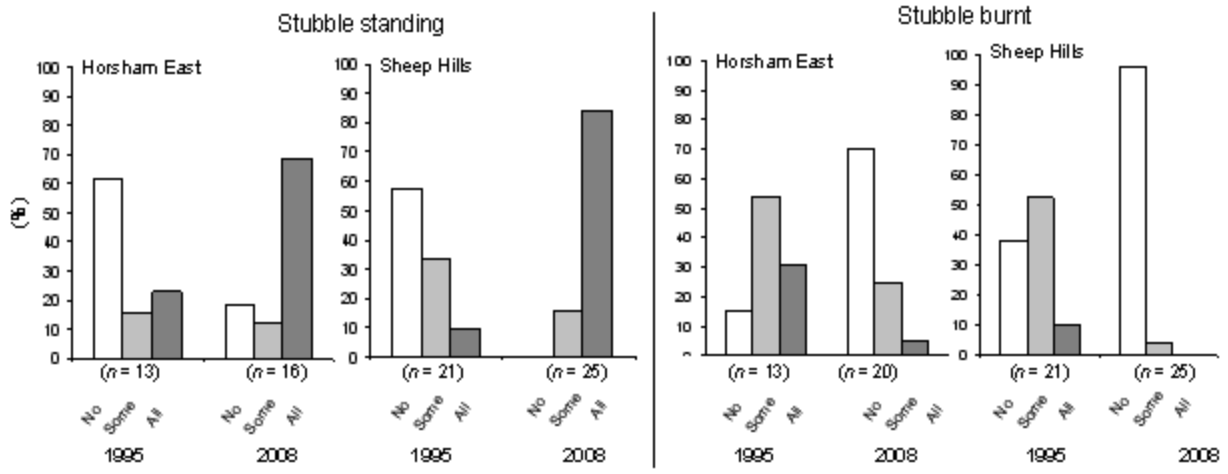

Figure 2. Shift in method of stubble management between 1995 and 2008 used by the Horsham East and Sheep Hills growers, where stubble standing and stubble burnt are compared. Grower response was either 'no', 'some' or 'all' in relation to whether that practice was used on their farm. Numeric values rep resent percentage of total responses which are define in parentheses.

Maintaining standing stubbles is matched with the increase in adoption of technology such as steering guidance systems and inter-row sowing. At Horsham East, no growers used GPS guidance systems on an entire farm basis in 1995; however by 2008, 30% of farmers were using this technology. At Sheep Hills, 12% of growers used GPS guidance in 1995 whereas this had increased to 70% in 2008. The high rate of adoption of guidance systems at Sheep Hills may be linked with the desire to inter-row sow, where 68% of farms sowed either some or all paddocks to this method in 2008. This is compared to 30% of farms at Horsham East being inter-row sown. Increasingly, growers perceive that maximizing crop success under low rainfall conditions, is linked with accruing and protecting soil water from evaporative loss. They believe management such as inter-row sowing and maintaining stubble builds soil structure, reduces soil strength and facilitates infiltration of soil water deeper in the profile, where it is protected from evaporative loss. To investigate links between these assumptions and crop yield, large replicated farmer sown plots using a range of stubble management are being tested within the PARD&E program.

Over the last decade seasons have been dominated by below average rainfall. This raises the question, is growing successful crops during this period due to good luck or good management? Horsham East growers believed it was a combination of both factors, whereas at Sheep Hills, farmers were of the strong opinion that a good crop was delivered through good management (Fig 3*a*). For the decade of dry seasonal conditions, growers across both regions were united in their opinion, that natural climatic variability was occurring and that the previous dry seasonal conditions were not related to human induced climate change (Fig 3*b*). This information is important for researchers to context the PARD&E work in terms of climate variability rather than anthropogenic induced climate change, which could risk growers disengaging from the learning process.

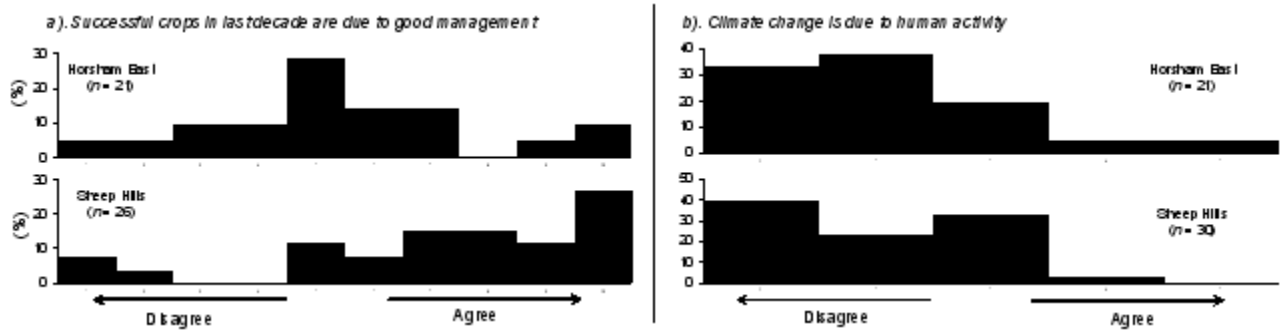

Figure 3. Farmer perception on a.) whether growing a successful crop in the last 10 years is related to good luck or good management and b.) if climate conditions over the last decade are due to man induced climate change. Response is percent of farmers (%). The two farmer groups, Horsham East and Sheep Hills in Victoria are compared.

Conclusion

Within cropping systems of south-eastern Australia, the PARD&E process across scientists, extension staff and growers provides a method of fast-tracking the identification and adoption of farming practices that are robust under dry seasonal conditions, whether resulting from climate variability and/or change. Although yields in the last decade have dropped, crops WUE have been maintained in cereals although not for pulse and oilseed crops. Importantly, some growers have maintained pulse and oilseed production and the process for this success needs to be identified and extended to other growers. It is increasingly apparent that growers perceive the accruement and protection of soil water through controlled traffic systems and inter-row sowing is increasing yields through reducing the soil evaporation component of evapo-transpiration of the crop. The experimental phase of this PARD&E process will test these assumptions.

Acknowledgements

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