Social research: insights into farmers' conversion to no-till farming systems

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Abstract. The conversion to no-till farming systems in the Victorian Mallee has been both recent and rapid. The Mallee Catchment Management Authority commissioned a project to begin the process of better understanding the no-till situation in the region by collecting local information regarding the extent of cropping practice change and the underlying reasons behind it. An exploratory social research approach was adopted using in-depth interviews as the primary means of data collection. Issues explored included: the extent and drivers of practice change, the reasons for some farmers maintaining a preference for cultivation, farmers' views about the profitability and sustainability of different tillage systems, farmers' preferences for accessing information to assist practice change, and their expectations and opinions about the role and value of agencies, producer groups, private advisors and resellers. Farmers changing to no-till are seeking greater flexibility around sowing decisions, agronomic gains and increased efficiency in their operation. They are accessing the services of private advisors to assist in making the change. In contrast, Multiple-till farmers are concerned about profitability and not yet convinced that no-till will advance their goals. They have specific concerns about the value of a no-till system on heavier soils. The findings reinforce the importance of understanding motivations for adoption of practices and designing extension activities around this.

Keywords: cropping practice, adoption, decision making, Mallee

Introduction

No-till crop production reduces soil erosion and conserves soil. With little new land available for agriculture, the need to mitigate and adapt to climate change, rising food security concerns and calls to increase the conservation value of private land, attention is increasingly turning to no-till crop production. No-till farming means broadly, that land is not cultivated prior to sowing, and is often referred to by other terms, such as conservation tillage. No-till also helps farmers respond to the critical problem of climate change. A no-till system can mean fewer passes and less fuel used and thus less carbon emitted (Khan et al. 2009). By keeping crop residue *in situ*, no-till also builds up soil organic matter, increases soil carbon sequestration, increases water infiltration and reduces evaporation and runoff (Huggins and Reganold 2008). For farmers in southern Australia, no-till's ability to help them mitigate climate change while also adapting to the drier conditions created by it makes it particularly pertinent (Ugalde et al. 2007).

Despite its potential contribution to sustainable agriculture, no-till farming is still the exception in most parts of the world, with only 7 per cent of the world's cropland under no-till management in 2004 (Huggins and Reganold 2008). A 2004 survey by D'Emden & Llewellyn (2006) reports that, while approximately 80% of respondents in Western Australia's grain growing region were using no-till technologies for at least part of their cropped area, less than 40% were in South Australia. Similarly, in Australia's northeastern grains belt, it is estimated that less than half of farmers employ no-till practices (NSW DPI 2009).

As valuable as no-till farming can be, it is not without its limitations. Chief among these is the trade-off farmers face in the greater reliance on chemical herbicides that no-till demands, with concomitant financial, human and ecological health, and weed resistance issues (D'Emden and Llewellyn 2004; D'Emden et al. 2006). No-till farming goes hand in hand with increased cropping intensity, which means greater inputs. A substantial amount of energy is embedded in agrochemicals, with nearly half of the energy expended in conventional dryland wheat production embedded in the fertilisers and herbicides used (Khan et al. 2009).

Given the importance of no-till, numerous studies have investigated what obstacles farmers face in adopting such a system. Previously reported obstacles to adopting no-till include the need for specialised machinery, stubble management (including other uses for crop residues), and concern about the performance of no-till on heavier soils (see, for example, Lal 2007; Davey and Furtan 2008, Huang et al. 2008, Huggins and Reganold 2008). More generic obstacles to change include the difficulty of obtaining new knowledge to convert from a conventional to no-till system (Junge et al. 2009).

Much has been written about obstacles to the adoption of new practices in agriculture. Such obstacles can be broadly summarised under the headings of farmer characteristics (including goals, circumstances and perception of the extension messenger) and practice characteristics (mainly to do with relative advantage and trialability). These influence the timing and type of

learning involved in the adoption process, which proceeds roughly along the following lines: awareness of the problem or opportunity; non-trial evaluation; trial evaluation; adoption; review and modification (Pannell et al. 2006). A farmer may also decide not to adopt or to cease adoption of a new practice at any stage. Furthermore, they may decide to partially adopt a new practice, not as a trial *per se* but as an endpoint in itself. Appreciating the temporal and intensity elements of adoption challenges the older 'black and white' picture of practice change.

Farmers' perceptions of the characteristics of no-till farming systems are central to this paper. According to a comprehensive review of adoption of conservation practices by Pannell et al. (2006), the two main characteristics of a practice that influence adoption are its relative advantage and trialability. Relative advantage - which the authors state is 'the decisive factor determining the ultimate level of adoption of most innovations in the long run' (p. 1413) – stems from a wide range of factors including: the expected profitability of the new practice over different time scales and in comparison with the practice it would replace; the innovation's expected effect on and compatibility with existing components of the farm and the lifestyle, beliefs, values and self-image of the farming family; the innovation's environmental credibility; the innovation's complexity and effect on the riskiness of production; and the adjustment costs involved in making the change.

The ease of learning about an innovation is its trialability, which is determined by two main factors: the risk and cost of trialling the innovation, including the ability to adopt it partially; and the ability to attribute results of the trial to the innovation. The riskiness of a trial is affected by the quality of information one has about the new practice, which is influenced in turn by how much trust one can place in the source of that information. As research in other fields such as public administration, public health and disaster management emphasises, trust is key to successful behaviour change and is dependent in large part on the relationships between 'messenger' and 'message recipient', in particular the latter's perception of whether the messenger respects them and their goals (Longstaff and Yang 2008, Palmer et al. 2009).

No-till farming is rich ground for investigating the above topics, given its complexity, substantial transaction costs and conflicting environmental credentials, among other factors. For this reason, the following paper contributes not only to improved extension efforts around no-till in the Victorian Mallee but to a broader understanding of obstacles to adoption and the role of extension efforts in contemporary agriculture.

The Victorian Mallee is a large and important crop-growing region in northwest Victoria. It is home to recent rapid adoption of no-till farming systems. In recognition of this adoption, the Mallee Catchment Management Authority commissioned exploratory social research into the extent of the practice change and the reasons behind it. The primary purposes of the project were to: collect local information about the extent of recent cropping practice change in the Mallee and the reasons behind the apparent widespread adoption of no-till; and to help define a direction for future extension services that encourage and help farmers adopt no-till. For the purposes of this study, "no-till" is a generic term used to include "direct drill" (one pass seeding with a full cut), "no-till" (one pass seeding with knife points) or "zero-till" (one pass disc seeding).

Methodology

Given the exploratory, 'early research' purpose of this study, a qualitative grounded theory methodology was adopted in which a relatively small number of in-depth interviews were used to collect suggestive insights about the no-till situation in the region. In keeping with this, a local interviewer approach was used, following Rickards (2008a, b). This approach was chosen to take advantage of the way local interviewers can easily develop rapport with interviewees from the same region and further the depth of questioning and quality of data collected, as they draw on their local knowledge of farming issues in the area. Training and using local advisors as interviewers also carries the further advantages of building social research capacity in the local extension population and allows more interviews to be conducted than would be possible using fewer external interviewers (such as the authors). The disadvantages of this approach are that multiple interviewers can introduce systematic variation into the results. To minimize this, structured questions were used, interviewers were carefully trained and interview findings were screened to check for obvious bias.

Potential interviewers were approached from local agricultural consulting businesses, farm input resellers and a local producer group. Six interviewers were selected (three consultant agronomists, two resellers and one producer group member) and trained in good interview technique and ethics.

A sample of 90 farmers, consisting of approximately even groupings (30 farmers) of full, partial or non-adopters of no-till practices, was then selected for interview. A purposive sampling frame was used whereby the six interviewers were each asked to use their local contacts to construct lists of approximately 5 farmers from each of the above categories, defined as:

1. No-till – those whose entire crop in 2007 was sown with no soil disturbance prior to sowing;
2. Combination – those who use a combination of no-till and conventional tillage;
3. Multiple-till – those who prepared the vast majority of their 2007 crop using one or more cultivations prior to sowing.

The farmer samples selected by the interviewers covered diverse geographical areas, rainfall zones and soil types, as well as a range of farmers in terms of age, enterprise size, business stage (expansion, consolidation, wind down), level of practice change and clients and non-clients. Accessing farmers via local interviewers reduced the randomness of the sample and thus the generalisability of the results, but was necessary for pragmatic reasons. Importantly, such an approach still allows valuable qualitative insights to emerge.

Interviews were conducted in February and March 2008. Set questions were asked for consistency in data collection and at the same time, a conversational approach was used to encourage farmers to talk freely about their business. Interview questions explored: the extent and drivers of practice change; the reasons for some farmers maintaining a preference for cultivation and the constraints to the adoption of no-till farming; views about profitability and sustainability of different farming systems; and where farmers access information to assist practice change and their expectations and opinions about the role and value of NRM agencies, producer groups, private advisors and others in the Mallee. Cropping data about the 2007 season in comparison to five years ago was also collected. Percentage frequencies of quantitative cropping practice data and attitudinal scale responses were collated, although the non-randomness of the sample meant that statistical testing was not appropriate. Qualitative responses were coded into themes and used to try to understand farmers' perspectives and stories.

Results

Rapid conversion to no-till

No-till farmers were using knifepoint seeding rather than "direct drill" or one pass seeding with a full cut. Combination farmers were using a mix of tynes and knife points. No one was disc seeding (zero till).

Around 85% of farmers interviewed reported that they had reduced their tillage levels over the past five years. The results are shown in Figure 1 and Figure 2. The conversion to no-till has been recent given that only 10 out of the 90 farmers interviewed were using no-till as a ground preparation method five years ago, increasing to 68 farmers or 75% (using it for at least part of their crop) for the 2007 season. Five years ago, No-till farmers were still preparing over 50% of their ground in a conventional or multi-till manner. Similarly, the Combination group multi-tilled over 80% of their ground five years ago compared with less than 40% now. While the Multiple-till group have not adopted no-till to any substantial extent, 70% reported that they had reduced the number of workings or level of cultivation over the past five years. Many initiated the fallow period using chemicals.

Cropping intensity had increased on over 60% of farms (participating in the study) over the past five years, with the average intensity across the sample being 77% sown for the 2007 season. Almost three quarters of interviewees rated livestock as either moderately or very important to their enterprise, despite livestock numbers dropping on nearly 40% of participating farms over the past five years.

Farmers using no-till (to any degree) were from diverse age groups and operated a range of farm sizes in various business growth stages. They were more likely to run a larger farm and to be planning to expand their operation than Multiple-till farmers.

The key reasons for adoption put forward by No-till and Combination farmers, was to reduce soil erosion and to gain increased flexibility around sowing decisions to enable a change in cropping plan as the season unfolds. Other prominent reasons for change included their desire for a system using less tractor hours (both less labour and wear and tear on machinery) and one that would increase the efficiency of their operation (greater cropping intensity and better use of capital) and ultimately business profit. No-till farmers were also striving for agronomic gains (for example, water use efficiency in growing grain, weed control, better targeting of inputs) and soil health improvements.

Figure 1. Proportion of crop by ground preparation method - 5 years ago

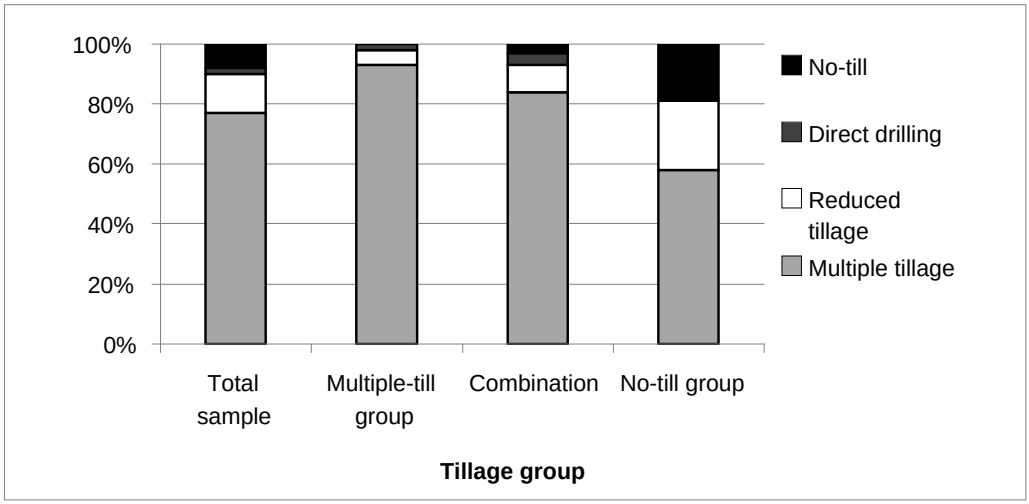
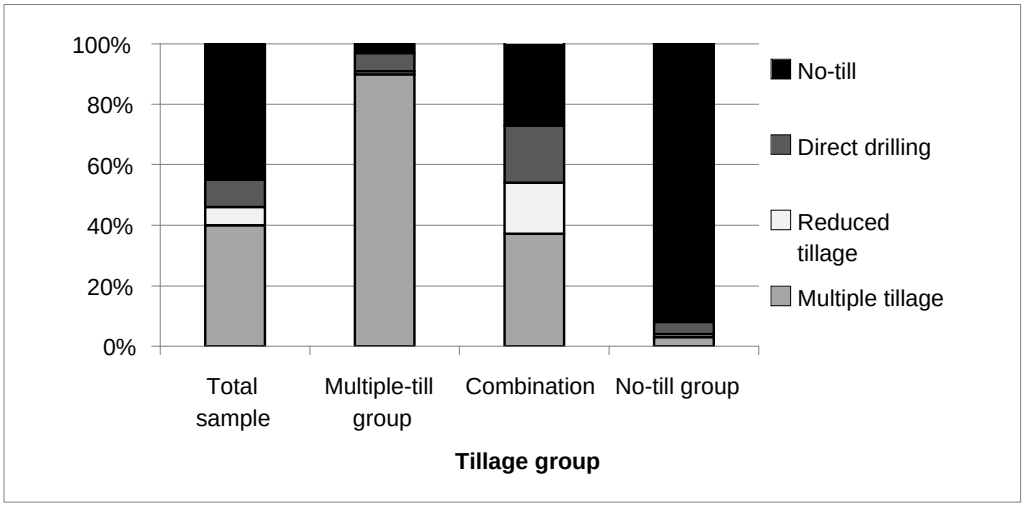


Figure 2. Proportion of crop by ground preparation method - 2007 season



Farmers within the Combination group included those trialling no-till and some building confidence with the new system and looking to convert to 100% no-till for the following season. Others expressed a preference for maintaining a flexible 'combined' system: one involving both no-till and conventional cultivation, with the mix determined by soil type and season.

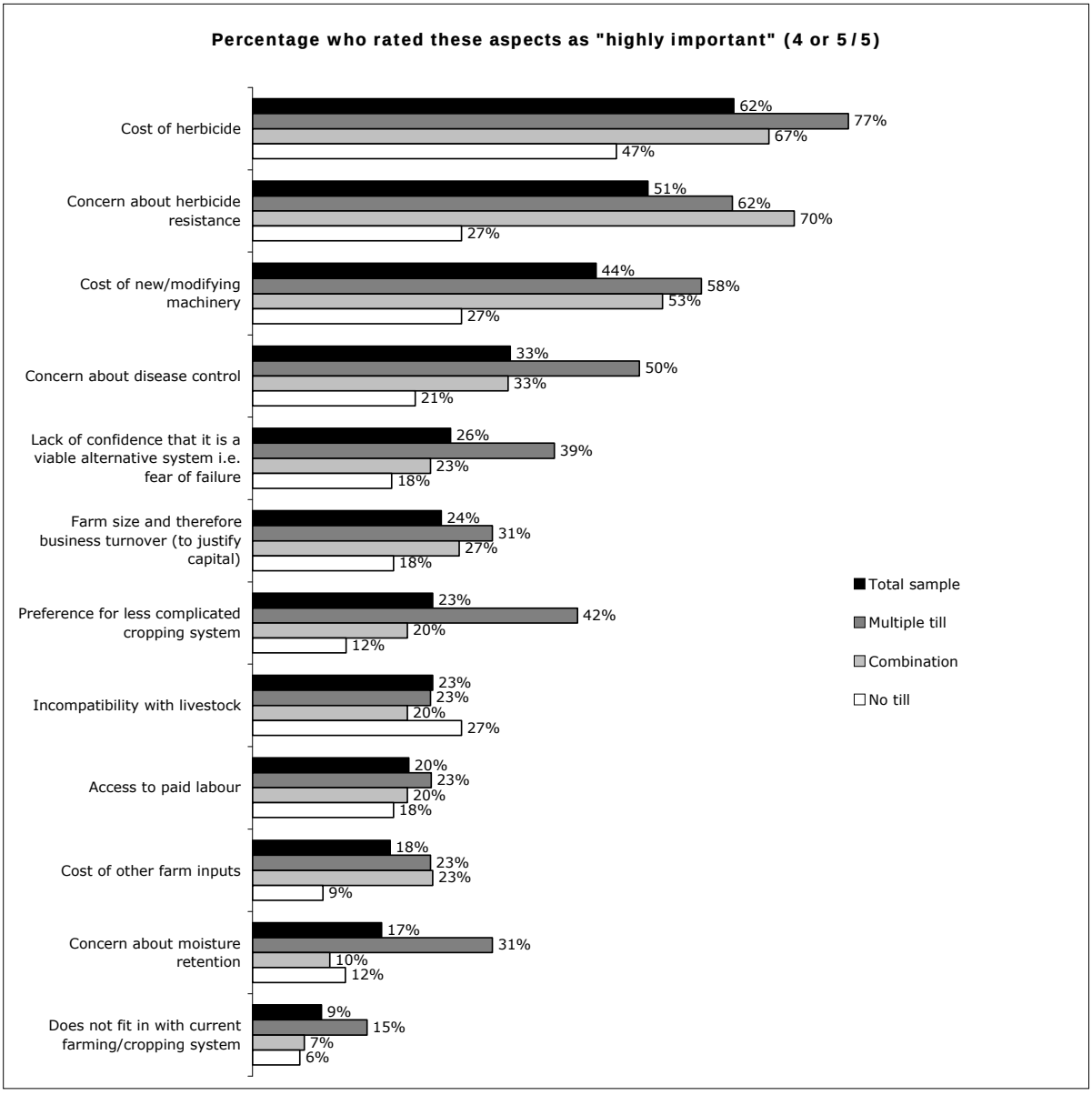
Almost half of Multiple-till farmers interviewed expressed a strong ongoing preference for cultivation for ground preparation. They had deeply held beliefs and concerns about shifting to no-till (discussed below) and were not contemplating making a change in this direction. The remaining Multiple-till farmers expressed a desire to change their system toward no-till sometime in the future. Like the others in this category, however, they resisted the idea that no-till was the best approach for all farmers and all land. As two of them stated:

> "Every farm and paddock is different and no one system fits them all",
>
> "Best management practices are different for different people – it comes down to farming practices for your own soil type".

Concerns about no-till

Farmers were asked to rate a list of potential obstacles to (or concerns about) adopting no-till according to level of importance, on a scale of one to five (five being very important). A summary of the 'high importance' responses (rated 4 or 5/5) is provided for each tillage group in Figure 3.

Figure 3. Main obstacles with the adoption of a no-till farming system – percentage rated as high importance



There was a high level of consistency across all tillage groups in terms of the order of importance of each of the main concerns listed. The top three concerns were: cost of herbicide; herbicide resistance; and the cost of modifying or purchasing new machinery. It is notable that there was concern (across all three tillage groups) about a heavy reliance on herbicides under a no-till system. There were also concerns about health effects, rising herbicide costs and resistance.

The main difference between the groups was the level of importance they attributed to each obstacle. It was evident that fewer No-till farmers rated each potential obstacle or concern as high importance. Combination farmers tended to be somewhere in between, while a higher percentage of Multi-till farmers reported stronger concerns for ten out of the twelve questions. An exception is that Multiple-till farmers place more importance on their preference for a less complicated cropping system and have a higher concern about moisture retention than the other two groups. Across all three groups, there were comparable levels of concern about the compatibility of livestock with an increasingly intensive cropping system, access to paid labour, and the cost of other farm inputs.

Many Multiple-till farmers expressed concern about the profitability of no-till and, especially, about yield penalties they believed to exist on heavier soils. Like some in the Combination

group, Multiple-till farmers were also troubled by the high labour demands of no-till at sowing time. Overall, they want to know more about:

- The financial aspects of no-till, particularly its profitability (or lack of).
- Yields and performance by region and broad soil type.
- Labour requirements at different times of the year.
- How to run livestock in an increasingly intensive cropping system.
- Herbicide resistance and weed control issues.

In reflecting on their own conversion to no-till, many of the No-till farmers indicated that the biggest hurdle was belief that the new system would work and the confidence to go through with the change. They then faced the hurdle of getting the machinery right and, most challengingly, the issue of managing the agronomic aspects of the no-till system, which tends to increase in complexity when operated at a higher cropping intensity.

Views about sustainability and profitability

Although some No-till farmers had reservations about its sustainability (due to the heavy reliance on chemicals) one of the most notable observations was their enthusiasm about the success of no-till and belief that the system was good for the environment. In contrast, those farmers expressing a preference for staying with multiple-till did not generally equate no-till farming with improved sustainability.

Around 50% of Combination and No-till farmers believed no-till to be more profitable and a further 24% of No-till and 13% of Combination farmers indicated they believed the systems to be as profitable as conventional systems. Only about 10% of these two groups felt no-till to be less profitable.

The No-till adopters who believed it to be more profitable mostly attributed this to: economies through more intensive cropping; ability to produce more grain on poorer ground; lower input costs per hectare; greater flexibility and efficiency, including enhanced sowing timeliness and responsiveness in the face of dry seasons; and better utilisation of fixed assets. Many also mentioned that their soil was now in better condition.

Most multiple-till farmers felt that no-till was either the same or less profitable in their area. Others were unsure of its profitability, with around 30% believing that no-till was profitable in other regions in the Mallee, namely those with lighter soils, but not in their particular region. As one stated:

> "I have been following neighbours with interest, and I like the idea of direct drill, but I would really like to see what cost savings or yield increases there are to be made".

For the time being many Multiple-till farmers don't see a strong relative advantage of no-till over multiple till for them.

Sources of advice and information

Use of paid advisors was a central difference between those who adopted no-till (partially or fully), and those who did not. No-till and Combination-till farmers generally used paid advisors for advice on business, agronomy and land management decisions. Around 80% of No-till farmers used a paid advisor compared with 40% of Multiple-till farmers (and 60% of Combination farmers). Multiple-till farmers also expressed a stronger preference for a less complicated cropping system. Over 40% of Multiple-tillers (compared with 12% of No-till farmers) considered this preference an important barrier to adoption (refer to Figure 3). No-till and Combination farmers were also more accustomed to accessing and using information and rated producer groups of moderate importance for information on land management decisions. In contrast, Multiple-till farmers sought advice more heavily from resellers and looked to agencies for information on land management matters. They did not regularly access extension information. There was found to be only limited engagement between the different sources of advice, namely: private advisors and resellers, with government agency staff and producer groups.

Discussion

Irrespective of the type of sowing system they are using, this study suggests that farmers in the Mallee region are aware of the need to reduce cultivation-induced soil erosion. The widespread reduction in the level of tillage reported by farmers in the sample points to the success of the extension message in the region about soil erosion and the role played by cultivation. While there is still obviously broad scope for further practice change, in terms of farmers reducing

their tillage intensity and practicing no-till proper (e.g. direct drilling), the farming population seems to be well versed about the issue.

In addition to a strong awareness of the link between no-till and reduced erosion, the main drivers for adoption of no-till seem to be the flexibility, efficiency and profitability it offers. These inter-related drivers point to adopters' focus on how they utilise their time, a concern which is further indicated by their use of private advisors to allow them to fast track the learning process by filtering information and receiving advice on decisions. Combined with the facts that the No-till group is generally characterised by their larger farm size and interest in expansion, and no-till generally demands the outsourcing of labour at sowing time, it seems adopters of no-till generally fall into what McGuckian and Rickards (2009) called 'the CEO model' of farmer. Such farmers are happy to delegate a significant number of farming tasks, ranging from tractor work to complicated decisions about aspects of the business such as finance, machinery and agronomy. The 'CEO farmer' is then left to manage and integrate the various components and people that make up the complex whole that is their modern farm business (see McGuckian and Rickards for further discussion). No-till assists farmers in implementing this approach by freeing up their time to focus on questions such as enterprise mix and the sort of just-in-time adjustments to cropping programs in response to dry seasons, for example, that no-till also enables.

In contrast to the No-till farmers, the Multiple-till farmers are a much more diverse group. Some are less used to outsourcing labour or advice, preferring to continue running a predominantly family operation (often one-person). A feedback loop ensues for a proportion of farmers, such that they do not have the time (or the money) to learn about or implement the no-till system that would then provide them with these resources. For some Multiple-till farmers, the shift in labour requirements under no-till from work across the season to a short sharp period at sowing time, is a threat to their self-sufficiency. While a cultivation-based sowing system may involve more hours overall, because these hours are more evenly spread throughout the year, it is still achievable for one person. Furthermore, the time savings that no-till offers across the year are of less value to a farmer who does not need to free up time to manage paid advisors and others. Overall, cultivation seems more in keeping with the self-sufficient model of farming that many Multiple-till farmers seem to value, and the benefits of flexibility, efficiency and profitability of no-till are of less relative advantage to Multiple-tillers than to those farmers using their time and money in a different, more CEO-like fashion.

One of the reasons that time is a prerequisite for adopting no-till (not only a consequence of it) is that it is a complicated practice that demands the acquisition of a significant amount of new knowledge and skills. To the extent that this investment involves employing a paid advisor and/or accessing and synthesising large amounts of information, it represents a greater risk and barrier to those unaccustomed to working in this way.

If paid advisors are in practice the main 'keepers of knowledge' about no-till, and engagement with them is virtually compulsory for successful evaluation and adoption of the practice, expanding adoption of no-till requires that these extension agents extend their reach to those currently not using their services. Moreover, it requires that these advisors develop a trusting relationship with potential Multiple-till clients. The literature on trust highlights, however, that this may be hampered if the advisor is unable to respect the farmer's style of operating, which, as discussed above, is characterised not only by certain tillage decisions but by their general preference for avoiding the purchase of services such as those the advisor offers. The risk is that if farmers such as the Multiple-till group feel their goals are not respected, they will not develop a trusting relationship with the sort of paid advisors who operate to a large degree as gatekeepers to no-till adoption. Such farmers then face becoming increasingly isolated and wedded to cultivation.

The trialability of no-till is further reduced for Multiple-till farmers by their lack of engagement with producer groups who, like paid advisors, are likely to be able to provide access to observable examples of no-till in action. Some farmers' comments that they do not believe no-till works well in their particular region suggests that they have few if any close neighbours using the system. It also suggests that cultivation type is clustered geographically, perhaps in keeping with soil type.

Trialability is enhanced in cropping by the ability to compare new and old types of cropping systems on the one property (Abadi Ghadim et al. 2005). This is one of the advantages enjoyed by the Combination-till group, who operate both conventional and no-till approaches. As their comments indicated, however, it cannot be assumed that the co-presence of the two approaches is purely about trialling no-till. In keeping with the literature on the non-linearity of adoption (e.g. Buck et al. 2001), some indicated a preference for maintaining a mixture of the

two. Flexibility for these farmers is about being able to move between system types as well as the flexibility inherent within no-till.

The Multiple-till group were relatively unique in raising concerns about the profitability of no-till. This suggests that their concerns could be addressed through further exposure to successful examples of no-till. However, elements of their farm systems such as heavier soils or a commitment to mixed farming could mean that their concerns are well-founded and point to limitations of no-till that require further research. Some benefits of no-till, for example erosion control and particular agronomic gains, are more easily won on lighter soils. Other elements of their systems such as a desire to remain relatively self-sufficient in labour further highlight how no-till – as currently practiced - demands trade-offs between their goals, and comes out the less appealing of the options available. A considerable proportion of the Multiple-till group are not convinced that there is a relative advantage for them with adopting no-till.

It is significant that herbicide costs and resistance, and machinery costs – which generally match the main limitations of no-till reported in an earlier survey of South Australian and Western Australian grain growers (D'Emden & Llewellyn 2004) – were reported as concerns with no-till irrespective of farmers' level of adoption of the system. The inverse relationship that exists between level of concern with these factors and level of adoption of the system indicates that, once practicing no-till, farmers' confidence in the no-till system builds and/or they begin to place less value on the system's shortcomings. Nevertheless, combined with widespread interest in further information about how compatible no-till is with livestock, weed management is a further area of no-till that demands primary research and improved answers as much as further extension efforts. There are questions about how sustainable is no-till's heavy reliance on chemical herbicides (D'Emden and Llewellyn 2006, Huggins and Reganold 2008). To the extent that no-till encourages a move away from livestock, there are also questions about how sustainable this direction is, given the recent emphasis placed on diversification and mixed farming as potential risk management tools in the face of drought and climate change (McGuckian and Rickards 2009). Greater compatibility between no-till and livestock would further increase the flexibility that farmers already value about no-till.

These ongoing gaps or imperfections in the no-till farming system as currently promoted and practiced are highlighted by the extension context it exists within. Side-by-side with the extension messages farmers receive about no-till is a general community call for reduced agrochemical use. There are also extension programs promoting better integration of livestock and crops (e.g. the Grain and Graze program). There are divergent views on the compatibility of no-till with livestock between growers, agencies and advisors, which tend to cloud the issue and is another barrier to adoption for those with more stock, particularly on heavier soils in the southern Mallee area. Unacknowledged and unresolved tensions between desired directions in extension messages risks confounding and irritating farmers, reducing the credibility of all the messages and messengers involved.

In addition to further work on resolving questions about no-till and improving the complementarities between different environmental and other goals, better integration of extension sources is needed to improve consistency across them. Given private advisors' and resellers' existing relationships with farmers and local knowledge, they themselves could be targeted with improved information on no-till as further research on the system produces results. Such integration could assist in overcoming the kind of cultural barriers between agribusiness and research and development found by Stone (2005, 2008).

Conclusion

No-till has an important role to play in improving the sustainability of agriculture in the Mallee and beyond, particularly in the context of reducing soil loss and also climate change. While only exploratory, this study has contributed insights about the farmer and practice characteristics influencing adoption and non-adoption of no-till. The small snap-shot provided by this study also points to the research and extension challenges that remain, including the need for a larger quantitative survey to test the statistical significance of the differences between groups suggested here, a more in-depth qualitative study to better understand how farmers weigh up the potential costs and benefits of no-till, and a longitudinal study into the process of decision-making and possible adoption.

One of the significant things this study suggests is that cultivation-based and no-till farming appeal to different models of farmer, with the former suiting those who value self-sufficiency and the latter suiting those taking on more of a 'CEO' role. One of the implications of this is that, to the extent that paid advice is a necessary route to no-till adoption, private advisors have a type of gate-keeping role in the adoption process. For those unused or unable to utilising

such paid services, this will remain a barrier to no-till. In recognition of their responsible role, private advisors should be targeted with high quality information about no-till, as should resellers, to whom Multiple-till farmers already talk. Further research is also needed into the role of external advice in encouraging no-till adoption or non-adoption and why and how different advisory professions seem to have developed different orientations towards no-till systems.

As emphasized by Vanclay (2004), it is important that extension efforts around no-till are respectful of the knowledge and experience of those resistant to or yet to change. Farmers' reasons for non-adoption or partial adoption are legitimate, and relate either to their own characteristics (such as some Multiple-till farmers' concerns about costs, which may be an involuntary consequence of their circumstances) or to the characteristics of the practice (such as unresolved shortcomings of no-till like its reliance on chemical herbicides, its possible incompatibility with livestock, and the poor visibility of environmental and agronomic gains on heavier soils). As Llewellyn et al. (2006) argue more generally, extension efforts need to selectively target the farmer perceptions about no-till, focusing on those that are able to be addressed through more information or by assisting farmers to apply the information to their properties to see how no-till could work for them. For such efforts to be credible and effective, they also need to be open about the gaps that remain in our knowledge about no-till and how it can best be integrated with other desirable practices. Further research is needed on no-till itself to address its limitations from a farmer viewpoint. By improving the environmental, social and production credentials of no-till systems as well as our understanding of how best to enable adoption of them, we could take a significant step toward a more sustainable agriculture.

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