Evaluating knowledge and practices to combat subsoil constraints in north-eastern Australia

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Abstract

The depth of soil that crop roots can exploit in the grain cropping regions of north-eastern Australia often varies due to the presence of naturally occurring subsoil constraints (SSC). These SSC may include one or more of the following; salinity, sodicity, acidity, nutrient toxicities, nutrient deficiencies and soil physical constraints such as compaction or gravel layers. The GRDC funded *Combating Subsoil Constraints Project* (SIP08) aims to improve the knowledge and ability of farmers and advisors to identify and manage SSC, leading to better economic and environmentally sustainable management of these soils.

At the commencement of the project in 2002, a survey was undertaken to benchmark farmers' and advisors' knowledge, attitudes, skills, aspirations and practices relating to SSC. A total of 421 farmers and 93 advisors in the northern grains region responded to the survey. More than 50% of farmers believed that SSC are somewhat to a major problem (10-100% of land affected) in their district. Of the many factors that potentially limit the profitability and sustainability of their enterprise, 30% of farmer respondents indicated that SSC were the major or most limiting factor. A number of farmers (39%) manage soil with SSC differently, with a range of management techniques being used. More than 90% of farmer respondents were interested to learn more about identification and management of SSC.

This information has been used to direct and focus the research, development and extension of management of SSC in the northern grains region. The information will also be used to assess the project's impact through comparison with an end-of-project survey.

Key Words

Evaluation, subsoil constraints, north-eastern Australia.

Introduction

The plant available water capacity (PAWC) of soils in the grain cropping regions of north-eastern Australia is often variable due to the presence of naturally occurring subsoil constraints (SSC). Subsoil constraints limit the plant's ability to utilize subsoil water and nutrients, or can have a detrimental effect on plant growth (Dang *et al.* 2004). Subsoil constraints may include chemical (salinity, sodicity, acidity, alkalinity, nutrient toxicities and nutrient deficiencies), physical (inherent high bulk density, compacted or gravel layers) or biological (low microbial activity or high numbers of pathogens) constraints (Dang *et al*. 2004).

The GRDC funded *Combating Subsoil Constraints Project* (SIP08) commenced in 2002 with the aim of improving the knowledge and ability of farmers and advisors to identify and manage SSC, leading to better economic and environmentally sustainable management of these soils. An important component of this project is to evaluate changes in farmer, advisor and project staff awareness, knowledge and ability to manage SSC resulting from project activities. As part of the project evaluation process, an extensive benchmarking survey was conducted at the commencement of the project. This survey was designed to provide baseline data on farmers' and advisors' Knowledge, Attitudes, Skills, Aspirations and Practices (KASAP) in relation to SSC.

This paper reports the results of the farmer and advisor benchmark survey and outlines some of the implications of the information collected.

Methods

A 12 question survey was developed by project staff and completed by both farmers and advisors in the grain-growing areas of the northern grains region (Qld and NSW). The survey collected information on current Knowledge, Attitudes, Skills, Aspirations and Practices (KASAP) in relation to SSC. Questions focused on awareness and extent of SSC in the respondents' own district, knowledge of what the constraints are, and current practices used to ameliorate or manage around SSC. Responses by farmers were collected at industry trade shows (AgShow; AgQuip), farmer meetings, workshops, field days and over the telephone. Responses from advisors were also collected before a number of action-learning workshops that were held between December 2003 and July 2004. Differences in responses between groups (farmers and advisors) were determined using a chi squared analysis.

Results and Discussion

In total, 421 farmers and 93 advisors completed the survey.

Awareness of subsoil constraints

Awareness of SSC was a main topic in the surveys, and analysis shows the response was related ($P<0.001$) to group (farmer or advisor), with a greater proportion of advisors responding that SSC are 'somewhat of a problem' and fewer responding 'small problem' and 'not a problem' compared with farmers (Table 1).

Table 1. Responses of farmers and advisors to a question regarding the severity of subsoil constraints in their region

Farmers	Advisors	Severity of problem
7%	0%	Not a problem
26%	8%	Small problem (0 – 10% of land affected)
32%	62%	Somewhat of a problem (10 – 50% of land affected)
20%	15%	Major problem (50 – 100% of land affected)
15%	15%	Not Sure
(n=421)	*(n=93)*	

Differences were occurring between the groups in awareness of the amount of land affected by SSC. However, very few farmers and no advisors responded that SSC were 'not a problem', indicating SSC are thought to be a problem in just about all districts of the northern grains region. Overall, only 15% of each group were unsure of the severity of SSC in their region, indicating there was a high level of awareness of SSC by both groups at the time of sampling. The challenge for the project will be how to improve this level of awareness. To provide knowledge and skills to further the awareness of SSC, the project team

have produced press releases and conducted field days highlighting which constraints are problematic in certain regions and results of research and development activities.

Knowledge of subsoil constraints

Table 2 shows the results when respondents were asked whether particular constraints were a problem on their property or in their district. The response to whether subsoil acidity was a problem was independent ($P<0.10$) of group. The response to whether subsoil alkalinity, high bulk density salinity, sodicity and nutrient deficiency were problems was related ($P<0.001$) to group, with a greater proportion of advisors making a 'yes' response compared with farmers (Table 2). In addition, for nutrient deficiency and sodicity, fewer advisors responded with 'unsure' compared with farmers (Table 2).

Table 2. Responses of farmers and advisors to a question regarding the extent of various subsoil constraints on their property or district

	Farmer response			Advisor response		
Subsoil Constraint	Yes	No	Unsure	Yes	No	Unsure
Salinity	22%	49%	30%	71%	9%	20%
Sodicity	42%	26%	32%	85%	0%	15%
Acidity	10%	49%	42%	16%	39%	45%
Alkalinity	24%	32%	44%	48%	12%	40%
High Bulk Density	31%	21%	43%	48%	8%	44%
Nutrient deficiency/toxicity	42%	18%	40%	77%	1%	22%

The differences in responses from farmers and advisors to this question indicate dissimilar opinions about which subsoil factors are problematic, or *if* a particular factor is problematic. This is most evident with the *yes* and *no* response to whether salinity is a problem, however similar numbers of respondents were *unsure* if salinity was a problem. Knowledge of subsoil sodicity issues was also markedly different between the two groups. These results indicate the knowledge needs of the two target audiences. During an action-learning workshop series conducted by the project, theory followed by case studies furthered participants knowledge of the various types of constraints, which would help them more accurately ascertain which constraints were problematic in their districts. On-farm research has been conducted to determine and verify the impacts of salinity, sodicity, acidity and nutrient deficiencies on a range of crops.

Respondents were also asked whether they agree or disagree with certain statements about the impacts of SSC. Responses to whether SSCs increase disease risk or can be successfully managed were independent ($P>0.10$) of group (farmer or advisor) with approximately half agreeing and half unsure (Table 3). Also, responses to whether SSCs reduce profitability was independent ($P>0.10$) of group with approximately 85% agreeing (Table 3). Responses relating to the impact of SSCs on plant available water, rooting depth, sustainability, yield and difficulties in managing were dependent ($P<0.05$) on group with a greater proportion of farmers being unsure (and less agreeing) compared with advisors (Table 3).

Table 3. Responses of farmers and advisors to a question on the impact of subsoil constraints.

	Farmer response			Advisor response		
Statement	**Disagree**	**Unsure**	**Agree**	**Disagree**	**Unsure**	**Agree**
SSC's limit plant rooting depth	2%	16%	82%	0%	2%	98%
SSC's reduce plant available water	3%	17%	80%	0%	2%	98%
SSC's can be successfully managed	3%	46%	52%	1%	47%	52%
SSC's reduce crop yield	2%	15%	83%	4%	3%	92%
SSC's reduce profitability	3%	12%	85%	5%	9%	86%
SSC's reduce sustainability	9%	39%	53%	14%	18%	67%
SSC's increase disease risk	12%	54%	34%	12%	55%	33%
SSC's make management more difficult	6%	20%	74%	2%	11%	87%

These results show a high level of pre-existing knowledge by both groups of the crop impacts of SSC, including reducing profitability and making management more difficult. The highest level of uncertainty is whether SSC can be successfully managed and if SSC increase disease risk. Overall, the pre-existing knowledge of SSC impacts is higher than the pre-existing knowledge of the type of SSC, as shown in Table 2. The project has since conducted research trials to quantify the impact SSC have on plant available water, crop rooting depth and grain yield, whilst concurrently investigating management options.

The survey contained a question asking respondents to indicate how serious a limiting factor they considered SSC to be, compared with other factors limiting the profitability and sustainability of their enterprise. The response obtained was related ($P<0.001$) to group (farmer or advisor) with a greater proportion of advisors responding that SSC are 'a moderately limiting factor' (Table 4). Compared with farmers, fewer advisors responded that SSC are 'the most limiting factor' or 'not limiting at all' (Table 4).

Table 4. Responses of farmers and advisors comparing the factors limiting the profitability and sustainability of the farm enterprise

Subsoil constraints are:	**Farmer response**	**Advisor response**
The most limiting factor	6%	0%
A major limiting factor	25%	17%

A moderately limiting factor	39%	65%
A minor limiting factor	24%	17%
Not limiting at all	7%	1%

Management of subsoil constraints

The response to a question about managing soils with subsoil constraints differently to soils without was related (P>0.001) to group (farmer or advisor), with a greater proportion of advisors responding 'yes' and 'don't have' compared with farmers (Table 5). Of the farmers who were managing soils with SSC differently, a range of techniques were used, including selecting tolerant crops/varieties; zero/minimum tillage; different fertiliser programs; deep ripping and replacing cropping with pastures. The range of techniques being advocated by advisors included crop and variety selection, including crop rotations; adjusting yield predictions and inputs (fertiliser, seeding rate) based on severity of SSC; quantifying zones where differences occur and managing inputs within; adjusting enterprise selection (cropping vs pasture vs trees) depending on SSC severity and crop profitability and ameliorating sodicity problems with gypsum.

Table 5. Response of farmers and advisors to a question regarding managing soils with subsoil constraints differently to soils without.

	Farmer response			Advisor response			
Region	**Yes**	**No**	**Don't Have**	**Yes**	**No**	**Don't have**	**Don't give advice**
All Regions	39%	48%	12%	68%	12%	1%	19%

The response that 68% of advisors (Table 5) manage soils with SSC differently to soils without is contrasting results from Table 3, where 47% of advisors were unsure if SSC could be successfully managed. Presumably this is because many advisors feel the need to do something about SSC, but some are unsure about the longer term success. To date, research trials undertaken by the project have investigated crop and variety selection, assessing tools (yield and EM38 soil maps, satellite imagery) which determine different zones, enterprise selection and ameliorating sodicity problems with gypsum. Developing threshold values for causal factors such as electrical conductivity, chloride, exchangeable sodium percentage and pH will also assist farmers and advisors in the selection of appropriate management strategies.

Learning more about subsoil constraints

One of the last questions on the survey targeted the respondents' desire to learn more about SSC. If they responded positively, space was allowed to note what knowledge and skills they needed to help manage SSC. All advisors and 92% of farmer respondents wanted to learn more about SSC (Table 6). A range of desired knowledge and skill needs were listed, including better understanding of where SSC exist, crop impacts and overall farm management. Also, compared to other information sources a high percentage of farmers indicated they prefer to receive information from their advisor, prompting the project to target advisors for the action-learning workshops (data not shown).

Table 6. Response of farmers and advisors to a question regarding their interest in learning more about managing subsoil constraints.

Farmer Response		Advisor response	
Yes	No	Yes	No
92%	8%	100%	0%

Conclusion

At the commencement of the project, many farmers and advisors were already aware of how much land is impacted by SSC and which constraints occurred in their districts. Large numbers of both groups, particularly advisors were managing soils with SSC differently to soils without. The content of research, development and learning activities such as field days, action-learning workshops and trial sites have been developed to address stakeholder needs, however there is still opportunity for this project to improve farmers' and advisors' skills in identification of SSC, and to increase their knowledge of the extent and impacts on the farming system. Also, there is significant scope for this project to further develop, test and extend the use of appropriate management solutions to further the profitability and sustainability of grain farms in the northern grains region.

References

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