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Results of a survey to inform future directions for irrigation and soil management RDE&A in Tasmania

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Executive summary

This report describes the results of a survey, conducted by the Tasmanian Institute of Agriculture in 2021, to understand producers' views on matters related to irrigation and soil management on their farms.

Participants in the survey

Sixty primary producers from a range of industry sectors and production regions in Tasmania were interviewed. Irrigated annual crops and irrigated pastures were the dominant sectors represented in the survey responses. The Huon, south-east and east coast were the least represented on a regional basis. These producers were selected from TIA's networks developed through previous research or extension work across Tasmania.

Almost 80% of participants reported that they irrigated more than 100 ha, with a high representation of irrigated annual cropping and pastures in the industry sector breakdown. Over 50% of participants have been irrigating for more than 20 years, with almost all the rest having 5-20 years of irrigation experience. Centre pivot irrigators are used by 70% of participants, reflective of the broad acre operations associated with annual cropping and pasture. Most participants draw their irrigation water from some combination of farm dams (filled by both run off and river extraction) and reticulated schemes.

Soil management

The three main soil management issues identified by survey participants were waterlogging, compaction and drainage. These issues were overwhelmingly noted as occurring in clay, clay loam and duplex soils. This is not a surprise, as these soil types are widely used for annual cropping and pasture production, which had the highest prevalence of these issues. Clay, clay loam and duplex soils are susceptible to compaction when moist (as is often the case in irrigated production) and through natural characteristics and management often exhibit poor internal drainage, which exacerbates waterlogging. Outside of these three main issues, the most important soil management issue noted was wind erosion in the southern midlands/Derwent Valley region.

When asked about changes in soil condition over the past 15 years, the most common perception noted by participants was an improvement in soil carbon. While noting that the responses are the opinions of landowners, not the result of a measurement and monitoring regime, this is a conceivable trend, as irrigation increases biomass production and hence offers more opportunities for carbon accumulation. This observation has to be tempered by the understanding that irrigation also leads to intensification of production, which can be detrimental to carbon stocks. Nevertheless, the view of those interviewed is that soil carbon levels have improved over time. The most commonly identified decline in soil condition was soil compaction, generally noted as being the result of increased machinery traffic, increased potato production and associated wet harvests, and increased grazing of cattle. Several respondents noted that their soil issues had been stable for a while. Historical issues had been rectified through pasture management, changes in crop rotation, subsurface drainage, and direct drilling.

An effort was made to link the main soil management issues with the length of pivots used by participants, on the anecdotal premise that the outer spans of long pivots are seen to experience more problematic irrigation management issues. While exercising caution based on the small sample sizes in some categories, a trend was observed whereby those with longer pivots see waterlogging and drainage as more problematic compared to compaction, whereas for those with shorter pivots, all three soil management issues were given more equal ranking.

The issues of compaction, drainage and waterlogging featured equally in the observations of those who had been irrigating for more than 20 years, whereas those with fewer years of irrigation experience gave more emphasis to waterlogging. The reason for this difference is unknown, but it may reflect newer irrigators operating on land which has more recently been converted to irrigation in areas with soils that are more difficult to manage.

Irrigation management

The three main irrigation management issues identified were application uniformity, rutting and bogging (an issue largely specific to pivot irrigators) and scheduling/soil moisture measurement. The ranking of these three issues was very consistent, regardless of the factor considered in the relationship – i.e. region, industry sector, area irrigated, irrigation technology used, pivot length, years of experience or soil type.

Interestingly, when asked which of the identified irrigation management issues deserved the most attention for resolution, most participants chose rutting and bogging as their priority – although not necessarily their only choice. This result is undoubtedly influenced by the high proportion of participants who use centre pivot irrigators, for which rutting and bogging is a particular issue, and is a significant issue in regions with flat topography and poorly drained soils – e.g. Midlands.

After rutting and bogging, the next four issues chosen for resolution were infiltration, run-off, waterlogging and drainage. All of these are related to one another. Despite application uniformity and scheduling/soil moisture measurement consistently ranking highly as identified issues, they did not rank highly when participants were asked to prioritise issues for resolution. Several participants mentioned that they had learned to manage these issues over time. Variable Rate Irrigation (VRI) and soil moisture measurement were identified as useful mitigating strategies, even though their cost limits widespread adoption.

Most participants sought to build redundancy in water supply through multiple sources and did not see water availability as a major issue. During dry periods, they said water allocation on farm would be prioritised by value of the crop and risk of loss. Cost is not an influence on allocation decisions for most growers, although for some, higher cost scheme water is prioritised for higher value crops. Soil moisture measurement and monitoring were identified as most important to improve water allocation decisions, but their cost was a barrier for most.

Summary

Soil and irrigation management cannot be separated. The most commonly reported soil management issues (compaction, drainage and waterlogging) are inextricably linked with the irrigation management issues identified (rutting and bogging, infiltration, run-off, waterlogging and drainage). Of the irrigation management issues, rutting and bogging was ranked as the most important issue to be addressed in future work.

Limitations and disclaimers

It is important to note that the relationships shown in the graphs that follow in the rest of the report should not be interpreted as statistically valid correlations, or indicators of causation, between the factors under consideration. The sample size for the survey was not large, and when broken down into specific categories such as industry sector or region, the numbers are smaller still. The purpose of the graphs is to indicate relationships or trends that are apparent from the data and which may be useful in informing directions of future work.

As much as anything, the relationships identified should be used as the catalyst for more targeted discussions and industry focus groups to refine the issues of most importance and to gain more nuanced feedback than is possible through a phone survey. The survey data is biased towards pivot irrigation management issues as pivots were the dominant irrigation technology used by participants in this survey. Given that pivots represent a very large percentage of the irrigation technology in Tasmania, it is reasonable that this area should be a focus of future work, whilst also being aware of issues with other technologies that deserve attention.

Recommendation

Further work is required to refine the soil and irrigation management issues that should be the focus of future RDE&A work in TIA. It is recommended that the key conclusions from this survey be tested in more in-depth discussions and/or focus groups with growers in specific regions and industry sectors such as annual irrigated cropping (primarily grains and vegetables) and irrigated pasture production (primarily dairy grazing and fodder production for silage or hay).

1 Background

Following the conclusion of the Water for Profit II program in 2018, attention turned to how the successes of that program could be built upon to allow TIA to take the next step in provision of research, development, extension and adoption to improve irrigated agriculture in Tasmania. This commenced with some internal TIA discussions involving a number of people, some who had worked on the Water for Profit program, and others who had not been involved in that program.

A presentation by Dr Marcus Hardie to the TIA Leadership Team in July 2020 highlighted some of the challenges linked to irrigation in Tasmania. These included the widespread occurrence of vulnerable soils in recently expanded irrigation districts and the inefficiencies associated with mismatches between irrigator design and soil function. The issues are known through previous research and engagement activities undertaken by TIA, but the evidence is largely anecdotal.

To gain a better understanding of the range of issues being experienced and the extent of their occurrence across Tasmania, a decision was made to conduct a phone survey of producers from different industry sectors. The survey was conducted by TIA between February 2021 and June 2021. This report describes the design and results of the survey. The results are to be interpreted considering the limitations of this survey, especially the number of people surveyed and the regions and enterprises covered.

2 Methods

The survey was designed by a core group of TIA researchers with additional input obtained from TIA Centre Leaders or nominated staff to ensure that the views of all industry sectors were included. The main questions the survey aimed to address were:

- What are the major soil and irrigation issues experienced by farmers in Tasmania?
- How do the issues vary by region, soil type, irrigation technology and enterprise?
- What are the issues that farmers are most interested in addressing?

The survey was piloted in February 2021 with 10 growers representing the sectors of annual and perennial horticulture, viticulture, dairy and grain and other annual crops. Minor adjustments were made to the survey, which was then used to interview a further 50 growers across the diverse agricultural industries and regions in Tasmania (see Table 1). The main survey commenced in late March 2021 and concluded in early June 2021. Participants were more evenly spread across industry sectors than the regions, with only four participants each from the Huon, South-East and East Coast regions. This is a key limitation of the survey.

The industry categories shown in Table 1 differ slightly from the categories used in the survey. The survey categories which participants could chose were irrigated annual cropping, irrigated pasture, non-irrigated annual cropping, non-irrigated pasture and tree, vine or berry crops. These categories were divided into sub-groups to ensure coverage of major sectors that were embedded in the upper level categories, specifically vegetables as a sub-set of irrigated annual cropping, and dairy as a sub-set of irrigated grazing/fodder.

Table 1. Number of interview participants by region and industry based on the interview tally sheet.

Industry / Region	Dairy	Pasture grazing/fodder	Grain/other annual	Vegetable	Tree, vine, berry crops	**Total x region**
North-west	4	1	1	5	2	**13**
Central north			3	2	2	**7**
North-east	7			1		**8**
N. Midlands	1	3	5			**9**
S. Midlands/ Derwent V		8	1		2	**11**
Huon				1	3	**4**
South-east		1		1	2	**4**
East coast		1			3	**4**
Total x industry	**12**	**14**	**10**	**10**	**14**	**60 (N)**

Contact details for the survey were obtained from contact lists of previous projects undertaken by TIA and personal contacts of those involved in the survey process. Surveys were conducted by phone interview and the responses were entered into an online version of the survey using the survey tool Alchemer. This approach was approved by the UTAS Human Research Ethics Committee (ID: 23542). In accordance with the requirements of ethics approval, prior consent was obtained from survey participants, and no names or other identifying details were included in the information recorded via the portal.

A modified survey was also used to interview three service providers with experience in the irrigated cropping industries. Although the number of these interviews was small, the three service providers interviewed included two consultants with extensive experience in the south and north of the state, and a company field officer with knowledge of irrigated vegetable cropping in the north-west.

Copies of the surveys used with growers and the service providers are included in Appendices A and B, respectively.

3 Results

It is important to note that the relationships shown in the graphs that follow in the rest of the report should not be interpreted as statistically valid correlations, or indicators of causation, between the factors under consideration. The sample size for the survey was not large, and when broken down into specific categories such as industry sector or region, the numbers are smaller still. Furthermore, participants were able to select multiple options in response to independent survey questions. The purpose of the graphs is to indicate relationships that are apparent from the data and which may be useful in informing directions of future work. As much as anything, the relationships identified should be used as the driver for more targeted discussions and focus groups with industry to refine the issues of most importance and to gain more nuanced feedback than is possible through a phone survey.

3.1 Enterprises of survey participants

The following graphs show the distribution of survey participants by region, enterprise, soil types and some characteristics of their irrigation operation, including area irrigated, years of involvement in irrigation and irrigation technology used. Participants were able to provide multiple responses to some questions (e.g., enterprises, soil types, irrigation technology). In these instances, the total number of responses (n value) can exceed the total number of participants (N value = 60).

Of the 60 producers who participated in the survey, more than half had multiple enterprises on their farms, resulting in total responses of n = 110 (Fig 3-1). Irrigated pastures for dairy, sheep or beef and annual crops such as grains and vegetables were the most widespread. A third of the participants had non-irrigated pastures and about a quarter were growing tree, vine, or berry crops.

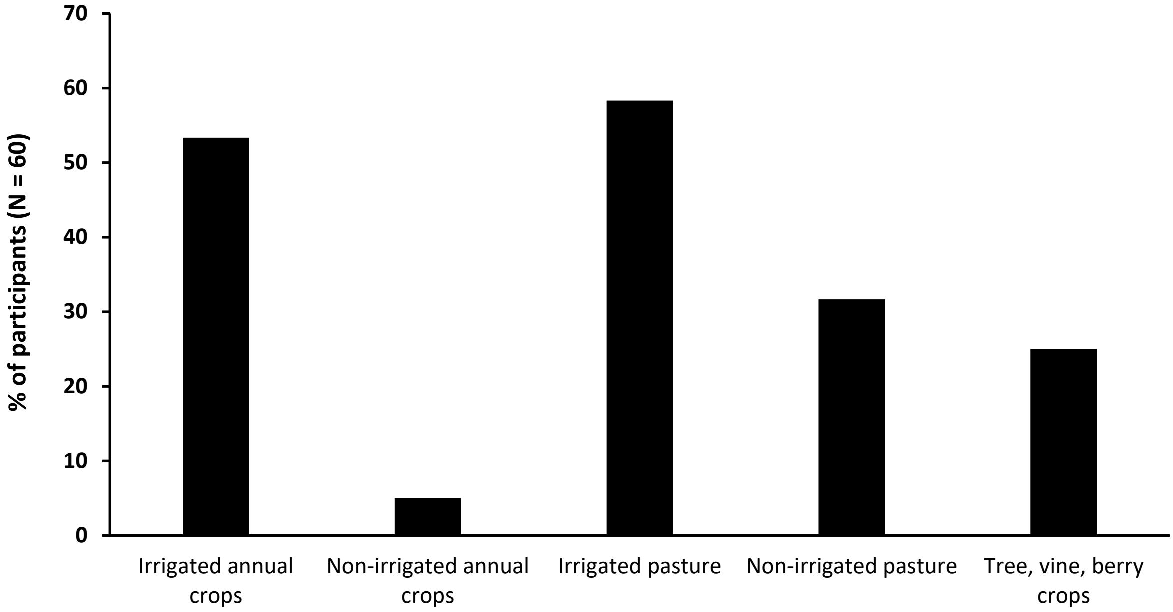

Figure 3-1 Percentage of survey participants engaged in the enterprise categories used in the survey (n= 111, N= 60).

3.2 Distribution of soil types identified by participants

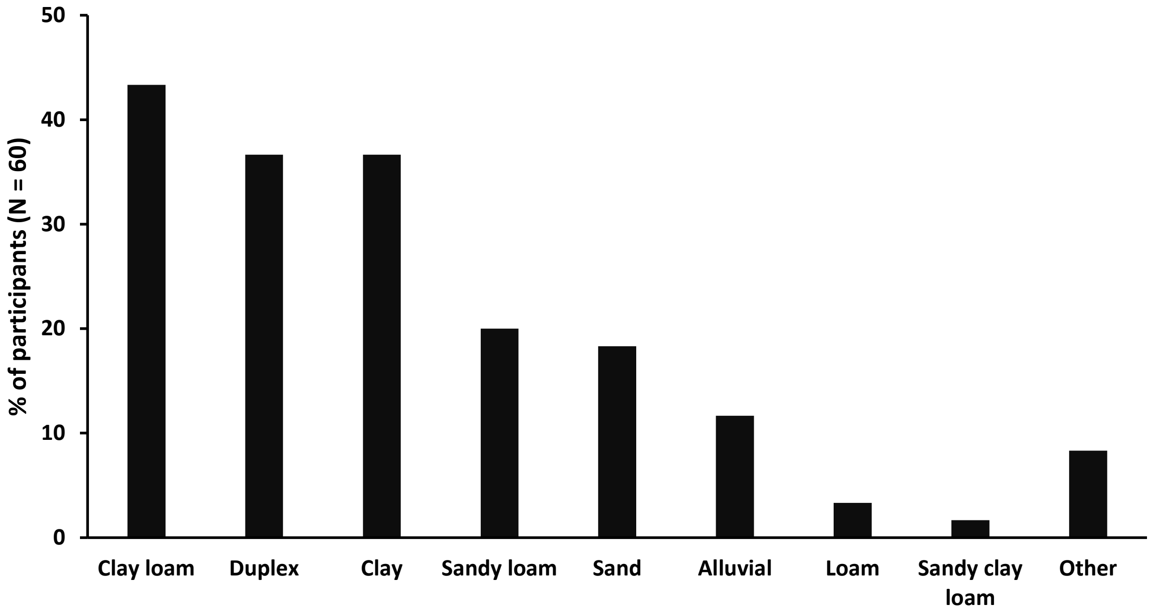

Figure 3-2 Percentage of participants identifying different soil types on their farms (n= 108, N = 60). "Other' comprises soils reported by very few participants and includes mudstone and siltstone soils and soil types unspecified by the respondent.

Participants identified multiple soil types on their farms (Fig 3-2). Clay loam, duplex and clay soils were identified by 30-40% of participants, while sandy loams and sandy soils were reported by 20% of participants. Ferrosol soils (dominant in NW and NE regions) are included under clay loam. There is possibly some double up across the duplex and clay categories, since subsoil clay is a common feature of duplex soils. The distribution of soil types across the enterprises is shown in Fig 3-3. Clay loam, duplex and clay soils are seen to dominate across all enterprises.

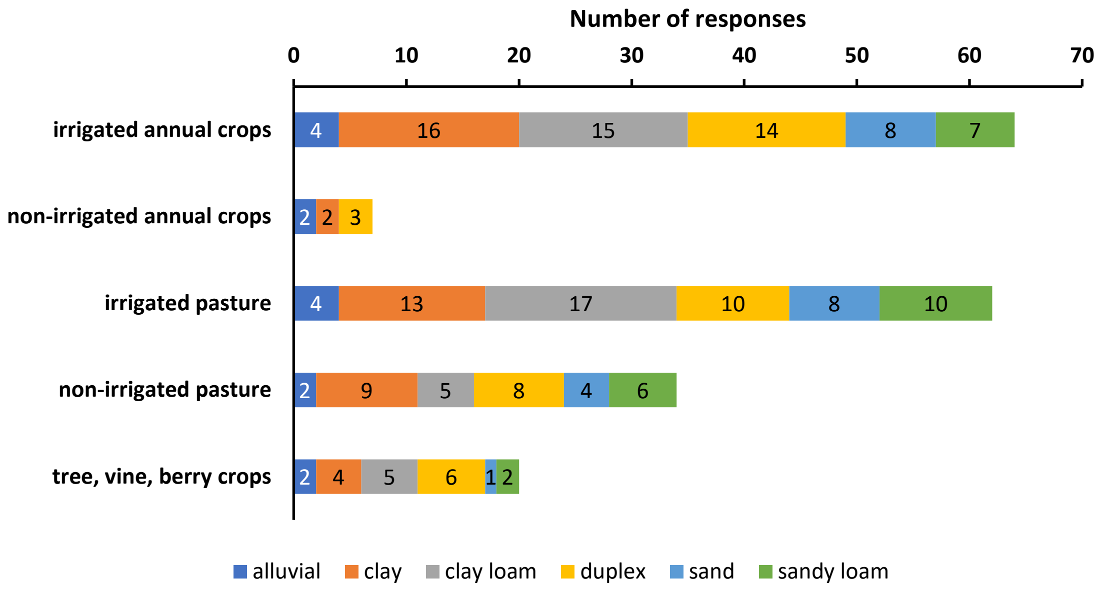

Figure 3-3 Main soil types noted across enterprises by survey participants (n = 203, N = 60). Clay, clay loam and duplex soils appear to dominate across most enterprises.

3.3 Irrigation characteristics of survey participants

All sixty producers had irrigation on their farms although some also engaged in non-irrigated production enterprises. The area under irrigation on each farm varied from 0.1 ha to 2000 ha, with the majority of producers irrigating between 200-500 ha (Fig 3-4). Over half the participants have been irrigating for more than 20 years (Fig 3-5). Only one participant had been irrigating for less than 5 years.

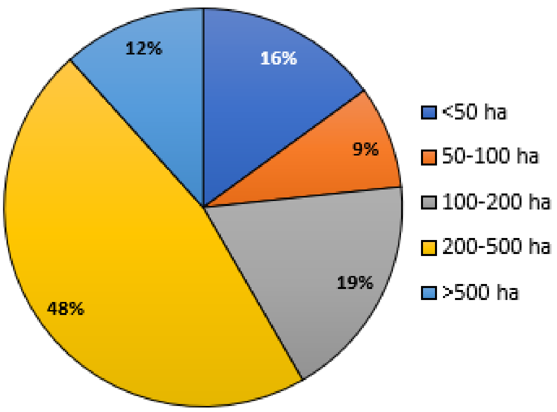

Figure 3-4 Percentage of participants in different area irrigated categories (N = 60).

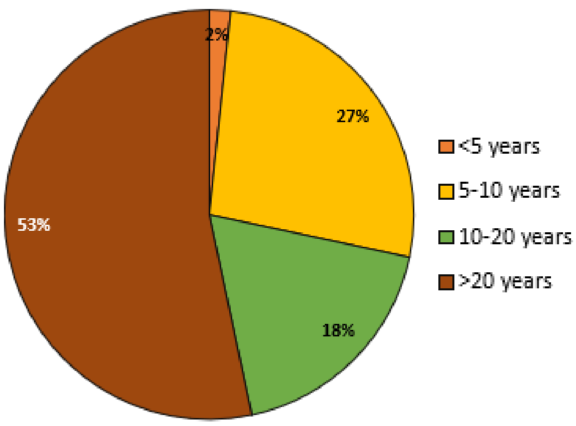

Figure 3-5 Percentage distribution of responses regarding irrigation experience (N = 60).

Figure 3-6 shows the range of irrigation technologies used by participants in this survey. Centre pivots were the most common irrigation technology, used by over 70% of participants. Traveller and drip technologies were used by 20-30% of participants.

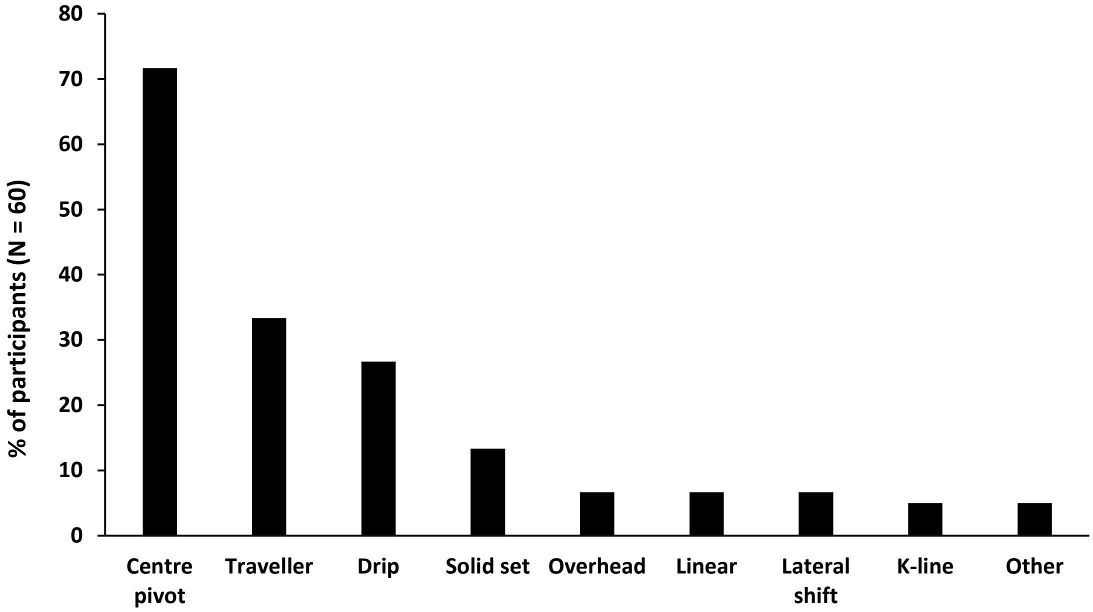

Figure 3-6 Percentage of participants identifying different irrigation technologies used in their enterprises (n = 105, N = 60). 'Other' includes microjets and flood.

Most pivot users had more than one pivot irrigator on their property, with some having more than 20 in use. Participants were asked the length of the longest pivot used on their farm, with the results shown in Table 2.

Table 2. Number of participants who selected the listed categories for their longest pivot irrigator.

Longest pivot category	**Number of responses** (n = 42)
<200 m	3
200-400 m	19
400-600 m	11
>600 m	9

The major sources of irrigation water for participants were farm dams, irrigation schemes and direct extraction from rivers (Fig 3-7). The distribution of irrigation water sources by region is shown in Figure 3-8.

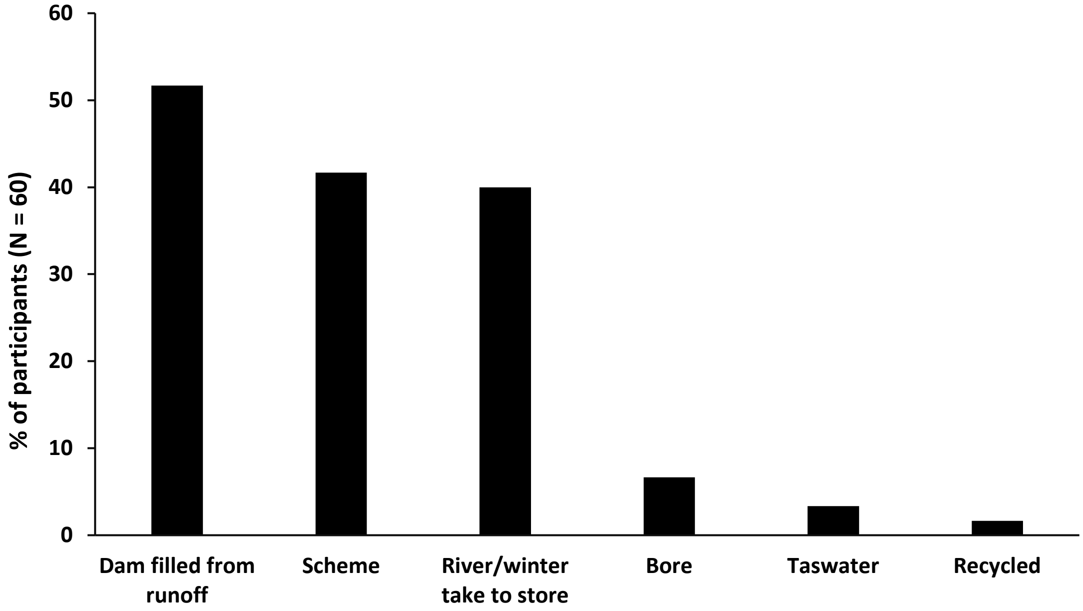

Figure 3-7. Responses related to water sources used for irrigation (n= 87, N = 50)

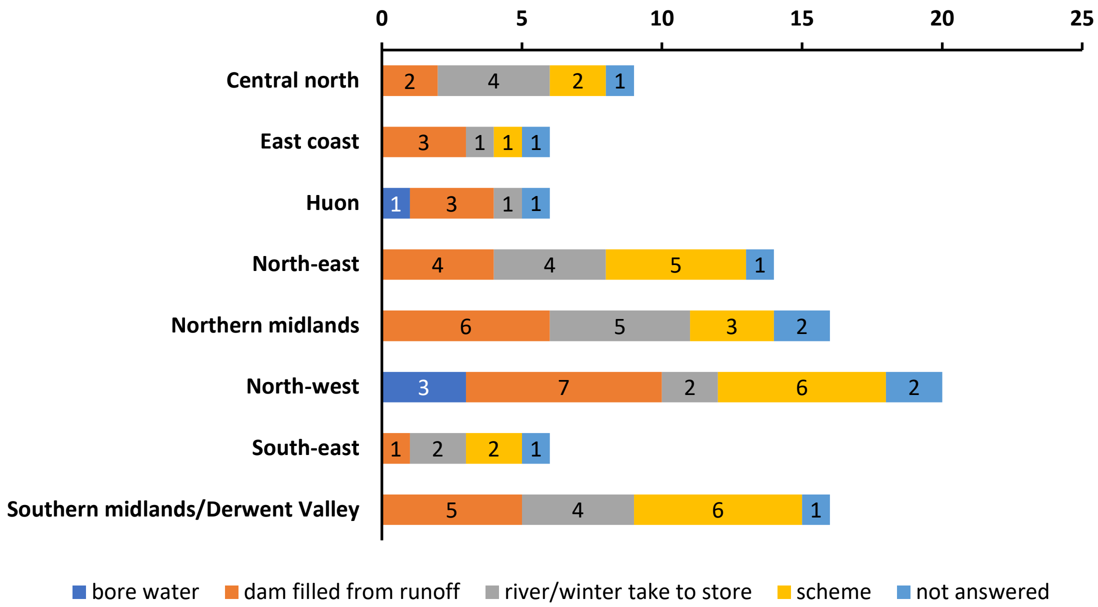

Figure 3-8 Distribution of irrigation water sources by region showing the number of responses for each category (n = 94, N = 50).

3.4 Soil issues identified by survey participants

Figure 3-9 shows the number of responses from participants who identified major soil issues associated with their farming operation. This shows that waterlogging, compaction and drainage feature prominently in the opinions of growers. The 'Other' category includes issues related to low infiltration rates, water repellence, poor soil health and structure, disease and bogging and rutting. The regional distribution of major soil issues is represented in Figure 3-10.

Waterlogging was the most common issue, with 36 participants identifying it as a major issue on their farms. Compaction and drainage were next, with 24 participants reporting each. All three issues were identified across most regions of the state.

Several participants in the north-west, central north and south-east regions noted issues with water erosion, most likely indicative of topographical influences. Wind erosion was predominantly reported in the southern midlands/Derwent Valley region. Sodicity and salinity were mostly reported in the northern midlands and southern midlands/Derwent Valley regions.

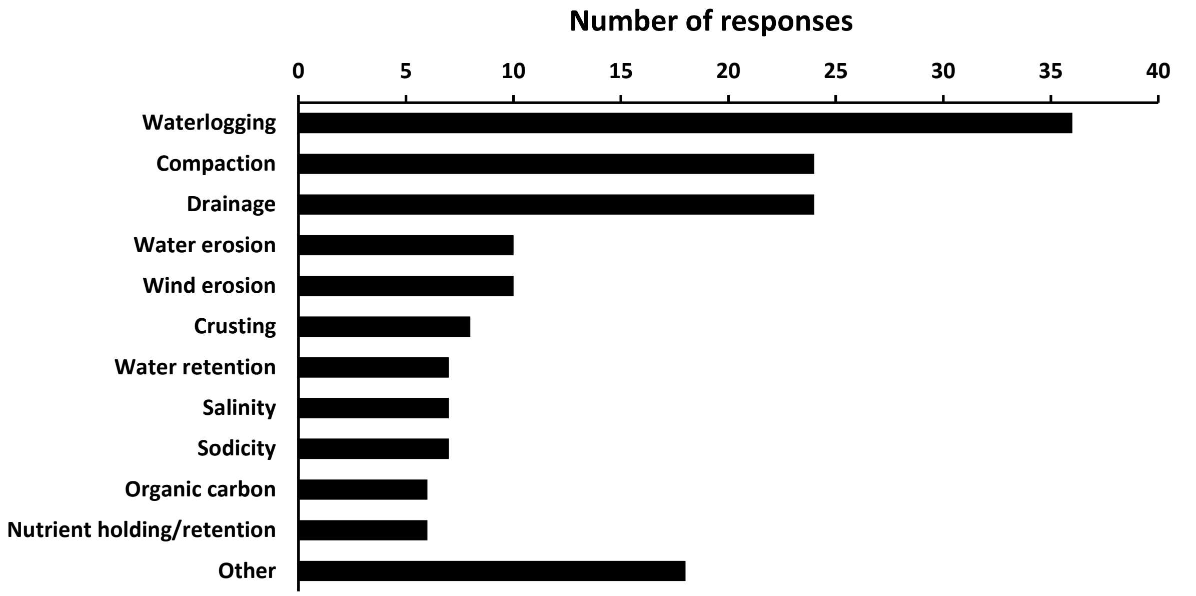

Figure 3-9 Number of responses identifying issues related to soil (n=163, N=60).

Waterlogging, compaction and drainage were also identified as the most widespread issues by consultants. Compaction was identified as a ubiquitous issue that tended to be ignored, while waterlogging was more closely managed. Water erosion and nutrient holding/retention were noted by the consultant servicing clients in the north-nest, while crusting was observed by consultants in the central-north, north-east and southern regions of the state.

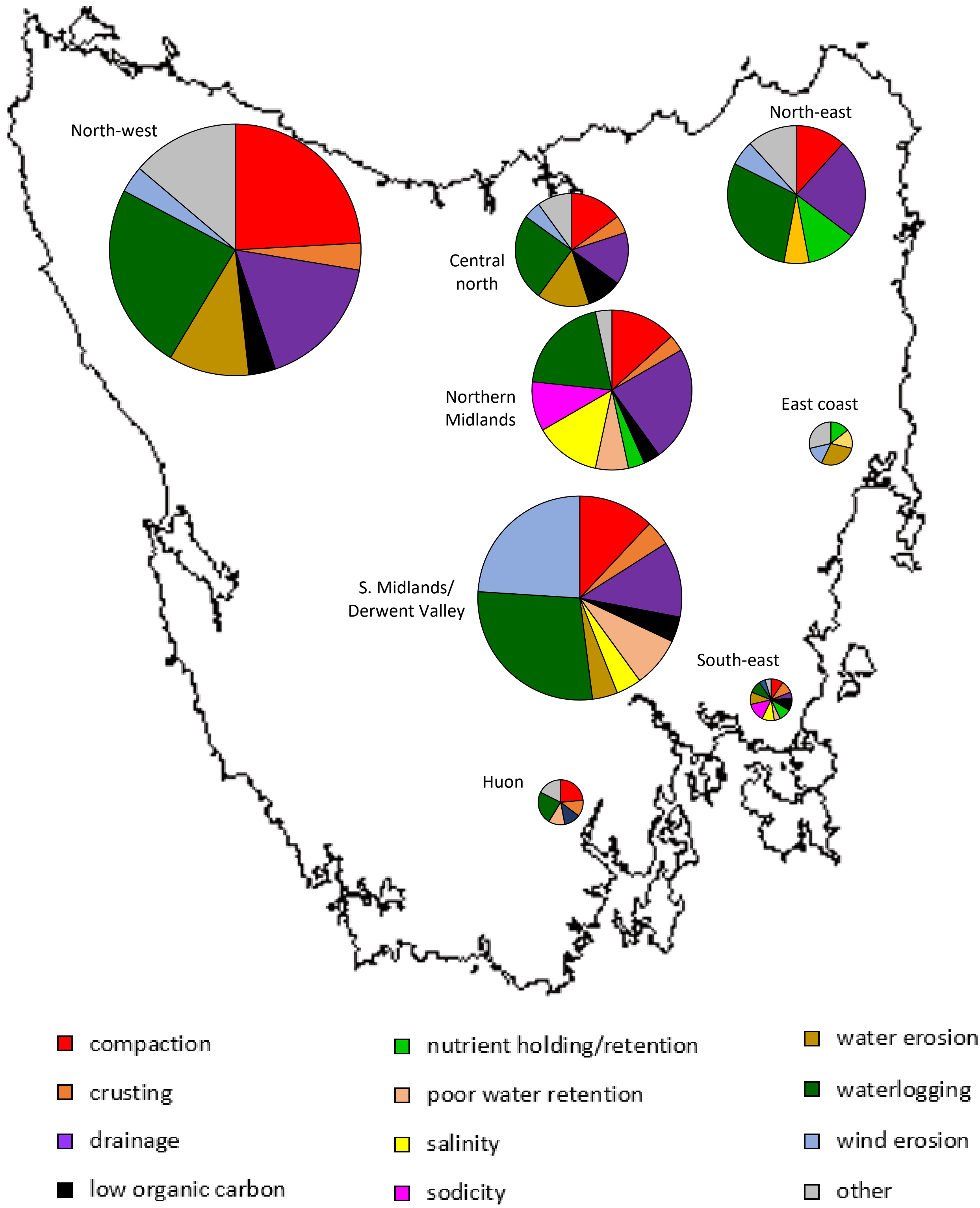

Fig 3-10 Major soil issues identified for each region used in the survey. The size of each pie chart is proportional to the number of respondents in each area. The data from the east coast, south-east and Huon should be treated with some caution, given the small sample size.

The three top issues – waterlogging, compaction and drainage – were more common in clay, clay loam and duplex soils (Table 3). The largest number of issues was reported by participants with clay, clay loam and duplex soils. Waterlogging was widely reported across most soil types.

Table 3. Responses linking soil issues to soil type (n = 332, N = 60). Only soil type and soil issue categories with responses falling in the top quartile in frequency (n = 292) are shown in the table. Coloured cells indicate the specific soil type x issue combinations with response frequency falling in the top quartile (n = 209).

Issue / Soil type	Waterlogging	Compaction	Drainage	Water erosion	Wind erosion	Crusting	Water retention	Salinity	Sodicity	Organic carbon	Other	Total
alluvial	6	4	4	1	1		1		1	1	2	21
clay	15	10	12	5	4	3	2	5	3	4	2	65
clay loam	17	11	12	6	3	4	2	2	1	2	11	71
duplex	13	11	11	7	6	5	5	4	5	5	7	79
sand	9	5	5	2	3	4	4	2			3	37
sandy loam	5		3	1	4			2	2		2	19

Relationships between soil issues and enterprises are shown in Fig 3-11. Producers of irrigated pastures and irrigated annual crops reported the most soil issues, with waterlogging, drainage and compaction being most widespread. In the case of non-irrigated pastures, waterlogging, compaction, drainage and erosion issues were noted most frequently. For tree, vine and berry producers, the most common issues were waterlogging and compaction.

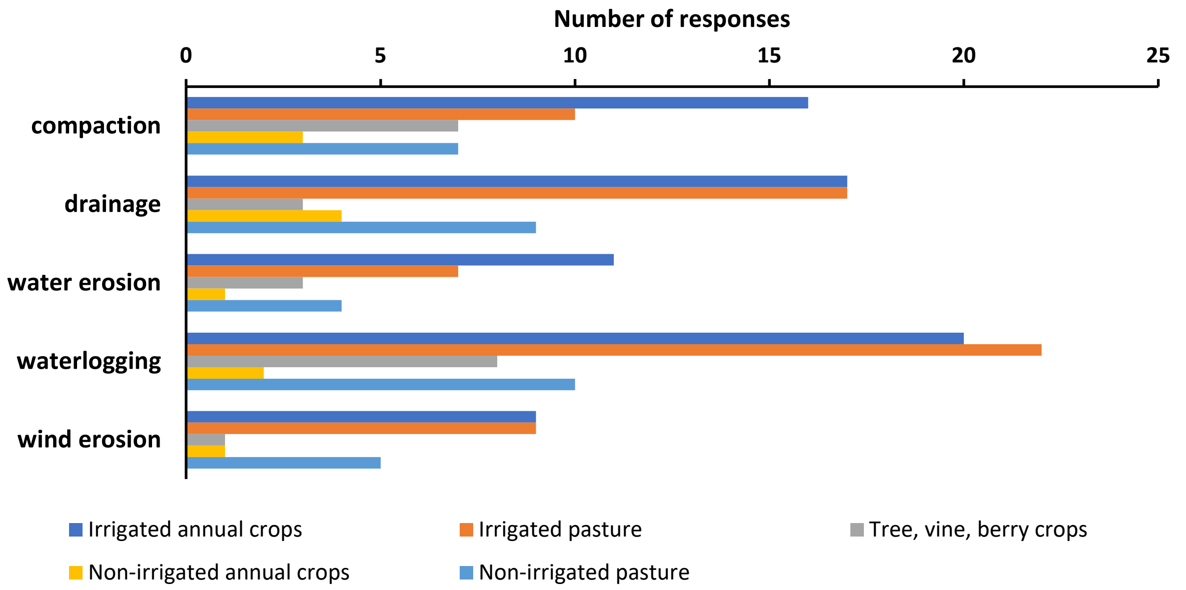

Figure 3-11. Dominant soil issues reported for various enterprise sectors (n = 206, N = 60).

Participants were asked if they had noticed any improvements or decline in their soil condition since they started irrigating, or in the last 15 years if they had been irrigating for longer. Their responses are shown in Table 4 and Figs 3-12, 3-13 and 3-14, categorized respectively by soil type, region, enterprise and years of irrigation experience. These responses are based on the perceptions of the participants. Overall, more improvements than declines in soil condition were noted. The strongest perception regarding improvements in soil condition relates to soil organic carbon, most frequently in clay and duplex soils (Table 4). Increase in groundcover, products/compost applied along with irrigation, and use of longer-term pastures were identified in the qualitative responses as reasons for the increase in soil carbon. Changes were also perceived in terms of reduced erosion and improved soil health and soil structure. Several respondents noted that their soil issues had been stable for a while. Historical issues had been rectified through pasture management, changes in crop rotation, subsurface drainage, and direct drilling. One of the consultants interviewed noted that early soil health issues linked to pivot irrigation had been reversed in some situations with the increase in irrigated ryegrass pastures enabled by high livestock prices.

Compaction had worsened for some participants in the central-north, northern midlands, north-west and southern midlands/Derwent valley regions (Fig 3-12). They attributed the increase in compaction to an increase in tractor passes, increase in potato production, harvesting of wet crops or agistment of cattle. While these issues are not directly related to irrigation, it is likely that the use of irrigation, particularly its expanded use in new areas, has had an influence on the frequency and geographic spread of these practices, and the general intensification of production. In the north-east, north-west and southern midlands/Derwent Valley regions, a few participants reported that drainage and waterlogging had worsened.

Table 4. Frequency of responses from survey participants when asked about changes in soil condition as related to soil type. Data in red reflects respondents' perception that soil condition had declined, while data in black reflects improvements (n = 157, N = 60).

Issue / Soil	Compaction	Drainage	Erosion (wind & water)	Infiltration	Nutrient retention	Organic carbon	Sodicity	Soil health	Water retention	Waterlogging
alluvial	2			1				1		1
	1				1	2				1
clay	3	2			1	1	1			2
	2	5	2		2	11		4	1	3
clay loam	5	2		3	1	2		2	1	2
	2	3	2			3		4		1
duplex	4	1		2	1	4		1	1	1
	3	3	2		4	10		3	3	4
sand		1				1		1		
		1			2	3		2	1	
sandy loam		3			2		1			2
						4		3		

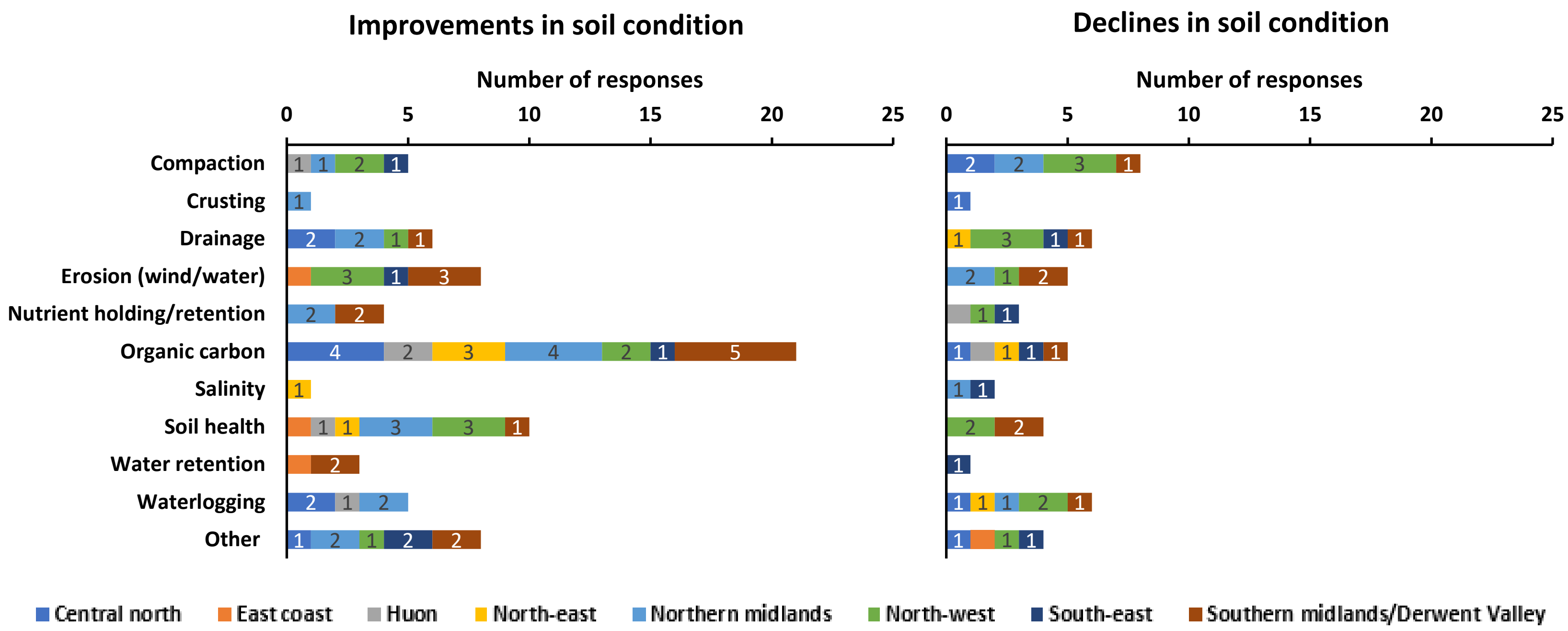

Figure 3-12. Number of responses indicating perceptions of improvement or decline in soil condition by region (n = 117, N = 60).

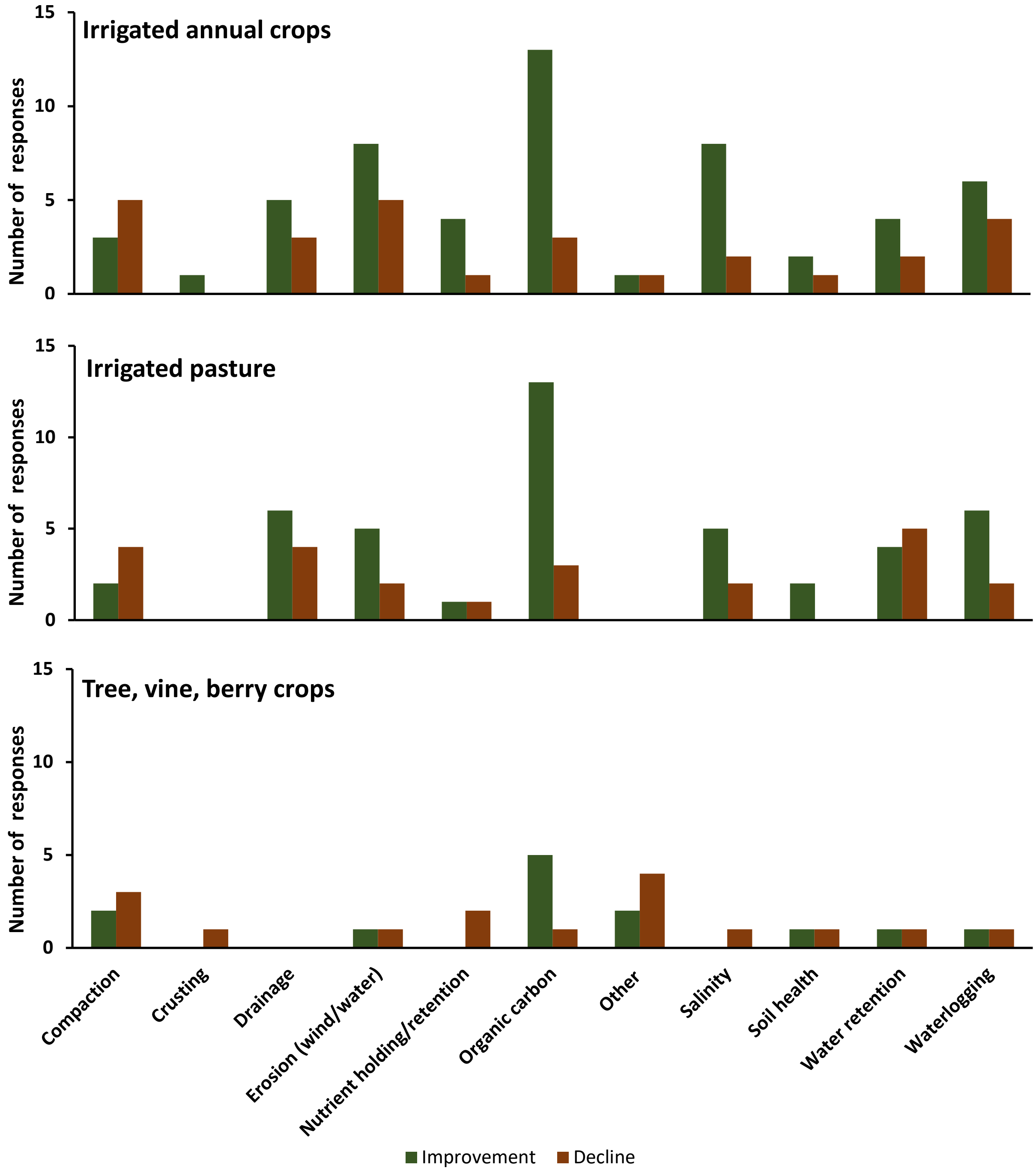

Figure 3-13. Number of responses indicating perceptions of improvement or decline in soil condition ranked by industry sector (n = 178, N = 60).

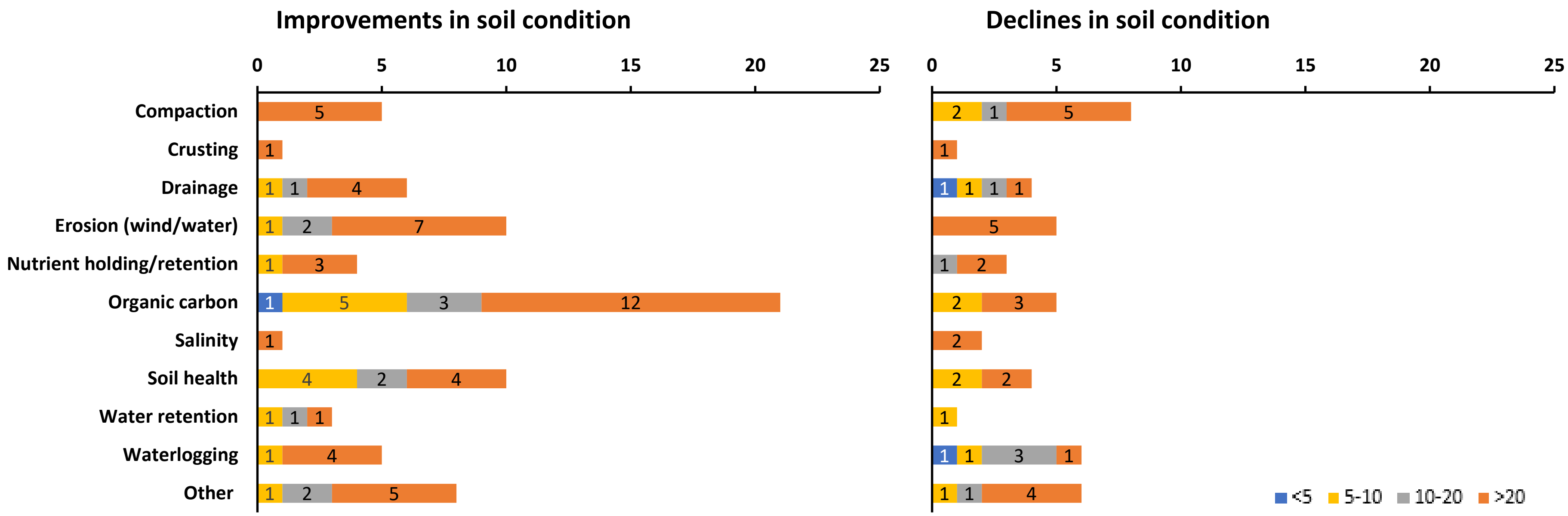

Figure 3-14. Number of responses indicating perceptions of improvement or decline in soil condition ranked against number of years of irrigation (n = 119, N = 60).

Figure 3-15 shows the relationship between the three major soil issues (compaction, drainage and waterlogging) and the irrigation technologies used by participants. It is noted from Fig 3-6 that over 70% of the participants used centre pivots on their farms. This is also reflected in Fig 3-15 with the high number of responses for soil issues associated with centre pivots. Waterlogging is an important issue across all the major irrigation technologies.

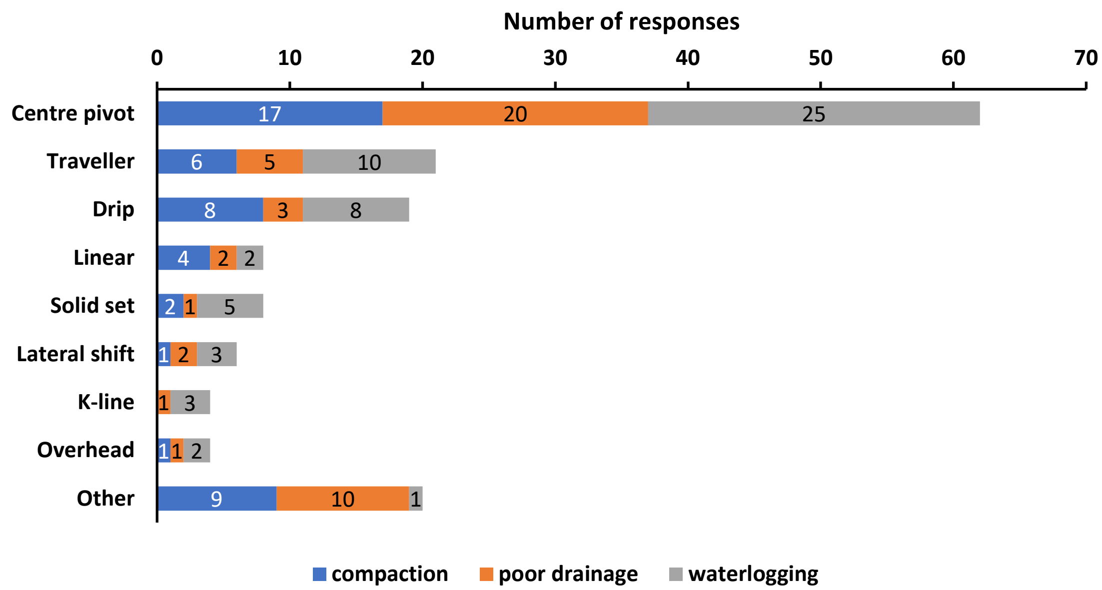

Figure 3-15. Relationship between irrigation technology and the number of responses associated with the top three soil management and degradation issues (n = 152, N = 60).

When the dominant soil issues are compared to the length of the longest pivot indicated by participants (Table 5), waterlogging once again dominates, irrespective of the length of pivot. Drainage issues, undoubtedly linked to waterlogging, were reported more often than compaction in farms with larger pivots.

Table 5. Number of responses reflecting the three most reported soil issues compared to length of the longest pivot noted by respondents.

		Major soil issues		
Length of longest pivot (m)	**No. of responses (n)**	**Compaction**	**Drainage**	**Waterlogging**
0-200	11	5	2	7
200-400	26	10	10	13
400-600	12	3	7	7
>600	9	3	5	8

The participants' years of experience with irrigation also influenced their views on major soil issues, as shown in Fig 3-16. While noting the limitations of having different numbers of respondents in each experience category, the data suggests that poor drainage was perceived as a major issue regardless of the number of years of irrigation experience, whereas compaction and waterlogging were also reported as important by participants who had been irrigating for longer than 20 years compared to those with fewer years of experience.

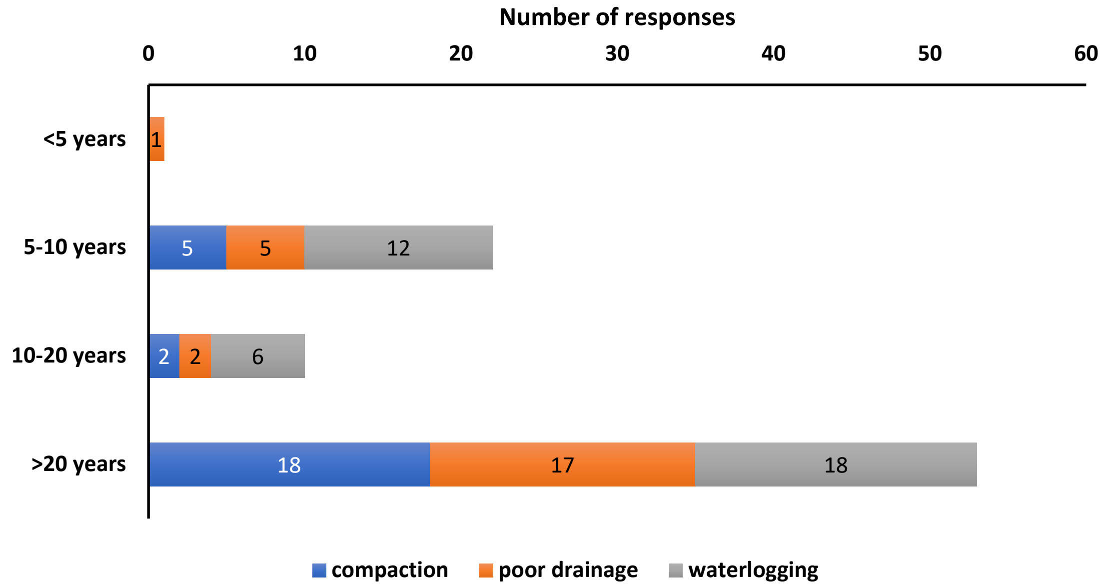

Figure 3-16. Perceived major soil management issues in relation to number of years irrigating (n = 86, N = 60).

3.5 Irrigation issues identified by survey participants

Participants were asked about issues related to irrigation. Some of the issues identified were inter-related with soil (e.g. infiltration, waterlogging) while others were more specific to irrigation technology or management (e.g. scheduling). Data are presented in Fig 3-17 through to Fig 3-23 in which the relationships between irrigation issues and frequency of response, regions, enterprises, area irrigated, technology, years of experience and pivot length are shown. Regardless of the comparisons made, application uniformity ranked as the number one irrigation issue of concern. The second most frequent issue identified was rutting and bogging, which is primarily a concern associated with centre pivot irrigators. Scheduling/soil moisture measurement, followed by infiltration, were the third and fourth most frequent issues indicated by participant responses in almost all comparisons. In some cases, infiltration and 'can't get enough water on' achieved very close to the same response. In some circumstances these may be considered similar issues, as sometimes the reason for not being able to apply sufficient water is that run-off occurs before the water has been absorbed into the soil profile. In all graphs related to irrigation issues, 'Other' includes issues related to non-wetting soils, time pressures, safety, reduced production efficiency, soil crusting, and while collectively these sometimes elicited a large response, individually each factor was of minor importance overall. A few participants and a consultant noted that poor quality of irrigation water was linked to several irrigation issues.

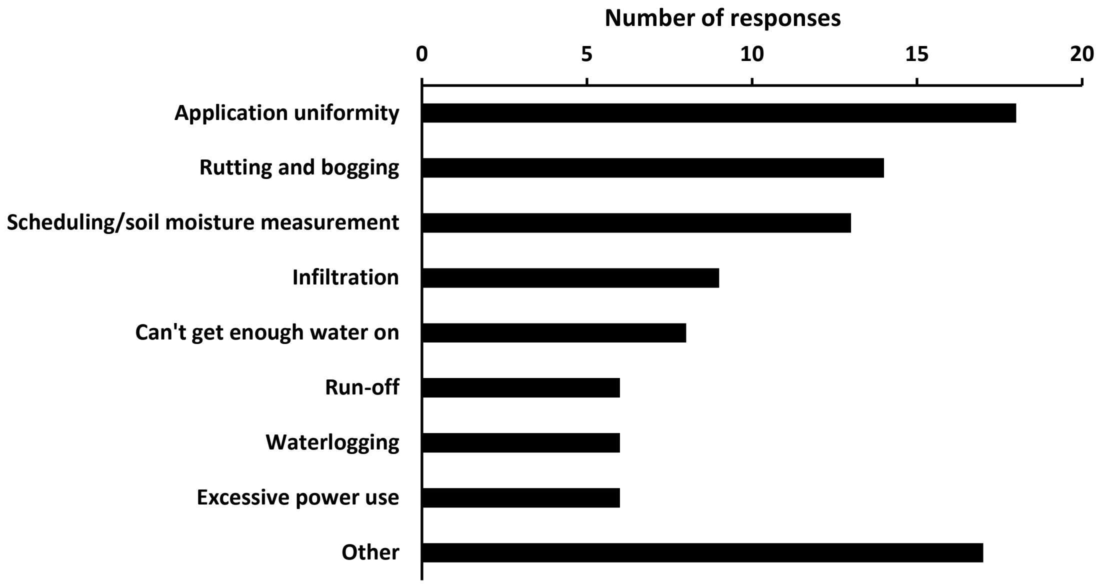

Figure 3-17. Number of responses related to problematic issues associated with irrigation (n = 97, N = 60).

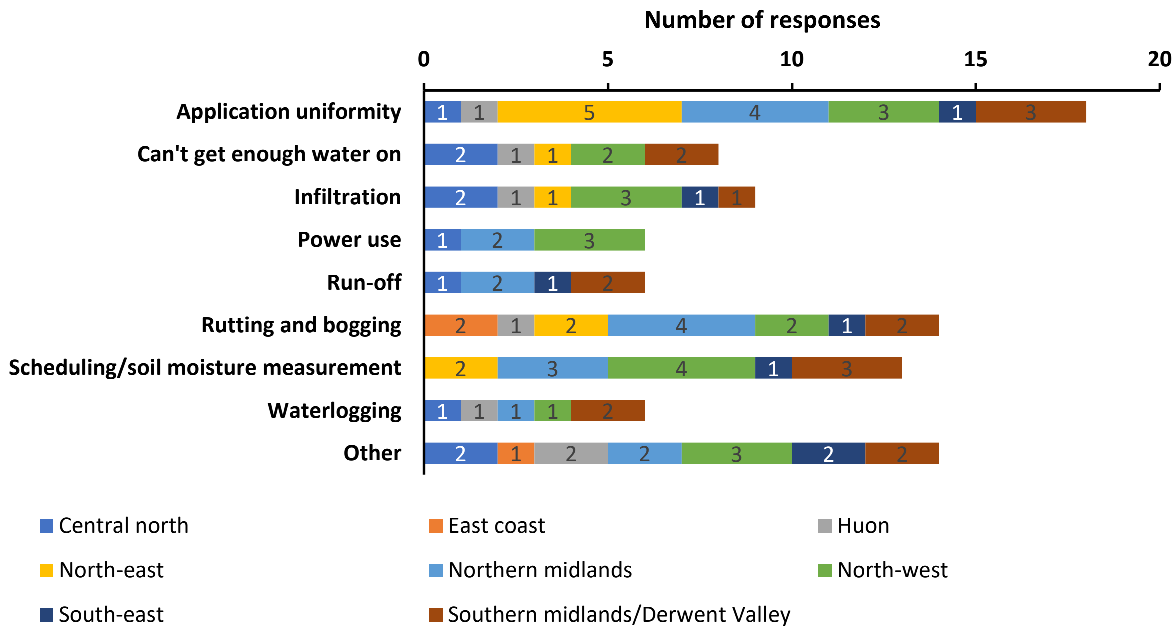

Figure 3-18. Number of responses by region noting major perceived issues with irrigation (n = 94, N = 60).

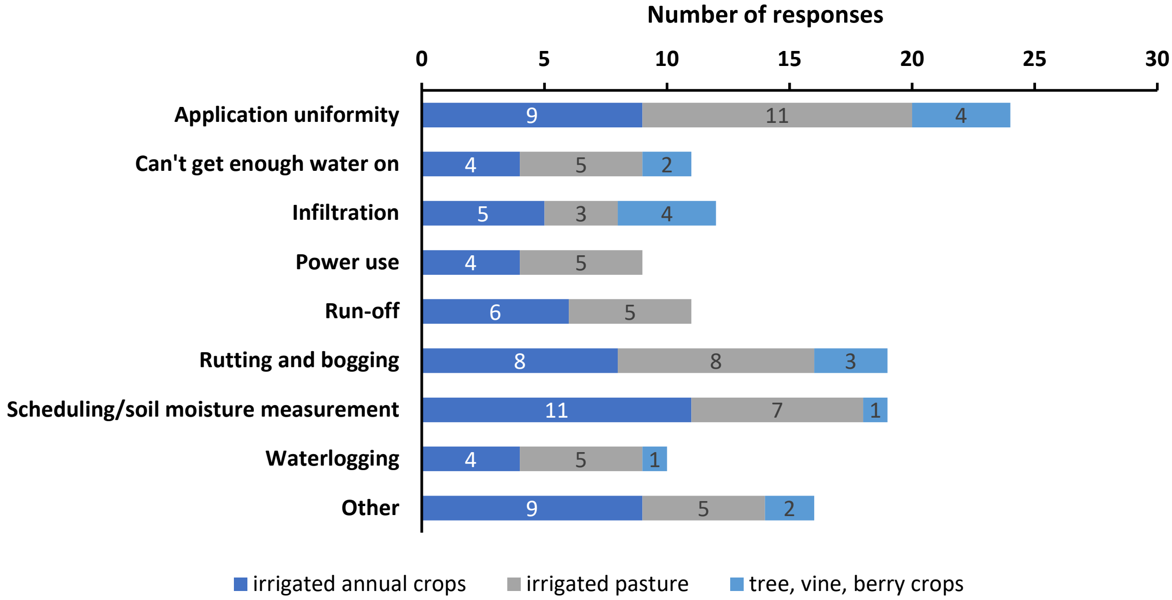

Figure 3-19. Number of responses related to perceived irrigation issues in different irrigated production sectors (n = 131, N = 60).

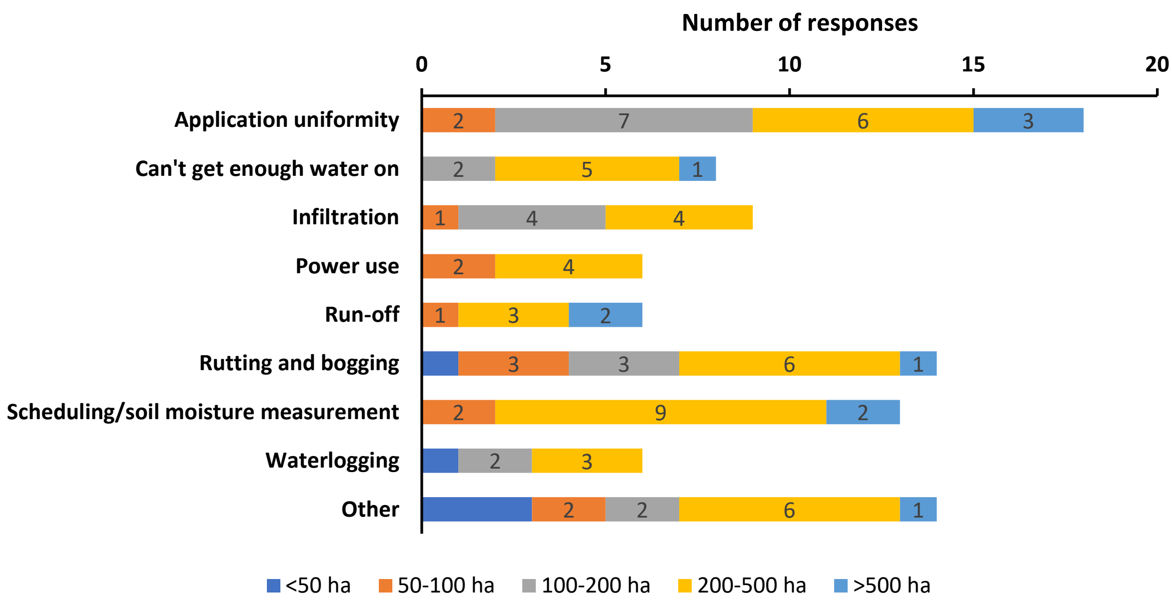

Figure 3-20. Number of responses highlighting perceived irrigation issues in relation to the area irrigated (n = 94, N = 60).

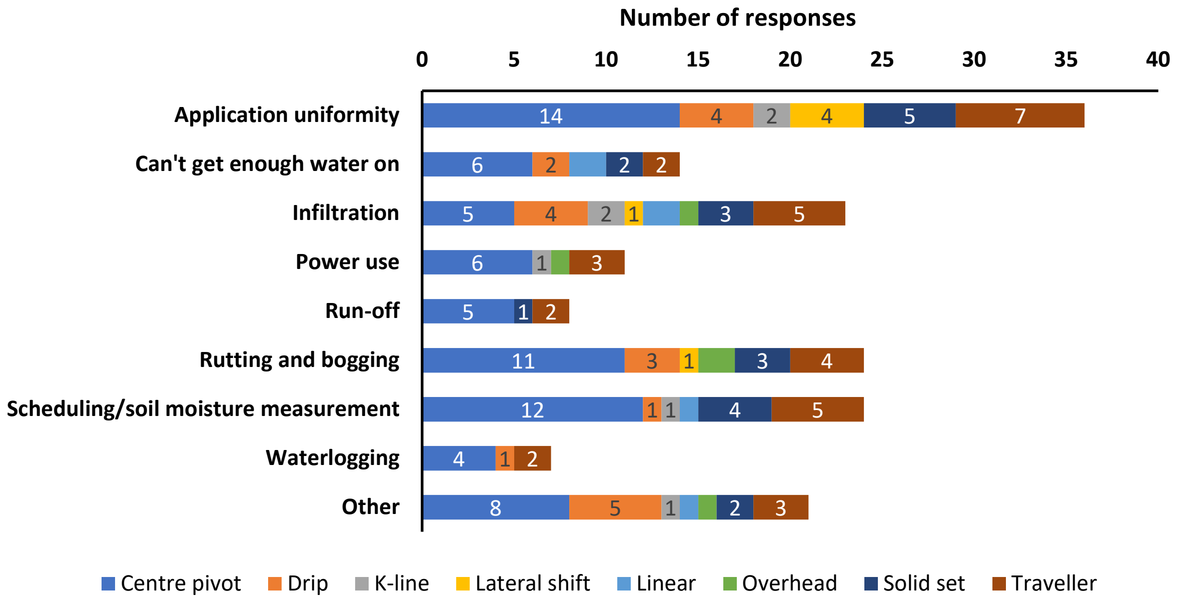

Figure 3-21. Number of responses highlighting perceived irrigation issues compared to the irrigation technology used (n = 169, N = 60).

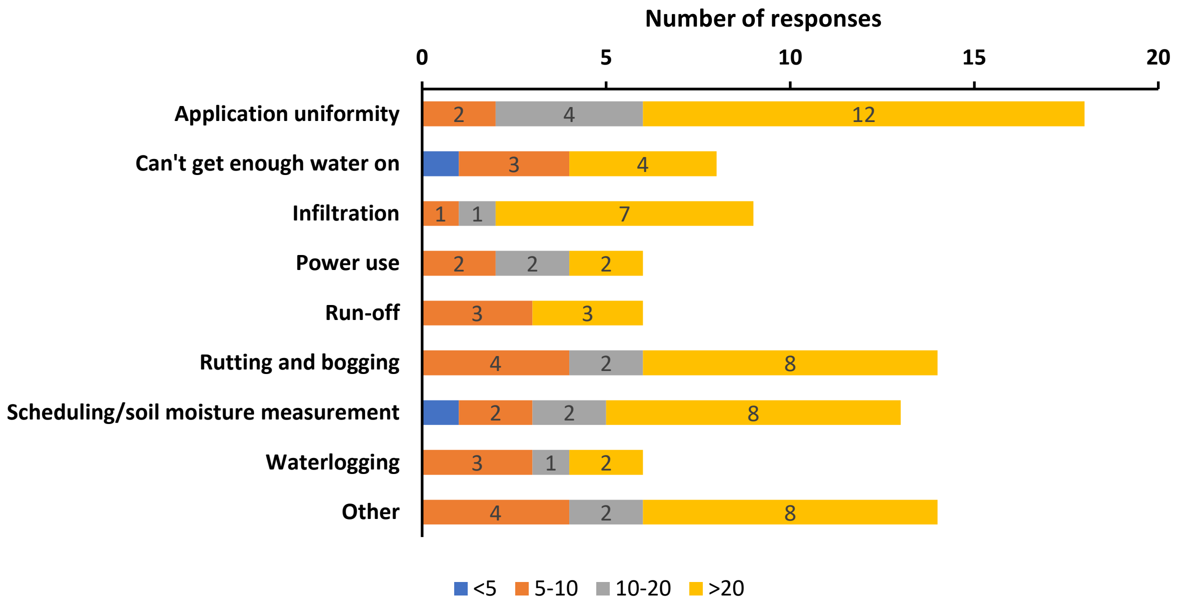

Figure 3-22. Number of responses indicating perceived irrigation issues in relation to the number of years of irrigation experience (n = 94, N = 60).

The bias of data towards irrigators with more than 20 years of experience is evident in Fig 3-22, although the major issues of concern remain the same as for other relationships considered.

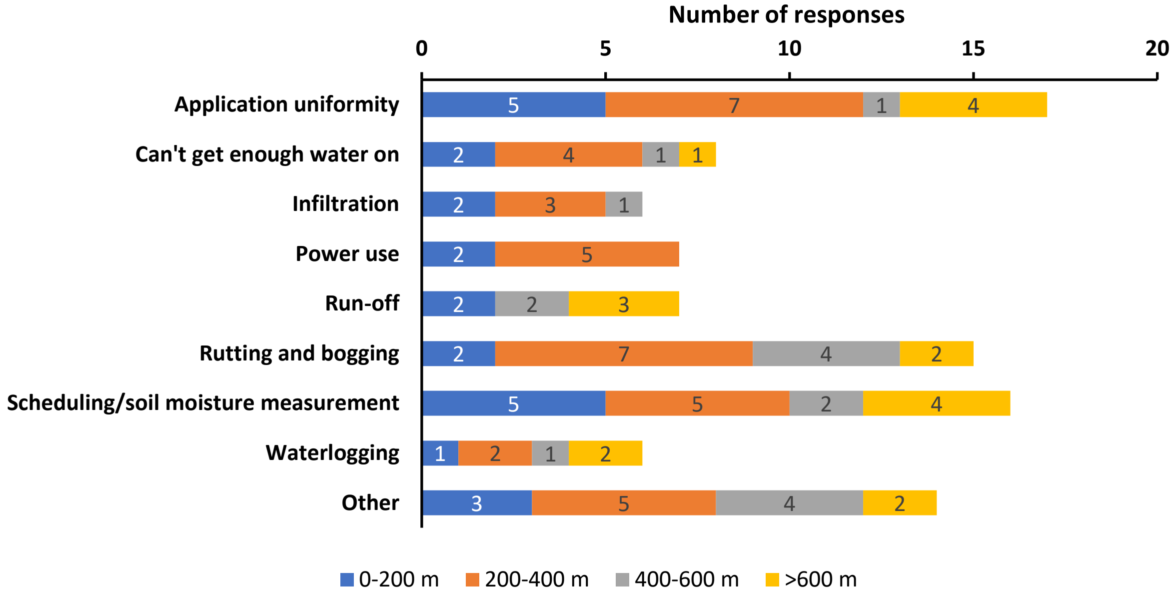

Figure 3-23. Number of responses indicating perceived irrigation issues in relation to the length of the longest pivot used on the farm (n = 96, N = 43).

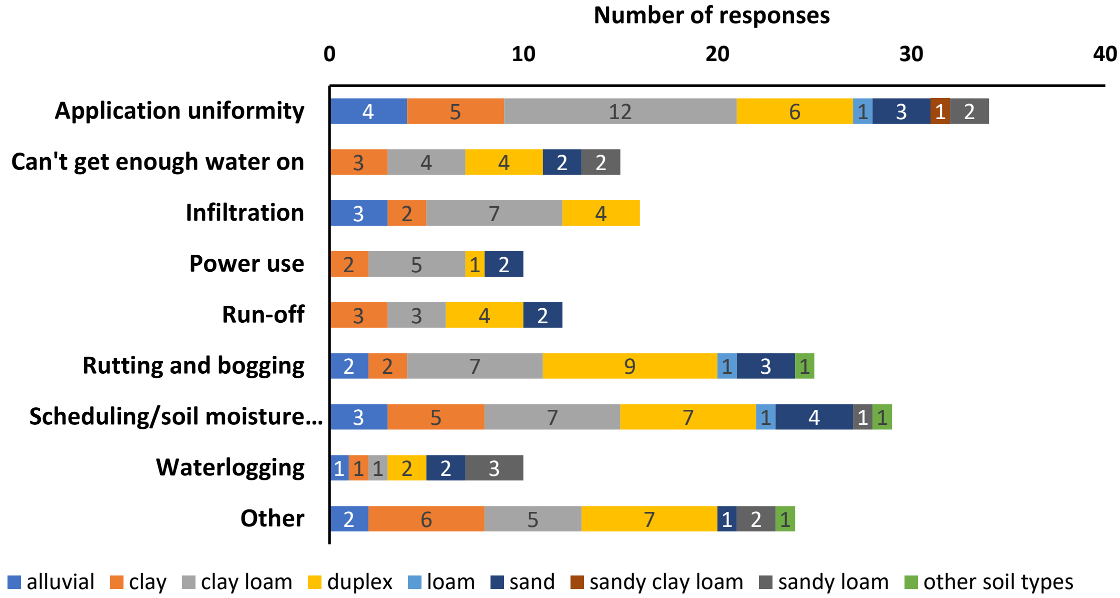

Figure 3-24. Number of responses noting major perceived issues with irrigation matched against soil type (n = 175, N = 60).

It is apparent that growers observe the full range of irrigation issues across all soil types. Clay loam and duplex soils feature prominently in relation to the issues observed, perhaps partly due to the higher number of responses in relation to those soils, but possibly also because they present more management challenges under irrigation.

3.6 Allocation decisions

Participants were asked how they made decisions regarding allocating irrigation water on their farms during dry seasons, if the cost of water influenced their decision and the technologies or information that could help them make better decisions. Remarkably, over 80% of of survey participants don't normally consider the cost of water in decision making (Fig 3-25). The cost of water was not a major driver of their decisions unless their major source of water was from an irrigation scheme. The cost of water extracted from rivers or captured as runoff was not a significant determinant of allocation decisions. Participants who were irrigating pastures with high-cost scheme water tended to say that cost always/often/occasionally influenced their allocation decision.

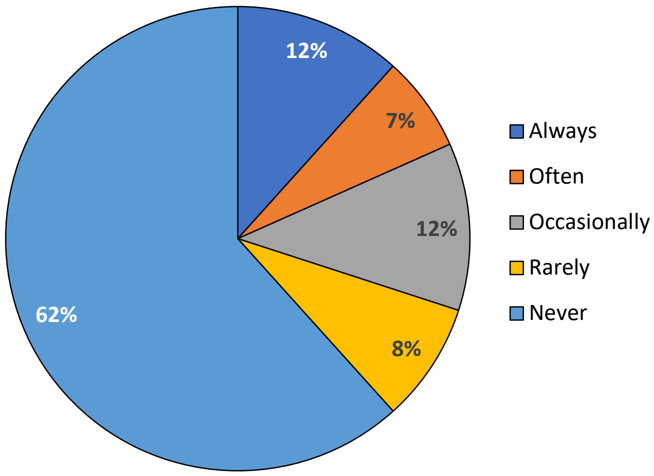

Figure 3-25. Percentage of respondents indicating how frequently the cost of water influences irrigation management decisions.

Most participants said they had adequate water to meet their demands in most seasons. In dry seasons, allocation depends on the farming mix, priorities and risk appetite of people. Participants described preparing a water budget to prioritize crops with the highest return (e.g. vines, berries) or highest risk of loss. The timing and application of water was further guided by topography, area to be irrigated, performance, growth potential and demand. Some participants deliberately sought to build redundancy in their water supplies in preparation for dry times, for example, by adding storage or by signing up to an irrigation scheme.

Participants and consultants identified soil moisture measurement and monitoring technologies as the most important technology to make better water allocation decisions on farm, to decide when to stop or start irrigating. However, their cost was considered a key limiting factor. A few suggested using sensors to keep track of moisture and allocate water, but they and several others emphasized the need to conduct visual assessments to validate the data and interpret it. One participant suggested a handheld device to measure real-time soil moisture levels while walking around a paddock. Variable Rate Irrigation (VRI) was also identified as a potential strategy, but cost was once again a limiting factor.

Long-term weather forecasts and regional soil-wetness indicators (measured by the Fire service) were identified as important information for management during a dry season and to guide recovery after a dry spell. A few participants suggested a scenario planning exercise to explore the value and cost of different crop options and irrigation strategies under different water availability scenarios. A consultant also indicated a need for greater awareness of crop life cycle watering demands so that irrigation can be targeted at the growth stages that provide the greatest benefit.

3.7 Irrigation Issues to address

Survey participants were asked to identify the most pressing irrigation management issues they would like to see addressed (Fig 3-26).

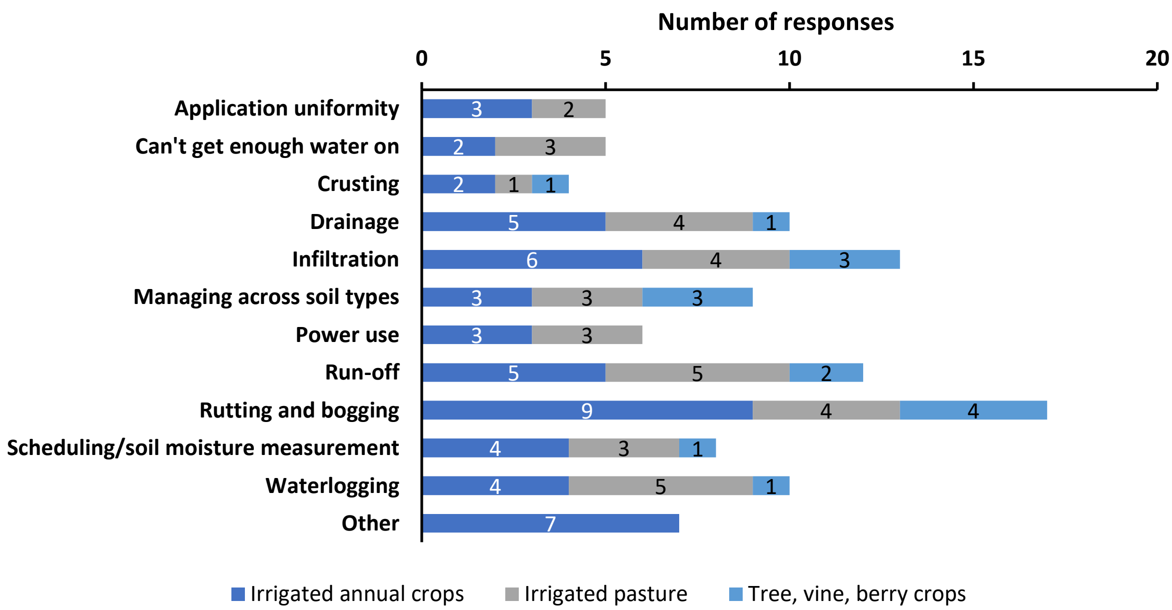

Figure 3-16. Participant responses regarding the most pressing issues to address in relation to irrigation management by industry sector (n = 116, N = 60).

Although analysis of previous responses (section 3.5) indicated that application uniformity was the most common issue raised, when asked to specifically identify an issue worthy of resolution, rutting and bogging was clearly the dominant concern. This ranked second in the analysis presented in section 3.5. Rutting and bogging is primarily a centre pivot issue, although can also be of concern when using hard or soft hose reel (traveller) irrigators. The high response rate for rutting and bogging is no doubt influenced by the high response rate for users of centre pivots.

Following rutting and bogging, infiltration (13), run-off (12), waterlogging (10) and drainage (10) are seen to be issues worthy of attention. All of these are related to (either primarily or in combination) crusting, compaction and matching application rate to soil function. Participants also attributed some of the issues to financial constraints limiting replacement of old technologies with newer alternatives.

Application uniformity and scheduling/soil moisture measurement, which ranked highly in previous questions, did not rank quite so highly in the context of issues that growers would like to see addressed. Several participants described having learned to manage these issues in the time they had been irrigating. Variable Rate Irrigation (VRI) and soil moisture measurements were often identified as helpful in addressing application uniformity and infiltration issues. Cost was a key limiting factor. However, without cost-effective real-time soil moisture measurement, VRI was not considered to be effective with highly variable soils. To address uniformity issues, a few participants indicated a need for sprinkler designs with a bigger wetted footprint so that instantaneous application rate could be reduced, allowing more time for applied water to infiltrate.