Adoption of practices and technologies on Australian grain farms

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Abstract

Understanding the adoption of new practices and technologies, as the final phase in innovation, underpins planning of successful RD&E and policy programs. The degree and rate of adoption vary with many factors specific to the practice and location. For example, complex practices, such as direct drill, can take 30 years or more for full adoption. By contrast more straightforward improvements, such as new wheat varieties, can have a complete adoption to disadoption span of between 6 and 30 years. These examples provide useful indicators and cautions for speeding up the adoption of new technologies to mitigate the emissions of greenhouse gases and to adapt to climate change.

Key Words

Direct-drill, wheat, varieties

Introduction

Adoption of new technologies and methods is the final phase of innovation. Consequently, an understanding of adoption underpins planning for successful investments by the rural Research and Development Corporations, and the development of agricultural policy programs for, amongst others, productivity, food security, sustainable development and natural resource management. There is a considerable lag between a new technology becoming available and its peak adoption. The lag time for adoption significantly affects estimates of returns on investments to rural R&D (Mullen 2007). Some technologies may need ongoing refinements to make their adoption practical and profitable. There are also delays incurred as the technology is tested by individual producers as they gain confidence in its use and evaluate its risks, the need to write off previous investments and undertake the investments necessary for the new technology (Thomas et al. 2007). Here I illustrate, based upon data from agricultural surveys, some of these patterns and trends on the adoption of direct-drill land preparation systems and of new varieties technology in the grains industry.

Methodology

The Australian Bureau of Statistics (ABS) undertakes annual surveys or census of agricultural producers, which provides data that can be used to track changes and display patterns on agricultural production and practices. From the catalogues 7121.0 (1996 to 2002) and 4627.0 (2008), I used responses to 'Land preparation for crops and pastures - Cultivation - No cultivation (apart from actual sowing operation) - Area (ha)', together with 'Businesses (No) and Area of land prepared for broadacre crops - Total Area or Businesses' items to calculate and track adoption of direct-drill technology. Earlier years provided the data collated by Fitzsimmons (1991) to track changes in adoption of wheat varieties in New South Wales.

Adoption of direct-drill cultivation

Direct-drill (including no-till and zero-till) cultivation is a form of conservation cropping that has benefits for erosion control, fallow soil water efficiency and soil organic matter (Thomas et al. 2007). It is a practice that became feasible with the development of herbicides in 1950s and was investigated in 1960s (Greenwood et al. 1970, Reeves and Ellington 1974). However, its uptake was limited by significant constraints in terms of suitable machinery, determination of its benefits and emergence of other problems such as a different disease spectrum in broadacre crops (Lewis et al. 2006). Significant uptake only began about 1980 (D'Emden et al. 2006) and the area under direct drill cultivation rapidly increased from 3.06 m ha in 1996 to 17.45 m ha in 2008.

Data from the ABS (Table 1 and Figure 1) indicate that there has been steady increase in the area of crop prepared using direct-drill. The adoption of direct-drill was relatively earlier in Western Australia with about 70 percent adoption in 2001-02 compared to other states at 30 percent or less. It is likely that this was partly due to the greater advantages gained in the WA environment by being able to sow earlier and more rapidly after the break of season. By 2007-08 the other states had doubled their adoption of direct-drill cultivation while WA it had peaked.

Table 1. Adoption of direct-drill cultivation in Australian states (percent area) between 1995-96 and 2007-08.

	1995-96	2001-02	2007-08	% change between	
				1996-2002	2002-2008
New South Wales	10.8	27.6	57.3	292	191
Victoria	14.5	24.2	62.8	133	319
Queensland	7.3	29.4	46.6	426	101
South Australia	8.8	27.5	66.5	357	176
Western Australia	41.2	71.7	79.2	132	32

Source: Australian Bureau of Statistics catalogue 7121.0 (1996, 2002) and 4627.0 (2008).

Another point of interest is that adoption appears to occur more rapidly by farms than in total area. This result shown in Figure 1, where the proportion of farms adopting direct-drill, particularly in the Wimmera region, was greater than the proportion of area prepared with direct-drill up to 2001-02 but by 2007-08 there was little difference. This pattern indicates that farmers will often trial small areas first and increase acreage once they gain confidence in managing the technology and its benefits.

The timing and rate of adoption appears to vary considerably between regions (Figure 1), so that by 2007-08, whilst direct-drill tillage was adopted widely, there were still considerable differences between regions (Figure 2). The values for Queensland regions shown in Figure 2 correspond to estimated rates of adoption of between 47 percent for non-participants in farming system projects to 69 percent for participants (Thomas et al. 2007). The Western Australia data suggest that adoption may peak at about 80 percent uptake on 70 percent of farms, which is remarkably high for a particular technology. For regions that are well below this level there may be considerable constraints to adoption (Thomas et al. 2007) including soil and stubble borne diseases, waterlogged soil and issues with crop rotation compatibilities, herbicide residues and resistance.

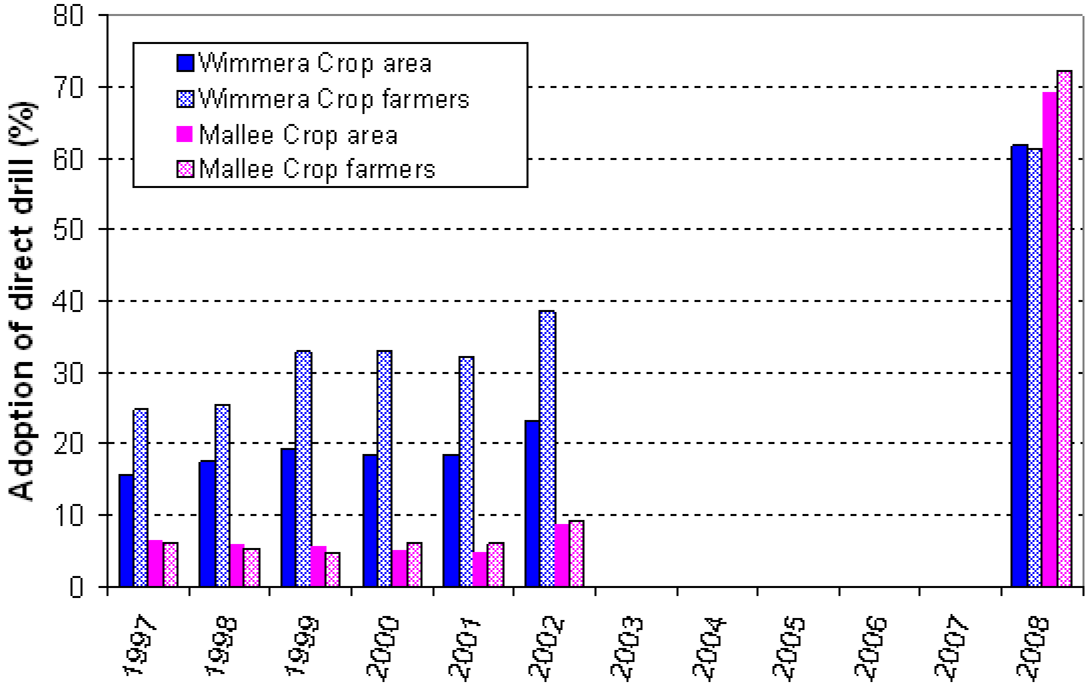

Figure 1. A comparison of the relative adoption of direct-drill in terms of area and farms between 1997 and 2008 in two regions of Victoria.

Source: Australian Bureau of Statistics catalogue 7121.0 (1997 to 2002) and 4627.0 (2008).

Adoption of new varieties

New crop varieties encapsulate certain forms of innovation: for instance, resistance to diseases and tolerance of nutrient deficiencies and toxicities. The potentially rapid adoption (and subsequent obsolescence) of a new wheat variety, which is generally a technology requiring only small changes in an established production system, is a different adoption pattern to that of slow uptake of a complex system such as direct-drill. Nevertheless, there are several factors that govern the adoption and success of new varieties. The wheat varieties selected in Figure 3 display a range of different initial rates of adoption, have different peak levels and different life spans (adoption to disadoption). Some varieties have low adoption and short life spans of about 4-5 years from release (such as Corella and Quarrion), possibly due to susceptibility to new strains of diseases, market quality changes or uncompetitive performance due to changed climatic conditions. Other varieties—presumably those that remain sufficiently tolerant of diseases, display consistently good performance and satisfy a large enough market demand—persist in substantial volumes for over 30 years (e.g., Olympic and Insignia). On average, varieties reach a peak share in a local area in the fifth year after release but continue to be grown for a further 17 years (Brennan and Bialowas 2001).

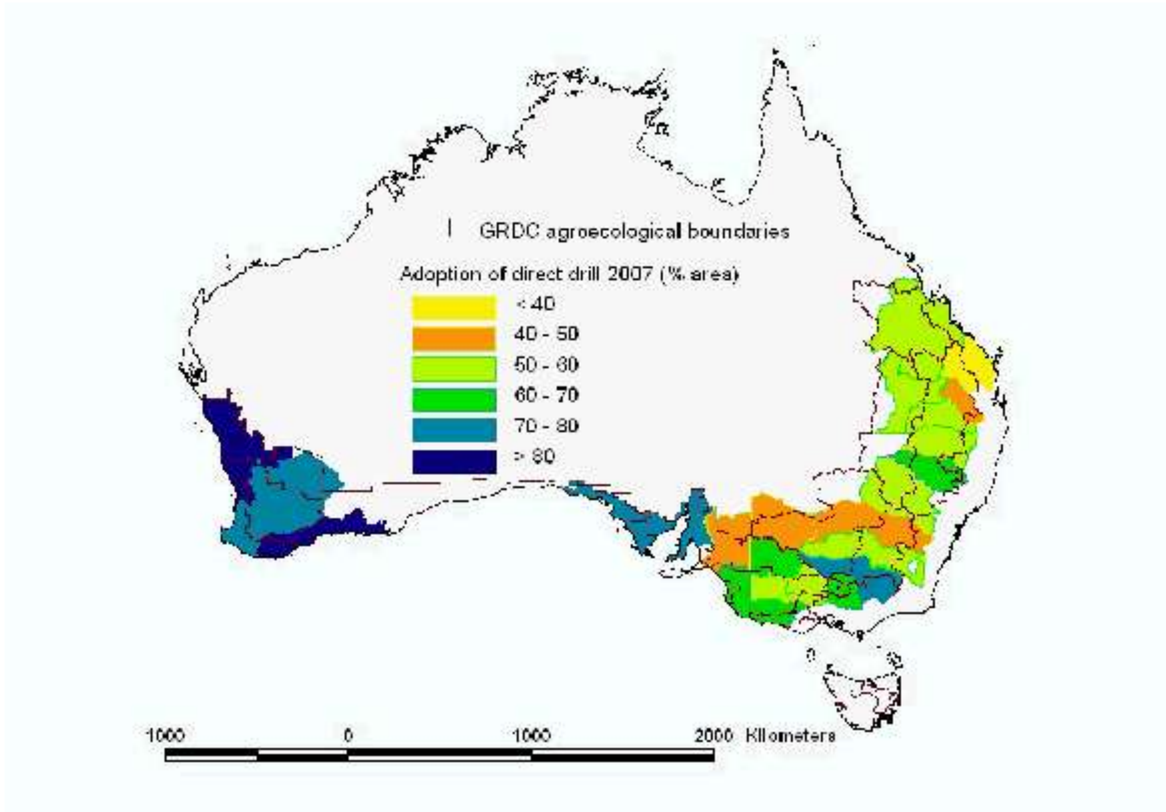

Figure 2. A comparison of the relative adoption of direct-drill across the Australian grain belt in terms of area in 2007-08.

Source: Australian Bureau of Statistics catalogue 4627.0 (2008).

A consequence of this relatively rapid pattern of adoption/obsolescence is that continuing investment in plant breeding is required. Consequently there has been a move to utilise Plant Breeders' Rights legislation and end-point royalties on those rights to set up plant breeding agencies as private operations, which gain their income from the adoption of their varieties rather than from general levies collected by government.

Discussion

The process of getting new systems and tools adopted is complicated and needs to be suited to the innovation and its customer (Barr and Cary, 2000). Adoption of innovations usually traverses through stages from awareness; information seeking; trialling; to reaffirming a decision for change. Innovations that are profitable and exhibit a relative advantage will be readily adopted, but will be influenced by other factors. These other factors could include complexity, trialability, compatibility, the observability of the outcomes, and the farmers' beliefs, motivations and attitudes to risk and change. Research projects can target the specific constraints identified to be most limiting for a particular region or market (Walcott 1993).

Both research funders and government programs prefer to see desirable practices adopted as rapidly as possible without increasing the risk of faulty adaptations. However, the examples here indicate that the adoption of new technologies follow a range of trajectories, sometimes taking considerable time (up to 40 years) or to only a limited extent (5 percent). New systems will require more concerted efforts and are likely to take longer to full adoption than will a new technology. These are factors to consider, especially when promoting technologies and systems to mitigate and adapt to climate change.

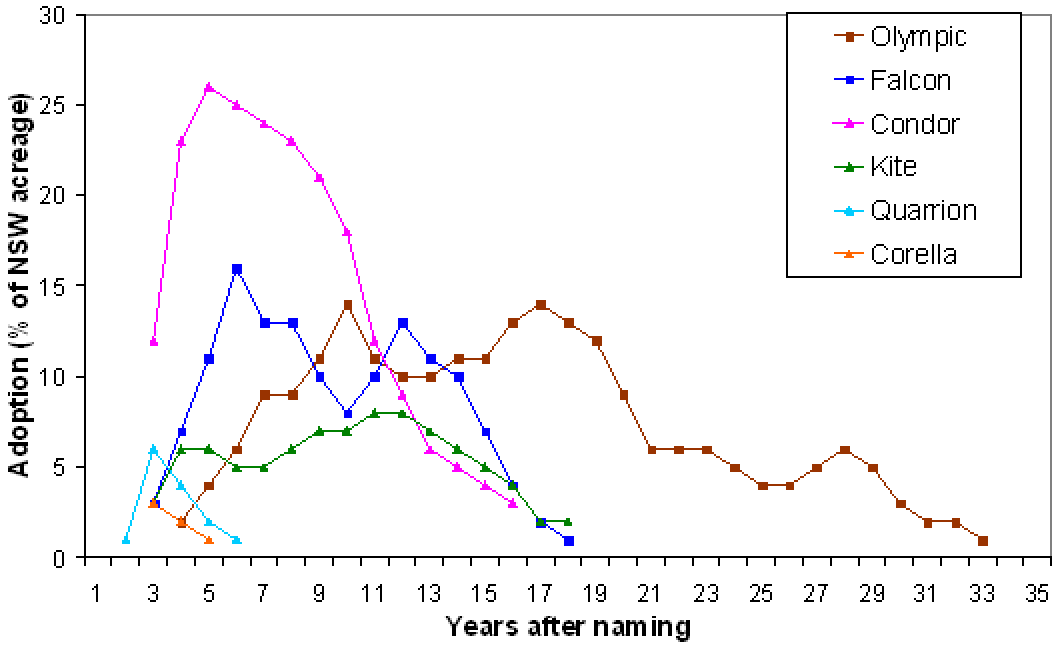

Figure 3. A comparison of the relative adoption of selected varieties of wheat in NSW between 1950 and 1990. Source: (Fitzsimmons 1991).

References

Barr N and Cary J (2000). Influencing improved natural resource management on farms: a guide to understanding factors influencing the adoption of sustainable resource practices. Canberra, ACT, Bureau of Rural Sciences. http://adl.brs.gov.au/brsShop/data/PC12790.pdf

Brennan JP and Bialowas A (2001). Changes in characteristics of NSW wheat varieties, 1965-1997. Economic Research Report No. 8. Orange, NSW: NSW Agriculture, Available: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/146373/err-08-Changes-in-Characteristics-of-NSW-Wheat-Varieties,1965-1997.pdf

D'Emden FH, Llewellyn RS and Burton MP (2006). Adoption of conservation tillage in Australian cropping regions: an application of duration analysis. Technological Forecasting and Social Change 73, 630-647.

Fitzsimmons RW (1991). Wheat variety statistics, NSW 1925-1990 (Areas of all wheat varieties planted, NSW, by Local Government Areas), Wahroonga, NSW: Australian Institute of Agricultural Science.

Greenwood EAN, Boyd WJR, Whitehead JA and Titmanis ZV (1970). Effects of time, cultivation and urea on nitrogen stress and yield of wheat in a low rainfall area of Western Australia. Australian Journal of Experimental Agriculture and Animal Husbandry 10, 763-767.

Lewis P, Malcom B and Steed G (2006) Conservation crop farming: a farm management perspective. Melbourne, University of Melbourne

Mullen, JD (2007). Productivity growth and the returns from public investment in R&D in Australian broadacre agriculture. Australian Journal of Agricultural and Resource Economics 51, 359-384.

Reeves TG and Ellington A (1974). Direct drilling experiments with wheat. Australian Journal of Experimental Agriculture and Animal Husbandry 14, 237-40.

Thomas, GA, Titmarsh, GW, Freebairn, DM and Radford, BJ (2007). No-tillage and conservation farming practices in grain growing areas of Queensland - a review of 40 years of development. Australian Journal of Experimental Agriculture 47, 887-898.

Walcott J (1993). Constraints to adoption of a grain legume: chickpea. In Proceedings of the 7th Australian Agronomy Conference, Adelaide, September, Australian Society of Agronomy, pp. 68-71.