The role of landholder education in adoption of soil health management systems

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Abstract
Management for soil health has received increasing attention, but, despite this, adoption of soil health management plans (SHM) has been slow and is possibly affected by landholder education. This paper investigates the role of landholder education in the adoption of SHM systems, using salinity and sodicity as indicators. Through the use of a landholder response mail based survey consisting of likert scale rank questions, categorical responses and open ended questions, education was shown to mildly affect the adoption of SHM programs, but was not considered an overriding impediment by landholders. However, there is a disparity between education as an impediment and landholders knowledge. This disparity is potentially overcome by a reliance on agronomists and extension officers to guide landholders through SHM issues that they find complex. In terms of managing soils for salinity, education was shown to be adequate, although for sodicity education is still a major limiting factor.

Introduction
The term 'soil health' has become increasingly prevalent in scientific documents, advertisements for agricultural company services, departmental extension programs, government-based discussion and policy, and farming communities. However, the adoption of soil health management (SHM) programs in Australia has been slow. Farmers remain hesitant to implement structured management plans tailored to address soil health, despite accumulating scientific evidence for the credibility of certain soil health indicators, increased reporting of program benefits, and progress in communicating these. Lobry de Bruyn and Abbey (2003) observe that soil health programs and their indicators are often too complex to be implemented by farmers independent of external assistance and advice. Hence, landholder education is potentially one way in which to address SHM adoption.

With reference to two specific SHM issues, salinity and sodicity, Watson *et al.* (2000) reported that 54% of Australian local governments questioned believed that sodicity *was not* an issue in their area, with a further 22% unsure, while 72% of local governments believed salinity *was* an issue, with only 9% unsure. These are curious statistics considering that sodicity currently affects ~340 million ha (Murphy 2002) and salinity is comparatively forecast to affect only ~4 million ha of Australian land by 2050 (Robertson 1996). Furthermore, this disparity is concerning because local governments are usually comprised of landholders, are responsible for the local farming community, and should be up-to-date with issues affecting their local community. Irrespective of this concern, Hajkowicz and Young (2005) make the assumption that landholder awareness of sodicity is really quite high, resulting from educational/training programs in the decade prior to 2005. However, this was not further explored.

This paper investigates the role of landholder education in the adoption of SHM systems, using salinity and sodicity as indicators.

Methods
The data used in this study was collected from landholders, via a mail-based survey, in the Lachlan and Macquarie Valleys of New South Wales. The survey questions used for this paper consisted of Likert-based scales (Likert 1932), with categorical selection used for salinity and sodicity definition testing. There was opportunity provided for an open response concerning the impediments for the adoption of SHM strategies. Technical terms used in the construction of questions were representative of those often used by agronomists, extension agencies and landholders. The survey was based on a survey template used in the studies of May (2006) and Mylek (2006), with further reference to the tailored design method (Dillman 2007). The information sent to each participant included a letter of explanation, the survey, a return addressed envelope and a stamp. A participant database was obtained from various Livestock Health and Pest Authorities (LHPA) within the survey region; this database constitutes rate payers within each individual LHPA region. This was supplemented, where necessary, through the use of the White Pages®,

cross-referenced with a real-estate database for landholding size and title details. A mailing list was selected at random and stratified using demographics of council regions. The survey data only comprised of landholding equal to, or exceeding, 60 ha. The number of eligible participants was 719.
The response rate achieved after the initial send out of the survey and one reminder card was approximately 20% (*n*=144, *N*=719) following exclusion of ineligible participants. Non-response bias was not evident, and was assessed by obtaining a second sample (*n*=96, *N*=100) from non-responders and comparing the frequency of auxiliary variable distributions for respondents and non-respondents.

Results

Education and training impediments

Of the education and training impediments listed (Table 1), lack of research into broadacre SHM (3) and lack of expert advice or assistance for SHM, other than an agronomist (4), represent the greatest impediment to adoption of SHM plans; 47% (N=115) and 44% (N=125) responded with 'large impediment', respectively. Responses to the statement concerning the time taken to learn SHM skills (5) were generally spread evenly across the impediment scale, while not knowing enough (1) and not enough ongoing technical advice (2) were spread across the slight impediment to large impediment categories. It is noted that the majority of respondents to statement (2) indicated a moderate or large impediment (66%, N=127).

Table 1. Education impediments to the adoption of a soil health management plan as ranked by landholders of the Lachlan and Macquarie Valleys

	Education and training impediments to the adoption of soil health management plans	Frequencies (%)				
		Not an impediment	Slight impediment	Moderate impediment	Large impediment	Sample size (N)
1.	I don't know enough about soil health management	17	26	27	30	130
2.	There is not enough ongoing technical advice on soil health management	10	24	34	32	127
3.	There has not been enough research into large-scale/broad-acre soil health management	7	24	23	47	115
4.	It is difficult to get expert advice or assistance for management of soil health, other than an agronomist	18	18	21	44	125
5.	It takes too much time to gain the knowledge and skills needed	25	30	19	25	130

Various landholders suggested that they now knew what it was they had to do in the future to manage for soil health based on their past experience, or past experience of others. For example:

> *"My wife and I have been running our farm for 9 years taking over from my parents… when it does rain we will have the hindsite (sic) we need to take advantage of every drop of rain and so improve soil quality"* (L24)

> *"Blindly following what dad did. Lesson learnt. I now know what I need to do"* (L120)

Others indicated that they didn't know what some of the soil health characteristics used in this study were, or what their impact on soil productivity was:

> *"…a lot of the issues you raised I am unfamiliar with, I am sure I have most of the other problems, we have very little help with & reduction of soil deficiencies – I have no idea in $ terms what they cost me in production."* (L16)

Soil health factors

Landholders were asked to rate the importance of various SHM factors (Table 2) to the management of their properties. All of the factors listed received the vast majority or responses in the 'highly important' category, with the exception of sodicity, slaking and electrolyte. The percentage of respondents who selected 'don't know' for sodicity, slaking and electrolyte was also notably higher than the remaining factors (17%, 34% and 33% respectively; N=144). Additionally, landholders were questioned on salinity and its definition. Given the direct relationship between salinity and electrolyte concentration, there was an interesting difference in numbers of respondents being unfamiliar with either factor. Compared to the 33% unfamiliar with electrolyte, it was found that 12% of landholders were unfamiliar with salinity and a further 1% selected an incorrect definition (N=135); 87% correctly identified the definition.

Organic matter content and soil structure were represented as the factors that the majority of landholders placed as most important to their management (86%, N=132 and N=131 respectively). Despite the relationship between sodicity and soil structure, sodicity was only considered to be highly important by 41% with a further 32% suggesting sodicity to be of no importance to their property management (N=110). When questioned about the definition of sodicity, 36% of landholders selected the correct definition, while the remaining 64% either did not know, thought sodicity was the same as salinity, or confused the definition of sodicity with its consequences (N=143).

Table 2. Landholder ranked importance of selected soil health management factors for the Lachlan and Macquarie Valley

Soil health factor	Response as a valid percent of N (%)			Sample Size (N)	Don't know** (%)
	Not important	*	Highly important		
Organic carbon	10	14	77	125	9
Water infiltration	5	9	87	129	5
Sodicity	32	27	41	110	17
Nitrogen	2	15	84	135	3
Microbial diversity	5	14	81	129	6
Phosphorus	2	17	81	136	3
Slaking	40	32	28	88	34
Organic matter content	1	10	89	132	4
Electrolyte	11	34	55	85	33
Soil structure	2	9	89	131	5
Soil erosion	16	10	74	136	2

* Those selecting a category between 'not important' and 'highly important'

**Those who selected 'don't know' reported as a percentage of the total response N_T=144

Discussion and Conclusions

Education as an impediment

Education as an impediment to SHM was shown to have a moderate influence. With the exception of broadacre research and expert advice, responses were relatively evenly spread over the impediment categories. While at least a quarter of landholders indicated education as a large impediment, the general consensus is that education does not have an overriding influence on the implementation of SHM programs. Comments made by landholders suggest that past experience provides adequate knowledge to continue with SHM. However, there appears to be conflict between the influence of education as an impediment and landholders' knowledge; i.e. there may be a propensity for landholders to think they understand adequately, irrespective of whether or not they do. This is highlighted in the current research through: (i) landholders' tendency to select 'not important' for soil health factors, such as slaking, that also had the highest proportion of landholders select 'don't know'; (ii) the number of landholders who actually know what sodicity is, compared to those who said it was important to their management; and, (iii) direct comments made by farmers with reference to their knowledge of soil health factors. Therefore, it is quite possibly the case that soil health education is still a major hurdle to consistent SHM.

Although landholders may have overrated their understanding of soil health issues, this does not necessarily make education an impediment to adoption. In the same way that Kelly *et al.* (2009) suggests that there is an over-reliance on agronomists and extension agencies, it is quite likely for those with a lesser SHM education to feel comfortable in implementing such a program through relying on the supervision and advice of their agronomist or local extension officer.

The extent to which education is perceived as an impediment to SHM adoption is also influenced by those who design and communicate the innovation. Landholders generally want and seek to understand processes and information that will aid them in their farming enterprises, although reason provides that simple innovations are likely to be adopted over those that are complex (Guerin and Guerin 1994). The current results indirectly show that the complexity of SHM is still a major concern for landholders. Almost half of the farmers indicate that there is a requirement for more ongoing expert advice or assistance for SHM, while approximately a third believe more ongoing technical advice is required. This shows a reliance on experts and technicians in order for landholders to be able to sustain a structured and consistent SHM program. Subsequently, it can be deduced that SHM is complex. It is not necessarily possible to make the soil physical, chemical and biological systems and interactions less complex, so it should be kept in mind by

those promoting structured SHM programs that adoption longevity is reliant on ongoing external advice. While we agree with Kelly *et al.* (2009) that farmers are at risk of losing connectivity with their land, the only apparent way around a reliance on external advice is through further and higher education, which is not necessarily an option. Therefore, this requirement for external advice must continue, but landholders should be encouraged to remain involved on all levels, from on-the-ground decision-making through to the conduct of research, contrary to the beliefs of Sojka and Upchurch (1999).

Sodicity versus salinity

Environmental salinity campaigns such as "Halt the Salt" continue to endure, having received much public attention and concern in the past three decades. So, it was not surprising to observe that 87% of responding landholders correctly identified the definition of salinity. In fact, it might be asked why the remaining 13% did not understand salinity as an environmental issue. Comparatively, sodicity has received less public exposure (Hajkowicz and Young 2005) and the results in this study reflect this, with only 36% of landholders correctly identifying the definition of sodicity. It may be suggested that only those who have sodic soils could be expected to understand the issue. However, given the relative affected land estimates, there is still an obvious disparity between the knowledge of salinity and salinity affected land as compared to sodicity and sodicity affected land. Northcote and Skene (1972) estimate that 47% of NSW is affected by sodicity, with the majority of affected land west of the Great Dividing Range (McKenzie *et al.* 1993). This increases the likelihood of sodicity being a SHM concern for the Lachlan and Macquarie Valley landholders.

Hajkowicz and Young (2005) further suggest that farmers have an intimate knowledge of their land and how it responds to treatment, such as applications of sodic ameliorants. Their argument extends to reason that if farmers are well aware of solutions, then it is possible that the marketplace has identified an optimum level of treatment; i.e. the decision to not address sodicity is a private investment based one, rather than a function of information failure. While it is plausible that farmers may not address sodicity, even if they are aware of it, they must be aware of it to make this decision. The results for the understanding of sodicity versus salinity do not support this notion. Hence, education is still a limiting factor where sodicity is concerned. Once again, the role of scientists, extension agencies and agronomists will be important in addressing this.

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