Collaborating with farmers to design a practical soil health checklist

L.A. Lobry de Bruyn

School of Rural Science and Natural Resources, University of New England, Armidale, NSW, 2351,

ABSTRACT

If farmers are to determine whether their farm goals for resource condition are being met, and whether changes in farm management are leading towards a more sustainable farming system, then they need to be able to monitor these areas. Yet to date, an easy to use, practical and reliable checklist to be used by farmers to monitor trends in soil health has not been developed. This project sought to collaborate with farmers in the development of a soil health checklist and the research process acknowledged the importance of local conditions, farmers' existing knowledge on soils and their preferences for delivery and presentation of the final product. The project was conducted in the north west cropping region of New South Wales, Australia. The project reports on a prototype for a farmers soil health checklist – the features they use, how they recognise those features, especially the language they use to describe a healthy and unhealthy soil, and finally the techniques they use to measure those features.

KEY WORDS

Soil health, sustainability, monitoring, farmers' understanding, local knowledge.

INTRODUCTION

Soil monitoring has typically occurred at the national scale, and its purpose is to audit the state of the environment and predict the effect of changing land use, principally agriculture, on soil quality (10). In Australia, the purpose of monitoring is to support implementation of environmental management systems, better land use planning and continuous productivity improvement (1). A priority for the Grains Research and Development Corporation (GRDC) and other research and development corporations is to "integrate existing indicators to make them more suited to strategic on-farm monitoring. Such indicators would need to be user friendly and relevant to the needs of grain growers…….in a time scale consistent with the decision making framework of the producer (1)." These priorities are aligned with the changes in agricultural extension that are:

- segmentation of the client base and only dealing with the *top-end* farmers
- privatisation and adoption of user-pays fees for services
- adoption of group extension approaches and *bottom-up* philosophies that reduce the cost of extension services and make farmers responsible for their own problems (9)

With the above changes in extension *modus operandi* there has emerged the need for a review on the value and application of traditional soil monitoring or soil testing. To allow soil monitoring to become "user friendly" will require the development of soil monitoring kits that are flexible, adaptable, operate over shorter time periods and monitor soil changes at the paddock level.

This paper focuses on farmers' understanding of soil health, and its implications for soil monitoring, especially their ability to identify the trends and patterns in soil health to determine the impact of their land use practices on soil condition. This project has produced, in cooperation with farmers, a prototype of a soil health checklist that if used over time could illustrate trends in soil health. Demonstration of improving or deteriorating soil health may act as an incentive to change or affirm current land management practices. I have also examined what farmers perceive as *monitoring*, because so far the soil monitoring kits developed by scientists are not widely recognised or used by farmers. Researchers have hypothesised, that farmers have not broadly adopted soil monitoring because the process requires too much technical expertise, is not cost-effective, nor timely to conduct and the results are not easily interpretable. Another reason for the lack of interest in monitoring soil health is that farmers do not

perceive there is a need to do so. I believe that by using farmers' language and their understanding of the definition, recognition and determination of soil health soil monitoring in the future will be a realistic option.

MATERIALS AND METHODS

Study region and participant profile

Seventy five interviews were conducted with farmers over the north-west cropping region of New South Wales, Australia, covering an area of approximately 400 by 500 kilometres. About eight to ten farmers were interviewed within a 50 km radius of each of the following rural centres: eastern region - Warialda, Gunnedah, Moree Narrabri, and in the western region: - Goondiwindi, Walgett, Coonamble and Gilgandra. Every effort was made to ensure that participants were representative of the broader farming community, and not just the upper echelon of farmers (in financial terms). Initial contacts with 54 farmers (mostly from eastern portion of north-west NSW) were obtained from a survey conducted by NSW Agriculture in the late 1980s (7. Of the respondents to this survey, only 34 remained farming in those districts. The sampling frame of potential interviewees was supplemented through contact with local organisations and members of the community in each district. With the completion of the interviews, it was apparent that the types of farmers interviewed were quite diverse. The greatest proportion of farmers owned the farm, a quarter were part-owners, 5% (or four in number) were managers and only one person was a tenant. Over the eight regions the majority of farmers were between 40 and 55 years old, which explains why their farming experience was, on average, 28 years (range 1-62 years). Most of the farmers had also been farming in their district for at least 24 years which means they had experience with and knowledge of the soil types in their district. Farm sizes varied from 66 to 30 000 ha (average 4173 ha). Most of the participants (63%) considered that they made all management decisions on the farm, 20% of the participants considered that they made 75% of the decisions, and the other 17% were minor parties in decision making. No participant indicated that they had no part in any decision making. The level of formal education most farmers' interviewed had attained was high school up to year 10 in 26% of cases, and up to year 12 in a further 26% of cases. In addition, another 26% had achieved some level of post high school education either at TAFE, University or Agricultural College.

Collection of data

During in-depth interviews the interviewer had a guide consisting of core questions and a series of follow-up prompts, but the interview was essentially a conversation as recommended by experienced researchers in the field (3,8). The intent was to draw out the interviewee's thoughts and information that they use in recognising soil health and how they apply their understanding, and not to impose the interviewer's perspective. The interviews were intended to gain 'thick descriptions' (meaning reporting details in context in sufficient detail to allow others to determine when another situation is similar enough to transfer findings to that setting, 4) of soil health – its definition, identification and determination. Farmers were encouraged to use the words they were comfortable with in describing a healthy and an unhealthy soil. The ordering of questions was intended to encourage the farmer in more reflective answers as the interview proceeded, and concluded with the background information. The interview data were coded – building themes and interpreting farmers' responses to the semi-structured questions (14 core questions) using a qualitative software program called QSR NUD*IST4 (**Q**ualitative **S**olutions for **R**esearch **N**on-numerical, **U**nstructured, **D**ata, **I**ndexing, **S**earching and **T**heory building). The software program allowed for thematic analysis and could accommodate the building of evidence, reiteration and an organic construction and reconstruction of ideas. This process required expertise in soil science to categorise the farmer responses, and to understand that the answers to the questions may be distributed throughout the interview transcript and not just be located in one place. QSR NUD*IST4 allows data to be coded as text units (which are farmers' responses to a question) from any part of the interview transcript and located in one or a number of nodes (themes). A header, which clearly identifies each farmer's code and location, defines each text unit, and hence ensures that the integrity of each farmer's views is retained. Also, after preliminary analysis of some of the primary questions eight focus group discussions at each of the rural towns named earlier were carried out to obtain feedback on the combined interview and soil survey results at various scales. Farmers commented on existing soil monitoring kits and made suggestions on what aspects of the soil monitoring kits would be useful to them, and should be included

in a prototype of a soil health checklist. For a more detailed account of the methodology of this project please refer to Lobry de Bruyn (5) and Lobry de Bruyn and Abbey (6).

RESULTS

Soil problems

This project asked farmers to define current impacts (soil health issues) and how they identified those impacts on their farm. Table 1 shows the type of soil health issues (current and potential) by examining the frequency of text units coded by NUD*IST for each district and averaged for the eastern (n =4) and western (n =4) regions of the study area. The standard deviation of the mean indicates the variability over the four districts in each region for the particular soil health issue. Table 1 indicates that the soil health issues of most concern to farmers are the decline in soil fertility, soil structure deterioration and water erosion. There are some regional variations with the areas being cropped for longer (Eastern Cropping Region) showing a greater concern for fertility decline but less for soil structure loss. Those areas where chemicals (herbicides and insecticides) are being used more often in farming (western region) also show a higher degree of concern over chemical residues, especially the slower breakdown of herbicide residues in alkaline soils. Despite the publicity over natural resource management issues such as salinity (for example the *Salinity Audit*, MDBC 1999) it appears not to be a high priority issue for farmers (Table 1).

Table 1. Soil health issues as identified by farmers (%) in the eastern and western regions of the north-west cropping region of NSW.

Locality	Nutrient rundown	Soil structure decline	Water erosion	Chemical residues	Soil salinity	Crop disease	No future soil problem	No of farmers interviewed
Eastern (mean %)	68	51	50	29	22	9	17	40
STDEV of mean	18	11	13	13	7	12	6	
Western (mean %)	54	71	35	39	28	14	34	35
STDEV of mean	15	31	32	10	14	10	7	

Identifying a healthy soil

The 14 most talked about features that farmers used to recognise soil health were identified through analysis of interview transcripts, and the main features are presented in Table 2. There were clear district variations in features with some districts favouring certain features above others. Nevertheless there was some strong commonalities. The most frequently and consistently mentioned features amongst farmers were plant growth, soil feel, and organic matter (Table 2). Table 2 shows that nearly 100% of the farmers mentioned plant growth and soil feel with at least five to six times the number of text units coded than any other feature. Plant growth featured frequently in farmers' conversations about soil health, with a clear link between a healthy plant and a healthy soil. Within 'plant growth', the form and colour (dark, deep green) of the plant was the best indicator of its vigour. In conjunction with plant growth farmers often examined

the plant roots (development and biomass) to identify hardpans and soil structure decline. By far the greatest diversity in terms for a healthy and an unhealthy soil were recorded under the theme ‘soil feel’. For instance, a healthy soil would be described as “friable, loose and easy to work, seeds germinate freely in it, soft and crumbly, fluffy, going to fall apart, and nice and soft”. In contrast, an unhealthy soil would be described as “big chunky pieces, shiny to pull apart, glazed, powdering and running together, it’s not flowing, powdered concrete, ground is packed hard, just massive, ground tighter, bit of concrete, setting down, setting like concrete”. It was also only through workshop meetings with farmers that it became apparent that several features mentioned by farmers in response to questions about soil health were later disregarded as soil health parameters and were used more in the recognition of soil type. This was particularly relevant for soil texture, soil colour and native vegetation.

Measuring soil health

The types of measures farmers use to evaluate soil health are limited to soil testing and evaluating yield and protein levels of the wheat crop. A common phrase used by farmers when talking about assessing soil health was ‘scratching around’. They would often pick up the soil and see how it broke up, or use the ‘boot test’ where they would kick the soil and see how much stuck onto the end of the boot. However, both these measures were used more for assessing soil moisture levels than soil health. Other techniques used by farmers to determine soil health were often incidental and done while completing other tasks such as cultivating, driving around the paddock, testing for soil moisture, checking for weeds, putting in a dam, taking a soil test or building a fence. Overall the level of formal record keeping on soil health or soil testing is low (only 16% of farmers keeping soil test records for paddocks), and most farmers keep information about soil health in their head or jotted into the pocket diary.

Soil testing was regarded by most farmers as a way of eliminating the causes of poor crop performance that could not be determined by “the naked eye” or to “ to see what’s depleted, what’s missing to make it good”. Hence a large proportion of farmers (65%) specifically talked about soil testing in relation to soil fertility and assessing whether there were adequate levels of Nitrogen and Phosphorus and to a lesser extent micronutrients. However, there was a small proportion of farmers (13%), who were quite emphatic in their view that soil tests results were not reliable (F67: “I don’t have a lot of faith in them”, or F26: “I am very sceptical”). Their scepticism stemmed from the dual role of the soil tester - one to sell fertiliser and the other to give advice - which they perceived as a conflict of interest. It is also clear that most farmers use a combination of techniques, and only a few farmers considered that they were not monitoring their soil condition. Usually soil testing was combined with other indicators such as crop growth, observation and yield and protein levels of crop.

Table 2. Features used by farmers to identify the health status of a soil in north-west NSW (n =75). Rank is based on average of total text units coded by NUD*IST for that feature for the four districts in the region.

Feature	Measure	East	West	Feature	Measure	East	West
Plant growth	text units per farmer	7.4	9.2	Hardpans	text units per farmer	2.4	4.4
	rank	**1.5**	**1.3**		rank	**10.8**	**7.0**
	% response	97.9	100.0		% response	50.9	71.4
Soil feel	text units per farmer	6.8	7.8	Water Absorption	text units per farmer	1.7	2.2

	rank	**1.5**	**2.3**		rank	**11.0**	**11.3**
	% response	97.9	97.5		% response	59.3	45.7
Organic matter	text units per farmer	4.2	3.9	Soil Colour	text units per farmer	2.8	2.5
	rank	**4.0**	**6.3**		rank	**14.5**	**10.0**
	% response	80.2	76.5		% response	29.4	54.2
Soil erosion	text units per farmer	3.4	3.7	Sodicity	text units per farmer	1.9	2.0
	rank	**4.8**	**7.0**		rank	**10.0**	**11.0**
	% response	83.8	74.2		% response	23.7	38.6
Plant roots	text units per farmer	4.2	3.5	Native Vegetation	text units per farmer	2.0	1.1
	rank	**6.5**	**7.8**		rank	**13.8**	**6.3**
	% response	55.8	73.7		% response	33.2	18.3
Soil life	text units per farmer	5.0	3.3	Salinity	text units per farmer	1.9	1.5
	rank	**7.5**	**8.0**		rank	**15.3**	**13.5**
	% response	52.0	69.8		% response	21.7	28.0
Texture	text units per farmer	2.6	3.2	Scalding	text units per farmer	0.5	1.0
	rank	**8.8**	**8.5**		rank	**7.8**	**10.5**
	% response	55.8	63.4		% response	13.1	18.8

Attributes that were clearly identified in Table 2 as important for soil health were not always measured, such as organic matter and soil erosion, while other attributes not clearly identified in recognising a healthy soil such as soil acidity were mentioned as part of soil testing. Organic matter was recognised as an important property for a healthy soil but usually was associated with the biomass (live or dead) above the soil rather than root biomass or humus in the soil. Farmers were also unclear as to how much organic matter was required in a good soil. For instance, when farmers were further probed about their understanding of organic matter levels (40% responded) at least a quarter could not recall the actual figure from tests they had done. While 30% of farmers could recall the soils organic carbon levels with

some level of accuracy, without referring to their soil test results, there was nevertheless a large proportion (40%) of farmers who did not know the levels of organic carbon in their soil and 6% responded incorrectly. Soil pH was discussed by 50% of farmers interviewed. A large proportion of those farmers (58%) appreciated the pH range of a healthy soil, while 11% were correct with some assistance from soil test advice, and another 11% did not know, while a further 17% did not have soil pH tested per se, and did not consider soil acidity or alkalinity a problem.

DISCUSSION

What attributes would a soil health checklist rely on and how would they be presented and how would it operate? At this stage Figure 1 shows a very generalised prototype based on those features that farmers talked about most and would require the least amount of interpretation. The idea would be to design the soil health checklist so it would be adaptable and flexible enough to apply to the soil types and conditions of the area. Guerin (2) identified that "limited adoption of land management research has been caused … by presentation of research findings in a general form which is not site- and season-specific, and is often difficult to integrate into existing work practices." The emphasis would be to formalise farmers' observation processes by supplying a "paper record" that could be integrated into everyday practices. It is critical that the monitoring process becomes part of day to day practice and not an onerous addition to a work schedule. Since the features used in the soil health checklist were constructed from farmers' language and properties that they already associate with an unhealthy or healthy soil, there would be little or no interpretation involved or explanation required. The actual descriptors would be based on farmers' terms used in interviews to describe a healthy and unhealthy soil. The choice, presented to farmers, for each feature is to decide if the soil in paddock X, at the time of assessment, would be classified as "healthy" or "unhealthy" as determined by the descriptors or goals. If the process were to be repeated over time there would be a confirmation of the soil health status of the particular paddock. The paddock's overall health status would be determined by the proportion of ticks in the healthy or unhealthy columns indicating agreement with the descriptors or goals, and then analysis would follow on for "Why" certain features were recorded as unhealthy or healthy.

Figure 1: Example of a soil health checklist for an individual paddock over several years

Paddock Identification: Paddock X

Features	Healthy Soil	1998	1999	2000	2001	Unhealthy Soil	1998	1999	2000	2001
	Descriptors					**Descriptors**				
Plant growth	Lush, green, growing healthily	✓				Stunted, wilted, ill-thrift, uneven germination		✓		
Organic matter	Material breaking down, stubble present	✓	✓			Low plant residues, little ground cover				
Soil Feel	Friable, fluffy	✓				Tight, hard		✓		
Soil life	Present	✓				Absent		✓		

Soil erosion	Absent	✓	✓	Present			
Soil Testing Goals	**Levels**			**Levels**			
Soil pH	> 5.5			< 5.5	✓	✓
Organic Carbon	> 2 %	✓	✓	< 2 %		
Yield Goal	> 2 t/ha	✓		< 2 t/ha		✓

A soil health checklist provides a qualitative appraisal of soil health that is commensurate with farmers' knowledge system, everyday language, and actions. Such a soil health checklist could be multi-purposed and marketed as a tool to assist farmers in interpreting and interrogating soils advice, either with or without outside assistance by a service provider. Since at least 60% of farmers are already soil testing, the motivation now is to extend the information they already have on their soil to other uses. The use of a soil health checklist could have several outcomes that include:

1. Empowering farmers to be more self reliant in terms of identifying their land management needs and problems by identifying the early warning signs of soil productivity decline, and probable causes,

2. Improve the effectiveness and usefulness of soil testing results for land management that, at the moment, are probably used by only 20% of farmers (Price, G. pers. com, INCITEC, Training Division, Federal President of Australian Soil Science Society Inc., "80% of our business is with 20% of farmers"),

3. Farmers taking the initiative on how, when and where to conduct soil testing, thereby reducing outlays (22% of farm on-costs are for chemicals and fertiliser), multiplying the benefits, and applying a more judicious and timely strategy to soil testing, and finally

4. Providing soil scientists, policy makers and technical advisers with a common language for communicating more effectively with farmers about their soil tests and vice versa.

ACKNOWLEDGEMENT

I would like to extend my thanks to the participants of the research project and to GRDC for funding this work, as well as to Jenny Abbey, Bob Patterson, Carol Quilkey and Nardia Keipert who all have worked at various stages, and in various capacities on this project.

REFERENCES

1. Grains Research and Development Corporation 1997. In: Information Paper – 1998-1999. (*GRDC,* Canberra) p176.

2. Guerin, T. F. *Env. Cons.* **26**, 289-304.

3. Kleinman, S. 1991. In: Experiencing Fieldwork: An Inside View of Qualitative Research. (Eds W. Shaffir and R. Stebbins), (*Sage Publications, Newbury Park*). Pp. 184-195.

4. Lincoln, Y. S. and Guba, E. G. 1985. In: Naturalistic Inquiry. (*Sage Publications*, Newbury Park)

5. Lobry de Bruyn, L. A. in press. In Land Degradation: Papers Selected from Contributions to the Sixth Meeting of the International Geographical Union's Commission on Land Degradation and Desertification, Perth, Western Australia, 20-28 September, 1999. (Ed. A J Conacher), (*Kluwer Academic Publishers, Dordrecht, The Netherlands*) pp 187-206.

6. Lobry de Bruyn, L. A. and J. A. Abbey 1999. *Proceedings of Association of Qualitative Research Conference*, 5-9 July Melbourne 1999. On web at: http://www.latrobe.edu.au/www/aqr/

7. Martin, R. J., McMillan, M. G. and Cook, J. B., 1988. *Aust. J. of Exp. Agric.* **28**, 499-509.

8. Minichiello, V., Aroni, R., Timewell, E. and Alexander, L. 1990. In: In-Depth Interviewing. Researching People. (*Longman Cheshire*, Melbourne).

9. Vanclay, F. 1994. *Rur. Soc.* **4**, 10-13.

10. Van Duijenbooden, W. 1998. *Agric. Ecos. and Env.* **67**, 189-196.