Growing more grain: A first cut at estimating and locating potential gains

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Abstract

Recent reports emphasise the need for Australian agricultural industries to invest in productivity gains to maintain a competitive edge in international trade. Rural R&D investments are under pressure to keep finding methods to improve industry productivity. We report on an analysis, based on regional grain yields and water use efficiencies over the last 20 years, to provide a first cut at where water use efficiencies can be improved still further by between 2 and 14 million tonnes per year on average, depending upon assumptions.

Key Words

Water use efficiency, productivity, potential gains.

Introduction

To compete in the international grains market, the Australian grains industry needs continuing gains in productivity (Agriculture and Food Policy Reference Group, 2006). Since research and development has a fundamental role in finding and implementing these gains, its efficiency and effectiveness can be improved when the investments are informed as to which areas are most constrained for productivity. GRDC commissioned us to develop a strategic overview of where crop performance is lagging and where targeted R&D investment could provide a significant return to the industry. Here we report on the first component.

Methods

We extended a previous analysis of grain yield trends and water use efficiencies from 1983-1997 (Stephens 2003) to 2002 and recast it to the GRDC agro-ecological zones. This exercise was based on the STIN model (the STressINdex model used by the Department of Agriculture Western Australia) to take out seasonal rainfall variation effect on crop yields. We then calculated the potential for increased production of grain that would result from improving current water use efficiencies to achieve various target water use efficiencies at the rate of 20 kg grain/mm (French and Schultz 1984). This was multiplied by the maximum area sown to grains in each SLA and summed for each agro-ecological zone. Production gains were calculated only for those SLAs where the WUE was below the benchmark. We also calculated the gain from a uniform improvement in water use efficiencies of 10 percentage points (other increases will be simple multiples of this). These should not be construed as actual targets and we recognise that actual improvements rest on decisions made by individual grain producers that influence yield gains and areas sown.

The calculations assumed that:

- the responses for wheat would apply uniformly across all other grains crops because although there has been considerable diversification in the grains industry in the last 20 years (Walcott 2004) wheat is still the dominant crop with about 55% of the area sown;
- the maximum area sown to grains in the last 15 years was appropriate for estimating potential gains so that zones that were producing at lower levels due to climatic factors were not disadvantaged; and

- water use is the primary constraint to the productivity of non-irrigated grain crops throughout Australia and therefore that an analysis of water use efficiency (or more correctly transpiration use efficiency), provides a valid means of measuring these constraints. This is less valid for the higher rainfall zones such as Vic High Rainfall and eastern portions of NSW/Vic Slopes where rainfall may exceed the crop's ability to use it and may lead to waterlogging that can reduce crop growth and yields.

Results

The summary of the calculations, presented in Table 1, indicates that considerable gains in production would result if there were moderate increases in water use efficiency undertaken uniformly across areas. The present water use efficiencies range widely between SLAs from about 20% to 98% (the latter is probably assisted by supplementary irrigation). The gains for the step up from 60% to 70% in average water use efficiency are much larger than those from 50% to 60% because progressively more SLAs can achieve the benchmark WUE and therefore expand the area factor in the calculations. Although the total gains for achieving the benchmark 50% WUE and for increasing by 10% are similar in total, their distribution across zones is quite different. For instance, the 50% WUE benchmark would mean a total increase in an average year of 1.18 Mt compared to 0.53 Mt for a 10% increase in NSW NE-Qld SE zone whereas in the WA Central zone the equivalent gains are 0.17 M t and 0.61 M t.

Some appreciation of the range of potential benefits comes from varying the area used in the calculations. For instance, using the minimum area that was sown to grains in each SLA during the period 1982 to 2001 (a total of 12.6 Mha compared to that of the maximum of 21.6 Mha), then the production gains are proportionately reduced. As indicated in the last row of Table 1 the increased production now ranges from 1.8 million tonnes to 7.6 million tonnes. Of course, changes in seasonal conditions amongst years adds further variability to the outcomes.

Table 1. Water use efficiencies (%) and estimates of average annual production gains (,000 tonnes) from meeting different benchmark water use efficiencies for agro-ecological zones. Estimates were based on the maximum area sown to grain within a zone uniformly achieving the benchmark water use efficiencies for wheat in each constituent SLA. Where does Now (ave) and Now (min) come from? Are they water use efficiency or production?

Agro-ecological Zone	Benchmark Water use efficiencies (%)					
	Now (ave)	**Now (min)**	**50**	**60**	**70**	**+10% from now**
NSW Central	59	36	73	400	677	254
NSW NE-Qld SE	40	31	1,182	2,306	3,531	531
NSW NW-Qld SW	36	26	708	1,188	1,667	172
NSW Vic Slopes	56	40	195	575	1,162	460
Qld Central	38	22	324	559	810	94
SA Midnorth- Yorke Eyre	56	40	225	539	1,003	361

SAVic Bordertn-Wimmera	61	49	12	162	473	313
SA Vic Mallee	59	37	212	490	843	368
Vic High Rainfall	55	57	0	11	55	26
WA Central	55	36	168	706	1,674	611
WA Eastern	50	40	109	348	613	149
WA Mallee and Sandplain	55	49	5	96	307	117
WA Northern	48	30	245	651	1,174	255
Total			3,459	8,030	13,990	3,713
Total using minimum area sown in each SLA			1,819	4,241	7,552	2,118

Conclusion

Despite uncertainties it is apparent that considerable gains can be made in most of the agro-ecological zones from improving overall water use efficiency. In total, depending on the level of water use efficiency achieved, they could range from 1.8 Mt up to 14 Mt of grain measured as wheat equivalents per year.

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