# Dry Saline Land Farmer Survey

# Murray Mallee & Eyre Peninsula


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# 1 Summary

Dry saline land or “magnesia patches” describe areas in paddocks that have become saline in the surface layer and toxic to plant growth, resulting in bare, unproductive patches of ground. They are not driven the underlying effects of ground water, stream flows or perched water tables. Their impacts can be highly detrimental to farming practices across a range of landscapes.

Concerns over the growing impacts of dry saline land degradation across the Murray Mallee and Eyre Peninsula have increased in recent years. A survey commissioned by the Murraylands and Riverland Landscape Board and AIR EP was conducted between December 2020 and January 2021, using survey monkey and distributed to farmers through various networks for on-line completion. In total, 100 surveys were completed including 43 from the Murraylands region and 57 representing the Eyre Peninsula.

The results from this survey clearly indicate that the land degradation issue of dry saline land presents a growing issue across a wide scope of landscapes of the Murray Mallee and Eyre Peninsula, affecting a conservative estimated total of 50,000ha, which could double into the future. This is affecting a very large number of farmers, causing a significant financial burden to their businesses (estimated in the vicinity of $50 million over the last 10 years). 36% of farmers had 50ha or more affected, with some as high as 2500ha, incurring very high costs to their individual businesses. Other farmers were currently experiencing smaller impacts (21% at 5ha or less), but are mildly to very concerned about losing more productive land to this issue in the future. Early preventative action could prove to be vital in all of these situations.

This survey shows famers are unsure of what do to about this issue, are looking for answers but don’t know who to ask or where to find the information. There is still a lack of understanding as to what the underlying causes of the problem is, how these are expressed within a variety of landscapes and what practical solutions can be applied. Farmers have tried a number of management approaches with varying levels of success. Many of these involve the addition of organic matter or sand to the topsoil. There are other situations that require further investigation and possible development.

Farmers strongly supported further research, demonstration and farmer case studies to be conducted on solving the dry saline land issues, with a willingness to be involved in some way to find these answers. It is therefore recommended that funding be sort for a large project involving both investigative and applied research and extension, across both the Murray Mallee and Eyre Peninsula regions. It is vital that this occurs within these low rainfall environments where the farm scale is large, seasons are variable, soils in the landscape can be challenging, risks are high and the effects of changing climatic patterns may well be exacerbating the issue.

# 2 Introduction

Dry saline land or “magnesia patches” are terms that describe areas in paddocks that have become saline in the surface layer, but are not driven the underlying effects of ground water, stream flows or perched water tables. The impacts of these saline patches are detrimental to farming practices, as they are toxic to plant growth, resulting in bare, unproductive patches of ground.

These patches have been present for many years, with numerous studies being conducted in the 1990 on Eyre Peninsula (Kennewell 1999). While the size and impacts of patches are reported to vary greatly with seasonal conditions, there has been strong concern expressed by Eyre Peninsula farmers that the issue has become larger in recent years, with patches becoming more permanently degraded and unproductive, leading to significant financial impacts on farm businesses (Photo 1).

***Photo 1. Dry saline “magnesia” patch on heavy ground near Kimba***

In 2015 and 2016 a SAMDB NRM Mallee Challenge project highlighted farmers concerns that much of the shallow stony paddocks in the northern Mallee were gradually becoming patchier with growing areas that were permanently degraded (see Photo 2). Preliminary basic soil test found that these patches were very high in soil salinity compared to the surrounding stony ground where crop was growing, but was not water table or seep related.

This lead to a further investigative study (McDonough 2020) that reported that the soil degradation has been caused by increases in surface soil salinity, not related to perched water tables, but most likely driven by subsoil transient salinity. The dry seasons and lack of soil cover has led to increased capillary rise of subsoil moisture through stone layers to the surface where it evaporates, leaving an accumulation of salts behind. These patches were not caused by the application of surface sprays or fertiliser, although there was some evidence of low level chemical residues being greater in the saline patches. There was evidence that soil improvement leading to improved crop growth was possible through the application of sand, thick organic matter and high rainfall, however, far more work was required to properly investigate the effectiveness, practicality and economics of these and other potential management options.

A small team of stakeholders, including agronomists, soil scientists, farmers, industry group, PIRSA and Landscape Board representatives were brought together in September 2020 to plan further action. One outcome of this meeting was to conduct a survey of farmers across the key regions of the Murray Mallee and Eyre Peninsula, through the support of the Murraylands and Riverland Landscape Board and AIR EP. The aim was to engage with land holders to find out the extent of the issue, the types and size of land affected, how quickly it was spreading, how concerned farmers were, and what levels for financial impact it was having on farm businesses. The survey would also explore farmers understanding of the causes of the issue, the success of any actions they had taken, whether they supported and would be willing to engage in further research and extension activities, as well as location and contact details.

The survey was constructed using the on-line Survey Monkey application, with links being sent out to farmers through various farmer group, farming system group and Landscapes Board's contact lists, emails, newsletters, and social media networks during December 2020 and January 2021. Some interviews were achieved through phone contact and uploaded to Survey Monkey.

It is hoped that the analysis, findings and recommendations form this survey will be the catalyst for further funding, research, innovation and adoption of further practical solutions to overcome the issue of dry saline land degradation within these regions and further abroad.

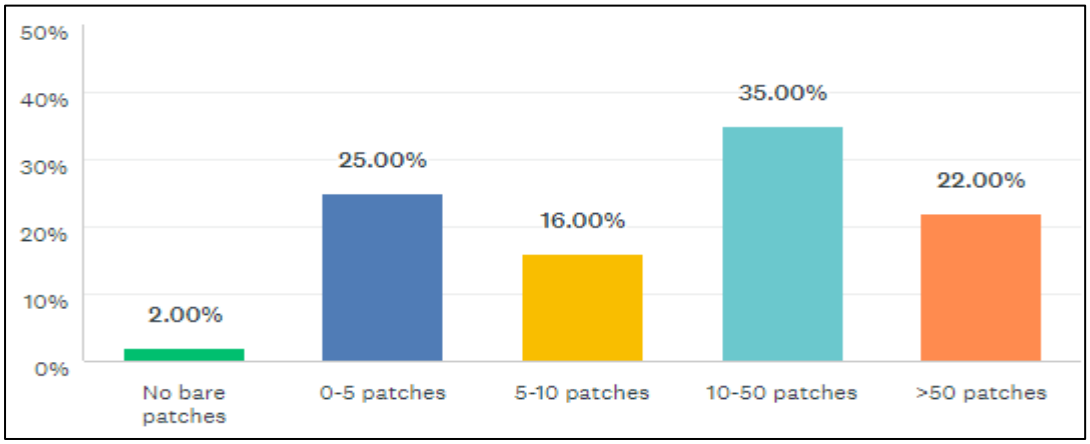
***Photo 2. Patchy degraded areas developing within a shallow stony paddocks near Wunkar***

# 3 Findings from Survey Question Analysis

This section presents a brief summary of data combining and comparing information gathered from both the SA Murray Mallee and Eyre Peninsula to give an overall perspective of the issues at hand. It provides an analysis and some discussion of each of the questions as they appeared in the survey.

## 3.1 Do you have any dry saline bare patches on your property?

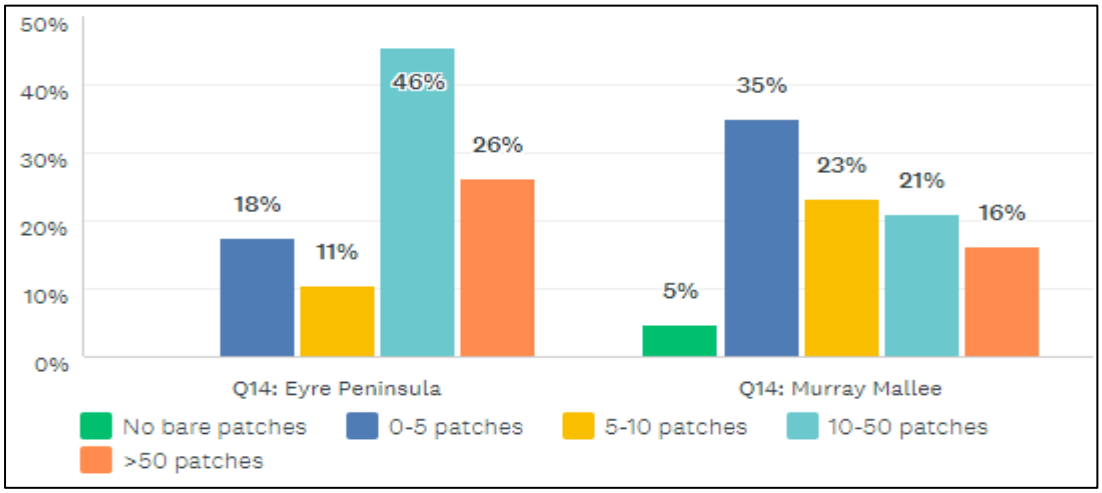
***Figure 1. Combined data for Q1."Do you have any dry saline bare patches on your property?"***




The results of the 100 responding farmers (Figure 1) shows the severity of dry saline land issues across these regions. 57% of have over 10 patches, with over 20% have more than 50 patches. It is also important to recognise the 41% who may be in the earlier stages of patch development, indicating 10 or less. This may present opportunity for action to be taken before major land degradation takes place.

Figure 2 reveals there are strong differences between regions, with more Eyre Peninsula farmers indicating that are experiencing higher numbers of patch development with over 70% of farmers having at least 10 patches and 26% of these with greater than 50 patches. The Murray Mallee appears to have had a more recent development of the issue, with over 60% or respondents having 10 patches or less. A few farmers were contacted on the edge of affected districts to indicate the limits of spread of the issue in some areas, which accounts for the few 'no bare patches' responses.

***Figure 2. Regional comparison of Q1 describing the extent of dry saline patches on properties.***



## 3.2 How big is the total area of land (hectares) affected by this patchy crop/pasture growth (patchy ground area, not just bare scalds)?

***Table 1. Total areas affected by dry saline land patchiness.***

| Affected areas (ha) | Total farmers | Ave Area (ha) | Murray Mallee farmers | Eyre Peninsula farmers |
|---|---|---|---|---|
| >500 | 3 | 2067 | 0 | 3 |
| 251-500 | 8 | 400 | 3 | 5 |
| 101-250 | 14 | 189 | 4 | 10 |
| 51-100 | 11 | 79 | 2 | 9 |
| 6-50 | 42 | 22 | 16 | 26 |
| 0-5 | 21 | 2.6 | 17 | 4 |

Table 1 reveals that at present the problem is generally affecting larger land areas on Eyre Peninsula (showing a higher % of farmers with larger areas impacted) than the Murray Mallee where more farmers have less than 5 ha. However, it still gives a very strong indication that this issue is impacting a significant portion of many business. Overall, 20% of the farmers surveyed recorded areas that made up 5% or greater of their property size affected. At the extreme end, 2 Eyre Peninsula farmers estimated that around 30% (2500ha) of their land was affected, and 2 lower Murray Mallee farmers estimated that 20% of their land was impacted.

36% of farmers had 50ha or more affected, incurring very high costs to their individual businesses. Other farmers were currently experiencing smaller impacts (21% at 5ha or less), but are mildly to very concerned about losing more productive land to this issue in the future. Early preventative action could prove to be vital in all of these situations.

While it is hard to put an accurate figure on total land areas directly affected, if we assume that this was completed by about 30% of affected farmers in these regions, then this equates to approximately 40,000 ha on Eyre Peninsula and 10,000 has in the Murray Mallee. These figures may well be conservative if less than 30% of affected farmers responded to the survey. As the affected land area is increasing, it is conceivable that if this area was to double over the nest 5-10 years, then 100,000 ha of productive land could become degraded, presenting massive costs to our farmers and rural communities.

## 3.3 What % of affected ground would you attribute to each of these soil types (total 100%)?

This question was asked to ascertain what soil types are most at risk and whether this differs between areas and regions. Essentially, where Table 2 shows higher numbers at either end it indicates whether more farmers have a particularly lower or higher percentage of that soil type affected. This may well influence the areas that need to be further targeted and tested and the types of management strategies that may be employed.

***Table 2. Total Farmers apportioning of dry saline ground patchiness to soil types.***

| Shallow Stone | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Q14: Eyre Peninsula | 25%<br>12 | 19%<br>9 | 13%<br>6 | 10%<br>5 | 8%<br>4 | 2%<br>1 | 10%<br>5 | 6%<br>3 | 0%<br>0 | 6%<br>3 | 49%<br>48 |
| Q14: Murray Mallee | 13%<br>4 | 16%<br>5 | 3%<br>1 | 0%<br>0 | 13%<br>4 | 16%<br>5 | 0%<br>0 | 13%<br>4 | 10%<br>3 | 16%<br>5 | 32%<br>31 |

| Clay/Clay Loams | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Q14: Eyre Peninsula | 9%<br>4 | 6%<br>3 | 15%<br>7 | 9%<br>4 | 9%<br>4 | 9%<br>4 | 4%<br>2 | 13%<br>6 | 13%<br>6 | 15%<br>7 | 48%<br>47 |
| Q14: Murray Mallee | 12%<br>4 | 12%<br>4 | 12%<br>4 | 12%<br>4 | 12%<br>4 | 0%<br>0 | 0%<br>0 | 12%<br>4 | 6%<br>2 | 21%<br>7 | 34%<br>33 |

| Other | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Q14: Eyre Peninsula | 17%<br>4 | 13%<br>3 | 17%<br>4 | 4%<br>1 | 9%<br>2 | 9%<br>2 | 9%<br>2 | 13%<br>3 | 4%<br>1 | 4%<br>1 | 23%<br>23 |
| Q14: Murray Mallee | 22%<br>2 | 11%<br>1 | 0%<br>0 | 11%<br>1 | 22%<br>2 | 11%<br>1 | 0%<br>0 | 11%<br>1 | 11%<br>1 | 0%<br>0 | 9%<br>9 |

Table 2 reveals that on Eyre Peninsula approximately 40% of the farmers apportioned at least 80% of this issue to Clay / Clay Loam soils and only 12% of the farmers apportioned at least 80% of this issue to their shallow stone soils. By contrast the Murray Mallee farmers had a more even distribution, with about 40% apportioning at least 80% of this issue to Clay / Clay Loam soils and only 40% of the farmers apportioning at least 80% of this issue to their shallow stone soils.

While farmers have attributed some of the problems to other soil types, generally in smaller areas, this will require some further investigation.

## 3.4 Have these patchy areas become more significant in size and crop effects in the last 10 years?

***Figure 3. Have patches become significant in size and crop effects in the last 10 years?***

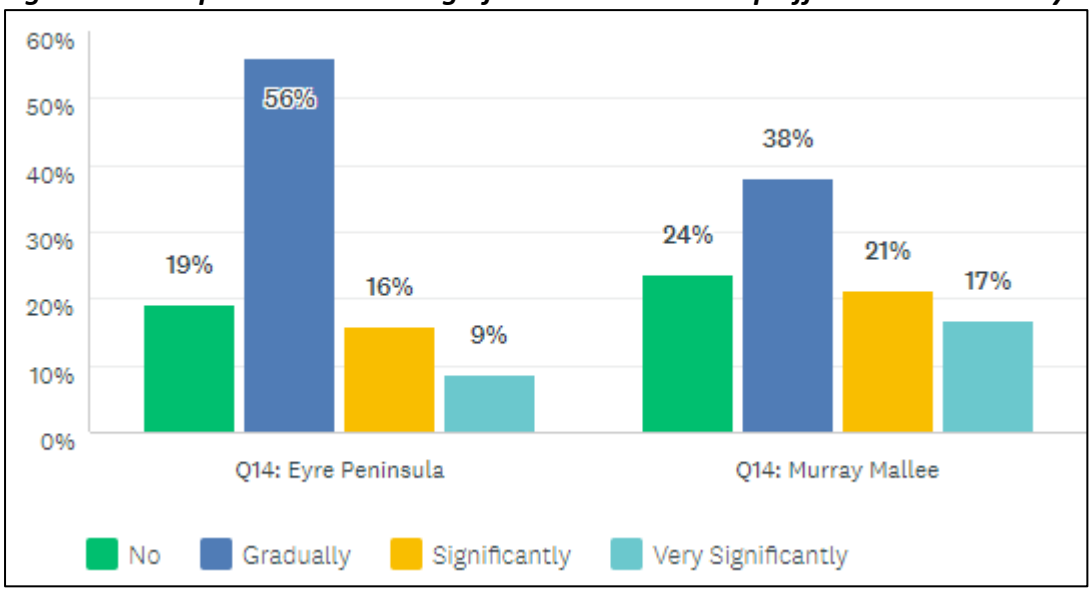



Figure 3 reveals that across both regions, the largest percentage of farmers believe that the issues are gradually getting worse. For some it is described like an insidious cancer that has gradually been getting worse, but now after a number of dry years is not being more noticed. Others, particularly on Eyre Peninsula, describe how the areas reduce and grow better crops only after wet periods leading into crop establishment, but long term are increasing.

It is also worth noting the large percentage of farmers indicating significant and very significant increase in areas and impacts, particularly across the Murray Mallee. This emphasises the need for taking urgent action to address this growing land degradation, particularly if there are found to be links with changing climatic conditions across low rainfall farming zones, which may move south.

While overall, 21% of farmers reported that they didn't think the size of their patches were growing, further investigation revealed that these were spread across large and small area affected farmers, some with estimated losses in the hundreds of thousands, and most were still concerned about the issues and looking for answers. 76% of these thought that the issue was driven by seasonal factors, suggesting that they just got worse in the drier years.

## 3.5 How concerned are you about the economic losses caused by dry saline land on your property?

***Figure 4. Concern over issue by region***

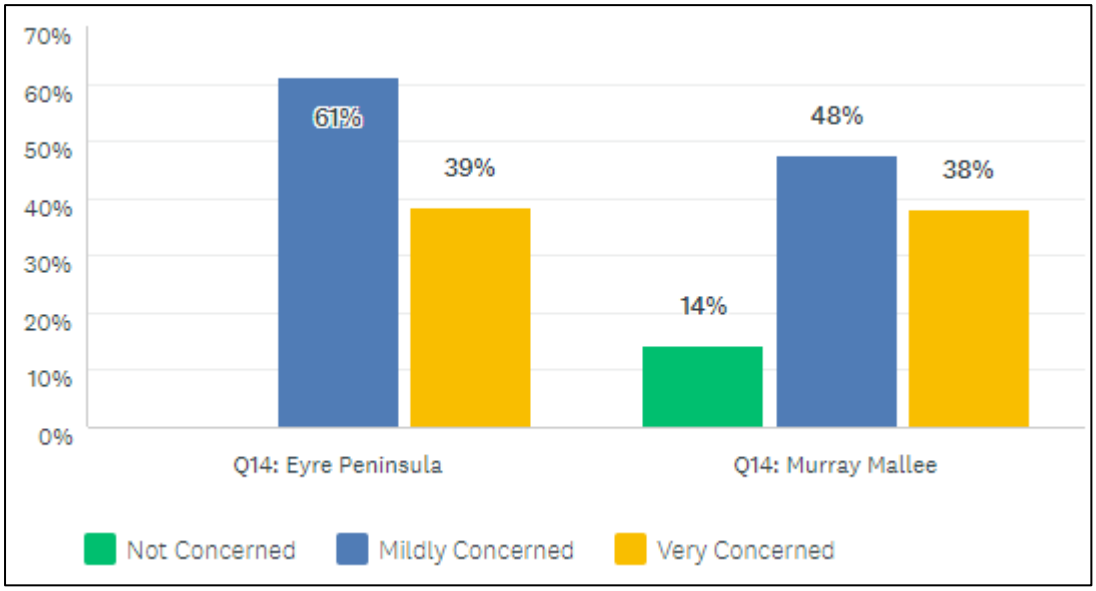



Figure 4 reveals that the vast majority of farmers responding to this survey were at least mildly concerned, with nearly 40% expressing a high level of concern. This high level was expressed by the majority of farmers with large areas of patchy ground, right down to those with growing areas from their 5ha affected at present.

The 14% in the Murray Mallee that were found to not be concerned were generally farmers on the outer ends of the areas thought to be of concern, saying that their patches were not big enough to be worried about at the present time.

## 3.6 What has been the estimated financial cost to your farm business from this issue over the last 10 years? (Total $)

***Table 3. Estimated financial cost to farm businesses over the last 10 years.***

| 10 Year Cost Ranges ($) | Total farmers | Ave 10 Year Cost ($) | Murray Mallee farmers | Eyre Peninsula farmers |
|---|---|---|---|---|
| >$500,000 | 4 | $ 1,362,500.00 | 1 | 3 |
| $100,000-$500,000 | 11 | $ 290,909.09 | 6 | 5 |
| $51,000-$100,000 | 12 | $ 89,083.33 | 1 | 11 |
| $11,000-$50,000 | 30 | $ 32,233.33 | 8 | 22 |
| $1,000-$10,000 | 24 | $ 5,645.83 | 18 | 6 |
| 0 | 4 | $ - | 4 | 0 |

Table 3 reveals that the cost of dry saline land has been estimated to be in the $ millions for some farmers when accumulating the production losses and wasted input costs over the last 10 years. 32% of respondents to this question said they had lost over $50,000, with a further 35% attributing costs of between $11,000 and $50,000.

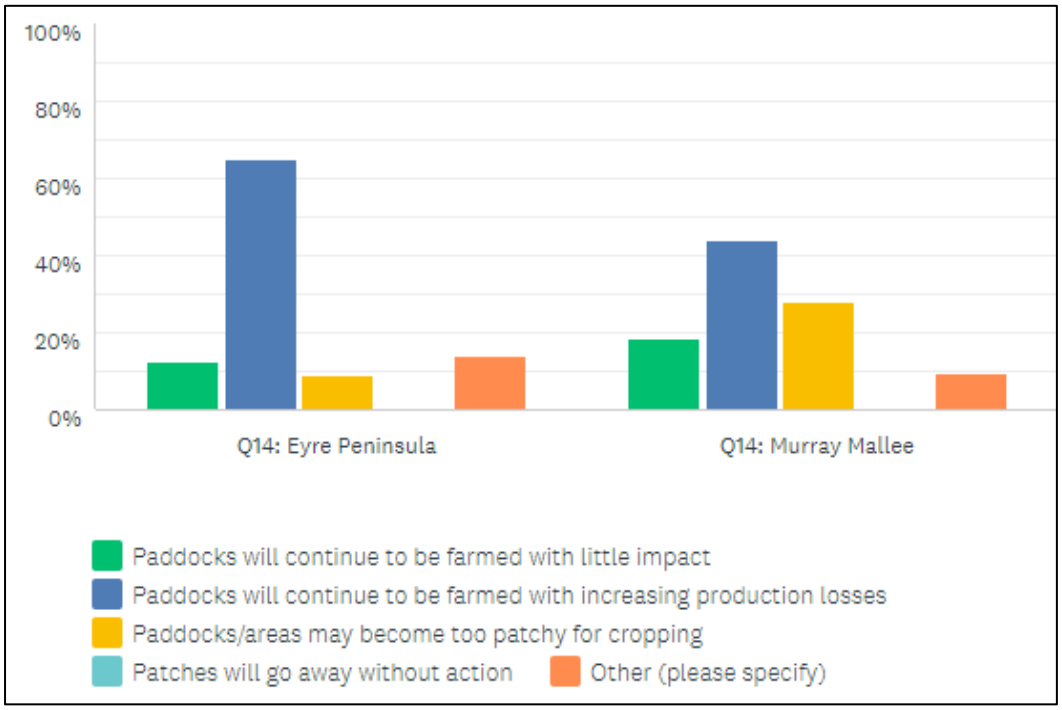
It is clear that at present the costs to Eyre Peninsula farmers is higher than that of the Murray Mallee (which currently has about 50% of respondents at $10,000 or less). The total 10 year costs per responding Eyre Peninsula farmers averaged out at $160,000. By comparison, the average total 10 year costs for the Murray Mallee farmers was $88,000.

The average of all 85 farmers who answered this question was $127,312. If it is assumed that the survey reached approximately 30% of affected farmers, then it is possible that these costs represent a figure close to $14 million in the Murray Mallee and $36 million on the Eyre Peninsula, for a combined total of $50 million in costs over the last 10 years. This may well be a conservative estimation, as there is possibly a higher percentage of affected farmers that did not participate in the survey.

If this land degradation continued to increase to double its size over the next 10 years then this could add a further $100 million dollars in costs and lost revenue across these regions.

## 3.7 What do you think will happen if no action is taken?

***Figure 5. Regional summary of farmer's expectations if no action is taken.***




Across both regions the expectation is that patches will continue to grow with increase production losses if no action is taken (Figure 5). The Murray Mallee farmers have placed a higher probability on some paddocks or areas becoming too patchy for cropping. This may be due to seeing a higher proportion of shallow stony ground degrading severely and becoming too risky to waste input costs on. These shallow stony patches do not appear to be as easily recoverable after wet season openings like the more clay scald 'magnesia patches' of the Eyre Peninsula. The slightly higher 'little impact" response in the Murray Mallee may be due to the higher proportion of farmers still with very small areas impacted, and that some of these farmers were targeted for a response to ascertain the edges of the affected districts.

Farmers that responded to the "Other" section usually made comments around the issue being seasonally dependent, with less issues after wet periods, but increases after dry periods.

## 3.8 What do you think may be causing these patchy growth issues on your farm?

***Figure 6. Farmer's perceptions of causes of the problem compared by region.***

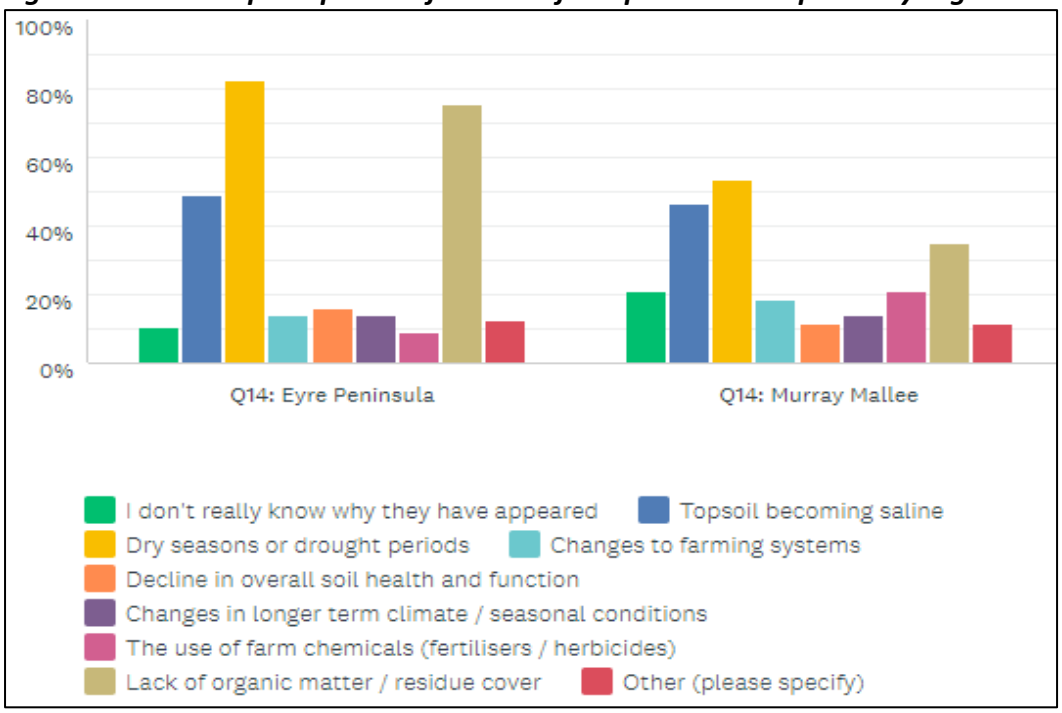



Figure 6 shows the main response given in each region for reasons why these issues have occurred is "Dry seasons or drought periods", which is not surprising given that these areas have just come through 3-4 years of very low rainfall as patch severity has noticeably increased. The second reason was that topsoil has become saline, which may have been influenced by the fact that this survey is labelled as the 'Dry Saline Land Survey', and that there has been some presentations of soil test results showing salinity amongst some farmer groups. The lack of organic matter / residue cover is likely due to the observations that once an area becomes bare it can quickly become worse and expand. It is also known that some farmers have rehabilitated these patches through the addition of hay or chaff.

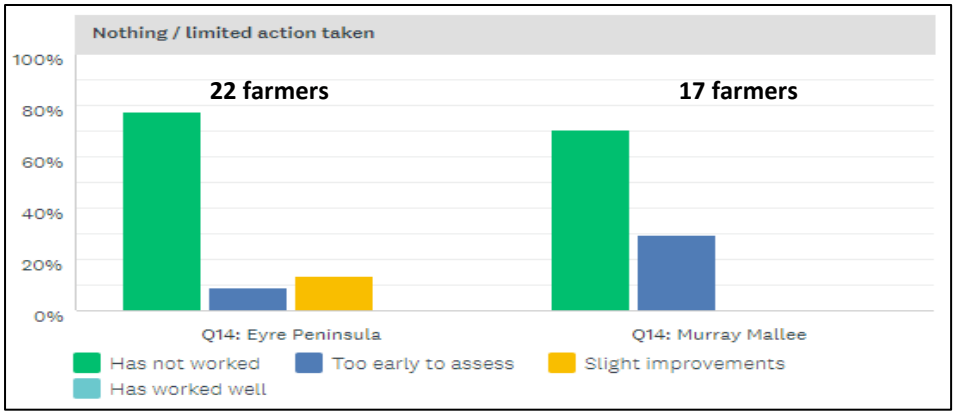
Interestingly, 20% of Murray Mallee farmers expressed they did not know why these patches have occurred, with 20% also suspicious that farm chemical use could be a driver.

## 3.9 What (if anything) have you done to try and manage this issue and how successful do you think this has been?

This question is very important for understanding the success of various things farmers have tried, which will greatly inform further research, demonstrations, innovations and recommendations that need to be explored in any further work to be explored. When assessing these figures, please note that not all farmers have tried each method, so the graph bars represent 100% of those who responded about that particular category. The number of farmers are indicated in each figure. Higher participant numbers is also an indication as to how worthwhile a method may seem.

Figure 7 gives a strong indication that doing nothing has generally not worked or resulted in land improvements. The issue gets worse. The slight improvements expressed by a few Eyre Peninsula farmers related to wet season openings that can lead to better crop establishment and growth.

***Figure 7. Regional comparisons for Nothing / limited action taken.***




The spreading of organic matter, such as hay, chaff or straw has clearly shown slight improvement or worked well for most of the 42 farmers that have done this (Figure 8). Organic matter is known to improve soil health with high biological activity, cation exchange and water holding capacity, but is still challenging where the surface salinity may have developed well beyond toxic levels. An important feature of this is providing soil cover that reduces evaporation and capillary rise of moisture that can leave salts to accumulate in the surface layers. It is therefore a rehabilitation method that must be further explored, including practical and affordable ways to achieve this.

***Figure 8. Regional comparisons for spreading hay, chaff or straw.***

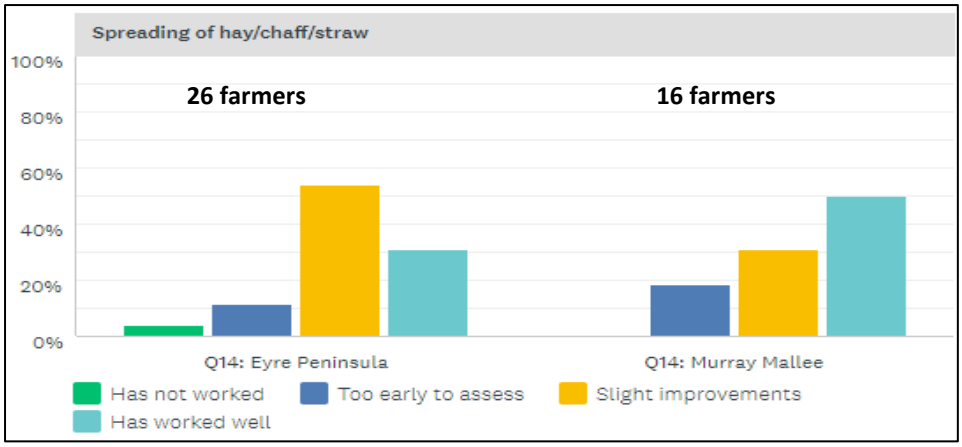
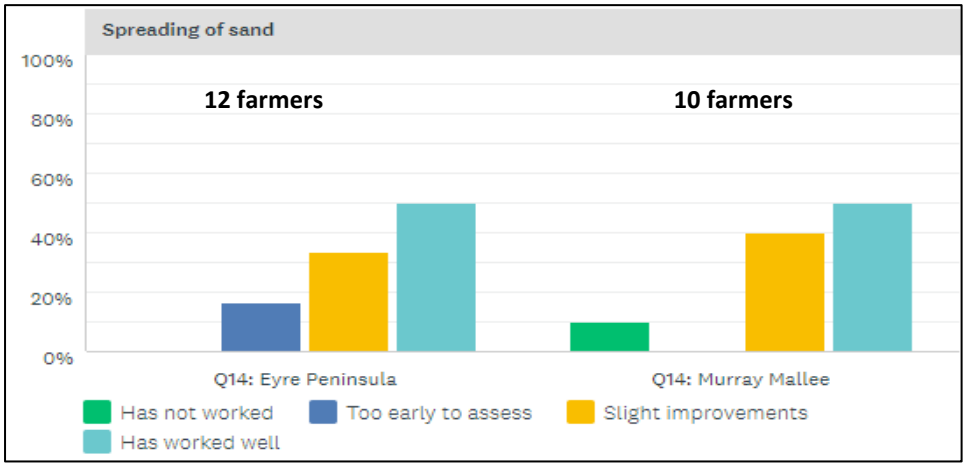


***Figure 9. Regional comparisons for spreading of sand on top of scalds.***




The spreading of sand on the surface has also shown very positive results across both regions (Figure 9), and should be explored further to understand the optimal depths required as well as whether this provides a permanent fix or may revert back to salinity over time. Due to the cost of shifting soil it is expected that this method will be most possible for farmers while patches are few in number and in early stages of development, with a sand source close by. This becomes more accessible with the increase of farmers owning equipment such as land planes in these regions.

The practice of only sowing affected areas after wet season openings, as shown in Figure 10, is far more prominent among the Eyre Peninsula farmers (25) that in the Murray Mallee (5). The Eyre Peninsula farmers are less willing to sow these areas dry, and have more confidence if good early rains have fallen. This is also a likely reflection that the majority of Mallee farmers are dealing with smaller, newer patches within paddocks and are presently still just sowing through them according to normal paddock management, along with the lower recognition that seasonal factors make a significant difference at present.

This may suggest that some farmers aimed to minimising input and production losses from these areas by sowing around them, rather than rehabilitation them back to health. Leaving scalds bare through dry seasons is only expected to increase the surface salt degradation in these patches.

***Figure 10. Regional comparisons for only sowing after wet season openings***

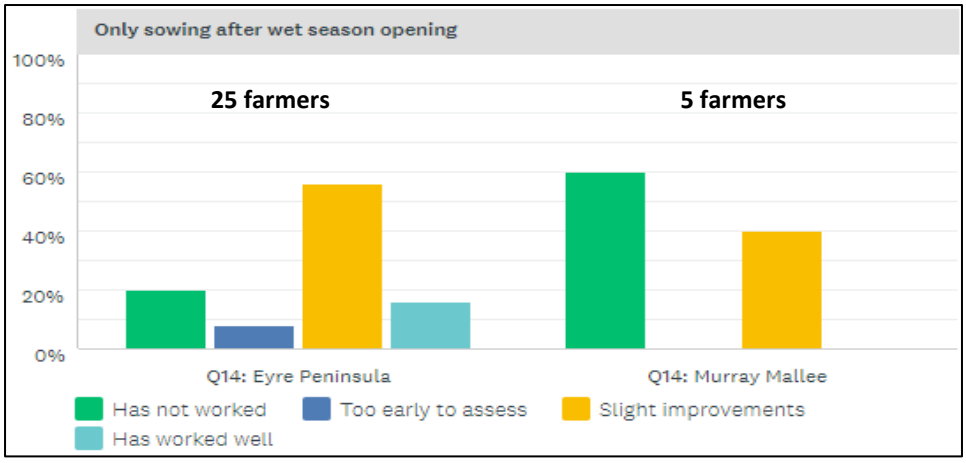
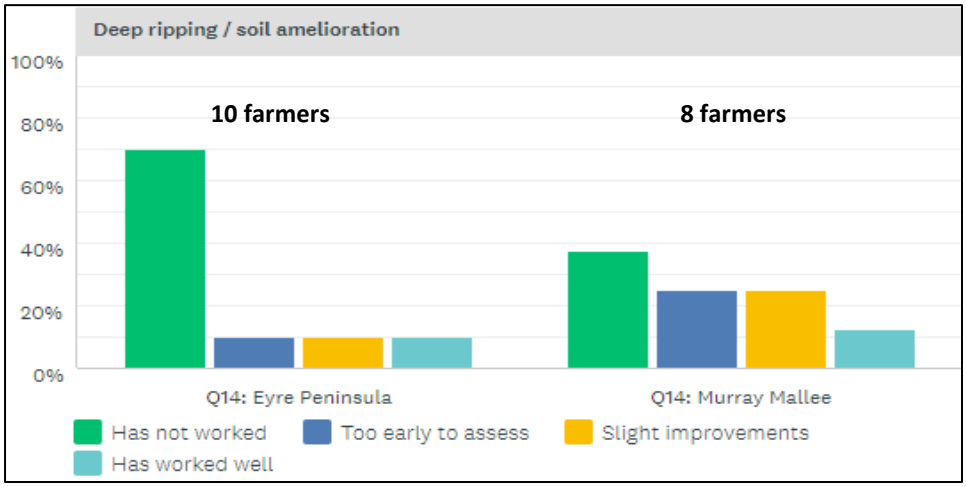


***Figure 11. Regional comparisons for deep ripping / soil amelioration***




The soil amelioration techniques such as deep ripping generally have not been successful amongst the few farmers that have tried them. This is difficult to achieve on shallow stony ground. Deep ripping will have limited effect on surface salinity unless it greatly improves infiltration and leaching of salts, or can change the topsoil by mixing with less saline subsoil layers. It may be worth visiting the 2 farmers who have had success to explore exactly what was done (Figure 11).

Similarly, the addition of gypsum may help infiltration within sodic clay layers, but also could add to the surface soil salinity, depending on its quality, particularly in the lower rainfall areas. It would appear that this has often been unsuccessful for those who tried it (Figure 12). However, it would be worthwhile exploring the circumstances in which a few farmers found it useful.

***Figure 12. Regional comparisons for spreading gypsum***

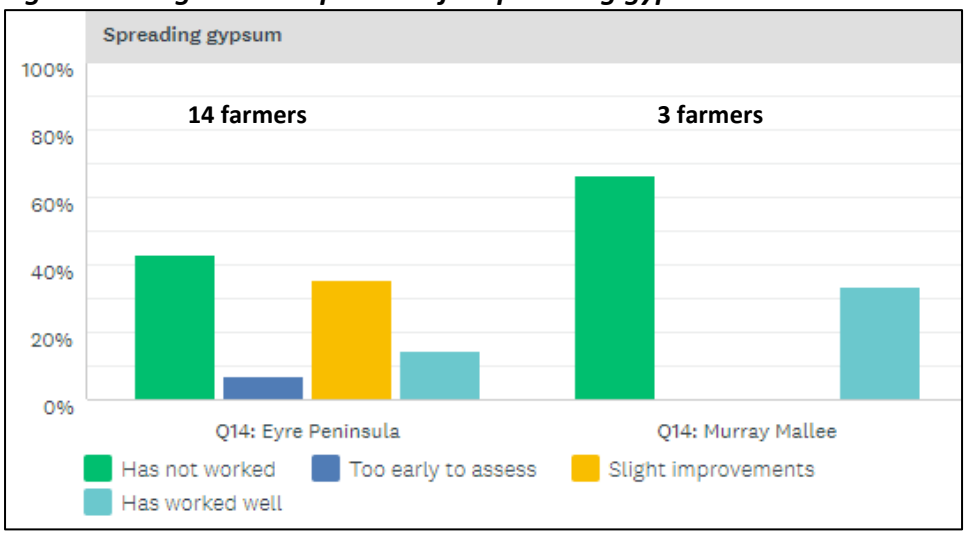
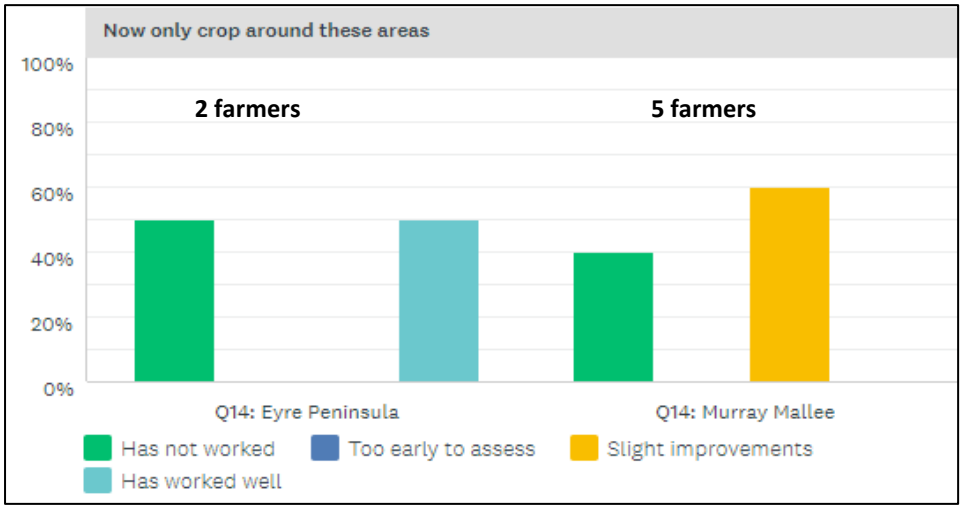


***Figure 13. Regional comparisons for now only cropping around these areas.***




7 farmers decided that some areas are now better left out completely (Figure 13). Results range between success and failure, and it is likely the gains are made by not wasting inputs and possibly gaining some soil cover through more salt tolerant volunteer growth which may provide limited grazing. However, this is not expected to rehabilitate this land back to previous production, but may be the easiest management option in some circumstances.

11 farmers have chosen to plant perennial woody vegetation into these scalded patchy zones (Figure 14). This does represent a significant change of farm practice for these patchy areas that will impact significantly on other cropping practices within these paddocks. However, given the favourable responses expressed by 8 of these farmers, there are circumstances where this has worked, and should be further followed up to see if this is practical for more farmers. One farmer has seen saltbush planted with wide gaps so pasture could be sown in between on these areas.

***Figure 14. Regional comparisons for establishing trees and shrubs***

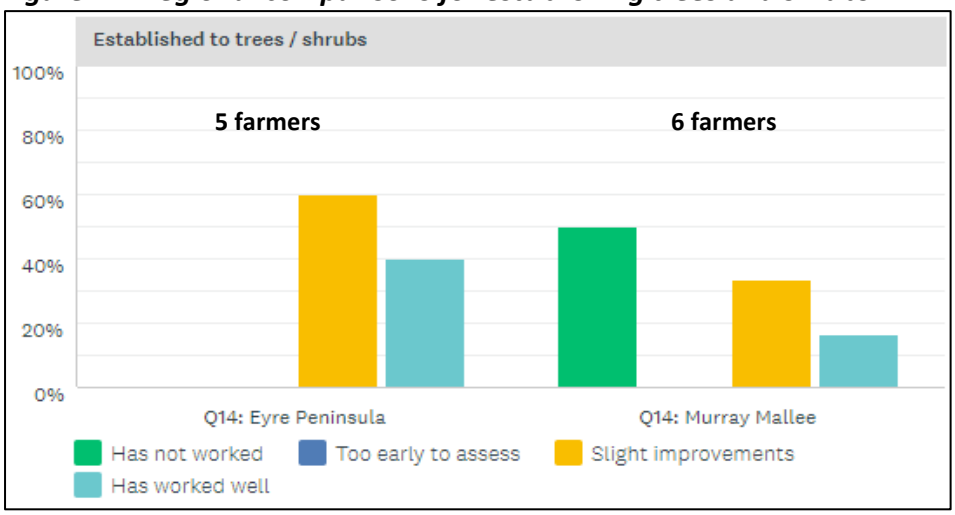


***Figure 15. Regional comparisons for planting specific crops / varieties***

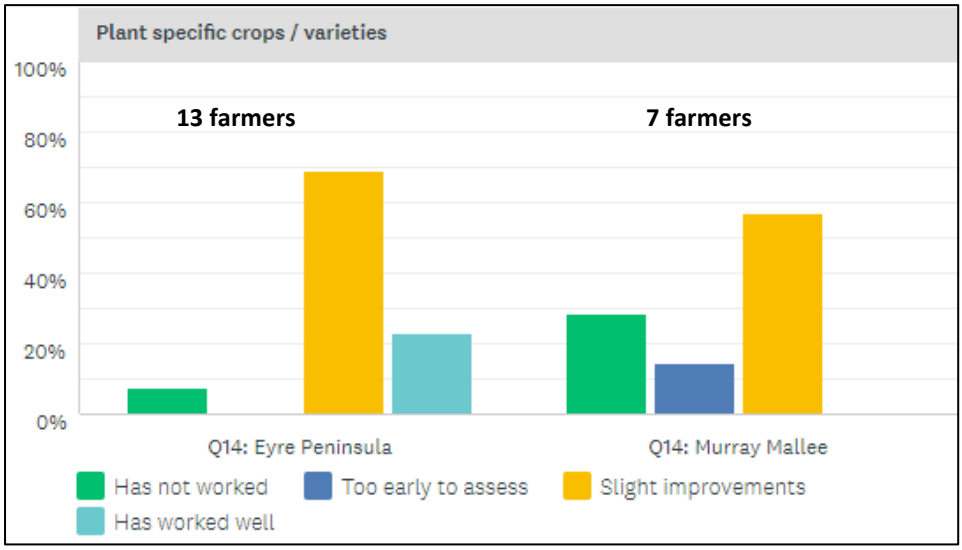



Figure 15 shows that some farmers have seen slight improvements by targeting specific crops or varieties into these patchy areas, with 3 Eyre Peninsula farmers saying it has worked well. These farmers reported targeting barley or rye, or short season varieties and sowing early in these areas. One farmer has sown continuous barley into his areas.

11 farmers have targeted specific pastures into these areas (Figure 16) with about half recording slight improvements. There was no specific pasture species recorded within these farmers' responses.

***Figure 16. Regional comparisons for planting specific pastures / varieties***

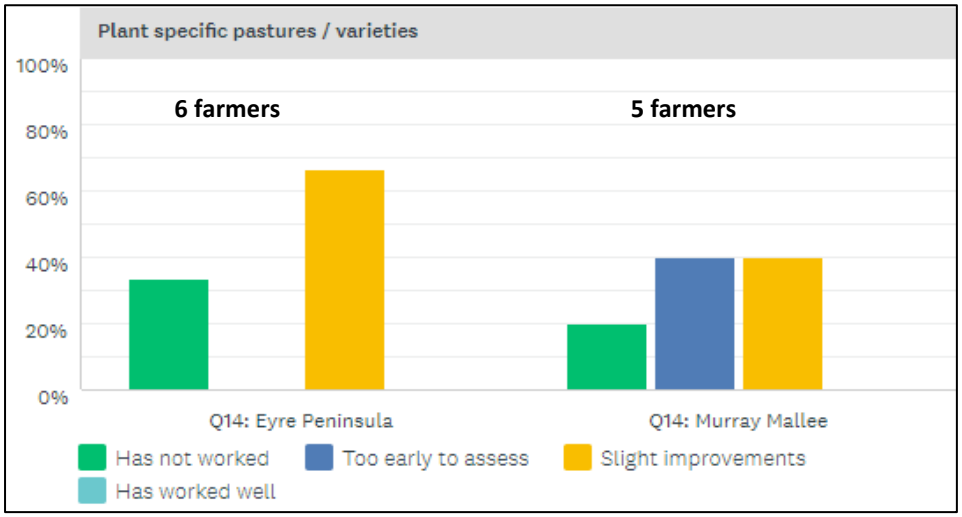


***Figure 17. Regional comparisons for other management methods***

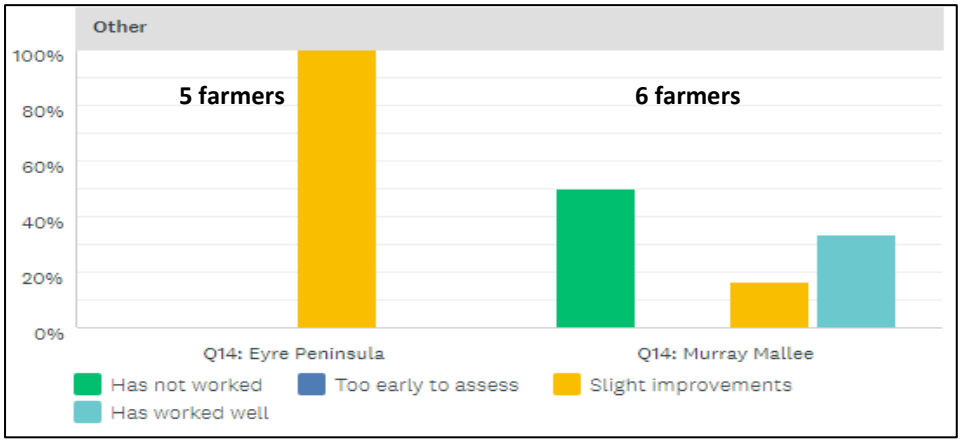



Figure 17 shows there were a number farmers have tried other management techniques, with some possible successes. A total of 31 farmers actually entered written responses into this section. Some methods were essentially more descriptive entries of the previous options given. However, a number of other specific comments/suggestions include:

- "Retain standing straw and residue as much as possible. Exclude stock as they like to camp on scalds."
- "Sow as normal and moisture timing dependant on plant establishment, temporary exclusion fencing to maintain cover"
- "I have tried using standard farming practices, sowing cereal and vetch but with dry autumns and winters nothing has established. Looking to do soils tests and then see what options I have, planting salt tolerant mixed species is where I think this will head. Problem getting too big to ignore and is being further degraded with every windy day that passes."
- "Maximising retained organic matter and crop residue help enormously. After the major flushing event of 2009 season and a run of very high production, the problem almost disappeared, while 2017 to 2020 has made the problem much worse because we steadily lost our retained stubble."
- "Sometimes a row of crop will emerge better than all the other rows which makes me wonder if can do something physical in that area eg experiment with raised beds vs troughs etc. Might find something that helps?"
- "Urea sometimes."
- "Dry sowing shallow."
- "Have seen saltbush planted in these areas in wide gaps to sow feed in between."
- "Continuous barley worked well, not good for diseases though. Sand spread thickly has been great, just have to do bigger trials and work out cost vs returns."
- "Spraying ice plant that grow on the patches, not sure it's helping or not."
- "Pleased to show or share what has worked very well for 10 years."

- “Decrease inputs in these small areas so not to waste money.”
- “Stopped using chemical fertilizers.”
- “Will start to till only for fallow. no chemicals (trial strips )”
- “Good farming systems, returning all straw has helped improve patches. Too many hay cuts makes it worse.”
- “Some claying.”
- “Fenced off and planted salt tolerant plants with limited effect.”
- “Only sow for sheep feed.”
- “Drift sand and rye.”
- “Deep ripping a bit (not able to penetrate very far) to try and break up stone. May try reefinator.”
- “Rotational grazing, don't let sheep bare out areas, and give ground long rest periods. Has worked well.”
- “Using Euc. Oxidentalis.”

A number of these suggestions will be worth following up and possibly trialling within future any project activities.

## 3.10 If you have taken no or limited action, what are the reasons for this?

***Figure 18. Reasons for taking limited action by region***

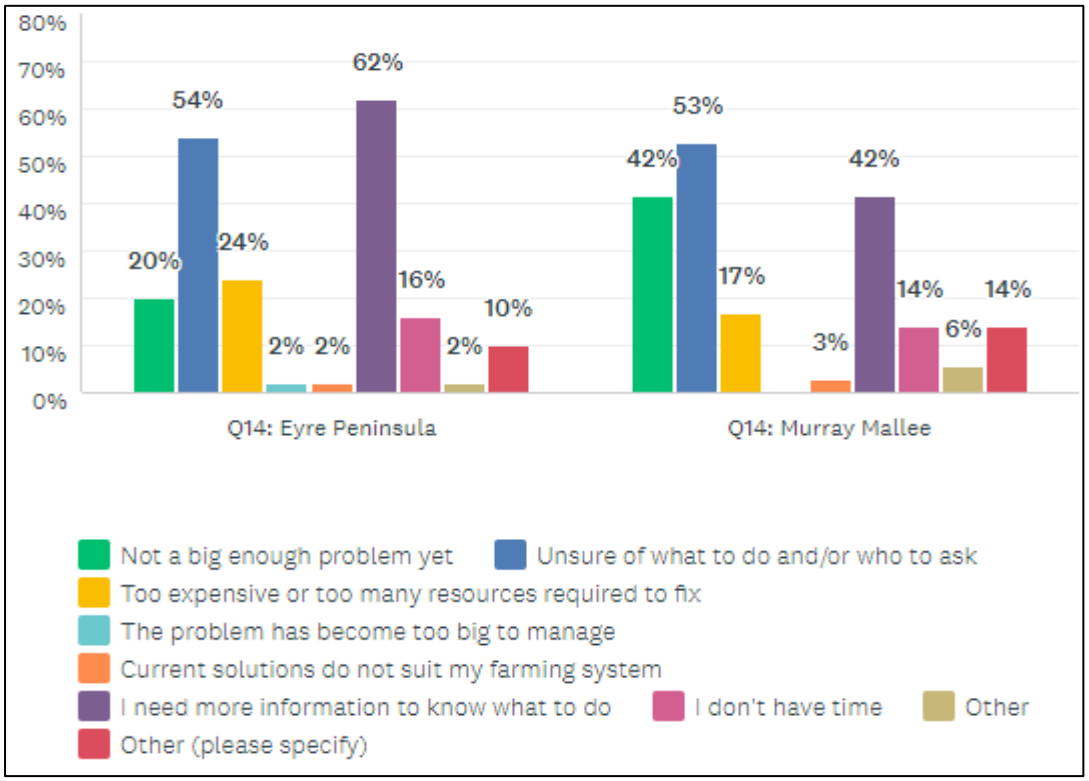



Figure 18 shows very clearly that across both regions the main reasons why farmers have taken no or only limited action is that they are unsure of what to do and who to ask, and they need more information to know what to do. This provides very strong evidence that more work needs to be done immediately to address this issue, to fill this knowledge gap and provide easy pathways for farmers to access and implement the outcomes.

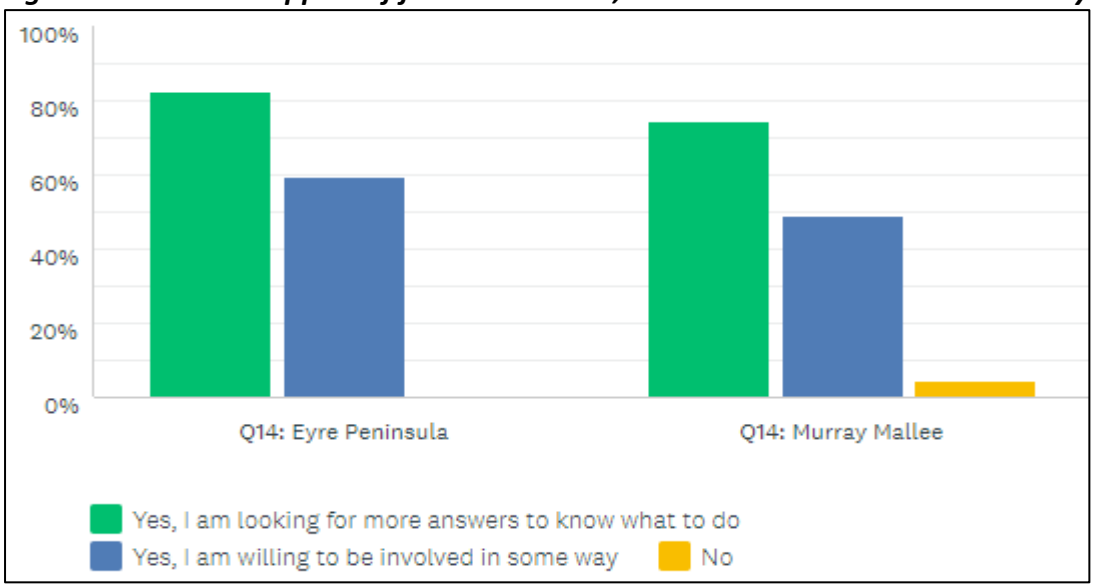
The higher level farmers in the Murray Mallee expressing that the problem is not big enough for them to take action yet, is a reflection of the general smaller areas currently experienced in this region. Importantly, it provides a real opportunity to help more farmers address this growing issue in its early stages, before it becomes a major land degradation issue on even more farms in more districts.

It is pleasing to see that very few farmers expressed that the problem has become too big to manage, however, about 20% of famers were concerned about the high expense that may be required to implement the necessary changes.

Most of the “Other” reasons related to the existing options mentioned, or that because they felt it was driven by seasonal conditions that were essentially out of their control.

## 3.11 Do you support further research, demonstrations and farmer case studies to help find accessible, practical solutions to these issues?

***Figure 19. Farmers support of further research, demonstration and case studies by regions.***




The results of survey question 11 (Figure 19) show very strong support for further research, demonstration and farmer case studies to be conducted on solving the dry saline land issues, with almost 80% of responants looking for more answers to know what to do, and 55% saying that they are willing to be involved in some way to find these answers. This gives a very strong indication that farmers are willing to further participate to develop solutions, which is a positive step for taking a participatory approach to extension, as well as likelihood that they will embrace and adopt the practical outcomes on their own farms. Any future research work needs to take full advantage and follow up on this initial response to ensure this takes place.

# 4 Specific Murray Mallee Results and Discussion

While Section 3 has highlighted many of the similarities and differences between the two regions, this section deals with important findings within the Murray Mallee region. This has been categorised into 6 districts based on landscape/climate similarities and responses gained. There were some respondents that did not give a specific location within this map, so results reflect 37 farmers.

***Figure 20. Mallee Region districts and respondent numbers, referred to in analysis***


## 4.1 Waikerie / Wunkar / Moorook

This district (10 farmer responses) has very low annual average rainfall (250-300mm) and has a high proportion of shallow stone flats and sandy rises. These farmers generally attributed 80-100% of their dry saline land issues to shallow stony ground. The majority had seen very significant increases and were highly concerned about the issue. Most thought that if nothing was done these areas would eventually become too patchy for cropping. The average areas affected was 145ha, but this ranged between 3 farmers with less that 2ha and 2 farmers reporting 500ha. The average loss of income was $102,625 over the last 10 years.

While some farmers have tried a variety of management options, 4 reflected that the issue has become too expensive or required too many resources to fix. This is due to 2 farmers reporting 10-50 patches and 3 with >50 patches, which can affect up to 30% or more of some paddocks.

This district represents numerous farmers with the most significant issues across the region. It should however be noted that there were still large farmers throughout this area that still had relatively few problems to report. Any further research should seek to explore why some neighbours can be experiencing such large differences in impacts, and what is driving these issues.

*Comments in Survey*
"We need more research to fix this cancer growing across our land!"

"We really need help in this area. Finding answers would be greatly appreciated."

"Is a rising issue"

"Every farm is different with soils and practices, so there needs to be range of solutions to give farmers options that best suit them."

## 4.2 Paringa / Alawoona / Paruna

This extended Loxton district is characterised by more loamy clay flats along with shallow stone, which is reflected in a more even distribution of the dry saline land across soil types by the 10 farmer respondents. The majority had less than 10 patches and were mildly concerned with gradual increases, while 2-3 had 10-50 patches and were very concerned at their very significant area increases. Most thought that if nothing was done these areas would continue to be farmed with increasing production losses. The average areas affected was 17ha, ranging between 2ha and 60ha. The average loss of income of these farmers was estimated at $11,500 over the last 10 years.

*Comments in Survey*
"Can also see patches on heavy ground going out on neighbours. 50% of my area is grey bull dusty ground"

"Getting worse"

"Glad someone showing interest"

## 4.3 Murray Plains

This area is more characterised by heavier, often sodic clay / clay loam flats, along with some stone and sandy areas. The majority of this issue is attributed to the heavier soil types in this district by the 6 responding farmers, with a large range in patch numbers and areas affected ranging from 1ha to 400ha, with 2 saying 20ha. Farmers were both mildly and very concerned, with a range of expected outcomes recorded. One farmer attributed production losses of $1,000,000 over the previous 10 year period. It is expected there are other farmers with high losses in this area.

There was a strong emphasis that dry seasons or drought periods were a main driver for the issue, which is more consistent with the clay flat zones. Some farmers had tried increasing organic matter on these sites, but most recorded they were unsure what to do and needed more information.

*Comments in Survey*
"The area concerned is adjacent to a salty underground water course which has flooded during heavy summer rains about 4 times in the last 50 years"

## 4.4 Parrakie / Pinnaroo

This district (5 farmers) had many similar responses to the Murray Plains, which is likely due to the predominance of heavier clay flat issues in the area. There with a large range in patch numbers and areas affected ranging from 1ha to 20ha with 10 year financial losses ranging from $3,000 to $50,000. Farmers were both mildly and very concerned, with a range of expected outcomes recorded. There was a strong emphasis that dry seasons or drought periods have been a main driver for the issue, which is more consistent with the clay flat zones.

Some of these farmers were directly contacted and it wasn't until they were forced to think about it that they realised that it was a more significant issues that they originally believed. It appears that dry saline land is creeping into this district, which could become far more prominent in time. Early action may become critical for the future this areas farming.

*Comments in Survey*
"When I came to property in 1985 there were a couple of salt affected patches on heavy ground. I eventually worked out that the more chemical fertilizers I used the bigger these patches got. If I added organic matter(hay mostly) the areas reduced in size over time."

## 4.5 Bow Hill / Karoonda

There were 3 responding farmers from this district, ranging from 0-50 patches and 0-5ha affected. There is currently no strong farmer group within this district which may explain why there was a only a limited response. 2 of these farmer were mildly to very concerned and wanting answers about the issue and willing to be involved in any future work to achieve this.

*Comments in Survey*
"I tried the above actions after Chris 's suggestion of there being some improvement in a trial on another property"

"We had one saline patch which we grew a variety of trees and some shrubs and within 2 years problem was gone. The answers I have given are due to wind erosion and blowouts just poor management"

## 4.6 Cooke Plains / Netherton

The Netherton farmer recorded 0-5 patches on various soil types with little concerns. The 2 Cooke Plains farmers each recorded over 200ha affected and losses of $200,000 to $500,000 over the last 10 years. However, there is some concern that they may be experiencing saline land issues from the shallow saline ground water. This may require further investigation to assess.

# 5 Specific Eyre Peninsula Results and Discussion

The Eyre Peninsula has been categorised into 6 districts based on landscape/climate similarities and responses gained. There were five respondents that did not give a specific location within this map, and they have been excluded from this section of the report. One grower was from Salmon Gums, WA (they frequently identify with EP soils and conditions), but with higher annual rainfall than the EP areas, has been excluded from this report section. This section is based on 51 respondents.


## 5.1 Far West (Nundroo, Penong, Ceduna, Mudamuckla)

This district (9 farmer responses) has very low annual average rainfall (250-300mm) and mainly calcareous soils and shallow soils on rock.

These farmers generally attributed 60-100% of their dry saline land issues to clay/clay loams with the remainder to shallow stony ground. The growth of areas response was mixed, although everyone was at least mildly concerned about the issue and everyone was impacted financially. Farmers in this area have been aware of the issue and attempting to gain answers via the Far West Soil Board since the 1990's.

Most thought that if nothing was done these areas will continue to be farmed with increasing production losses. The average areas affected was 550ha, but this ranged between 10ha to 2500ha. The average loss of income was $221,875 over the last 10 years.

One farmer had tried each management option listed, with varying levels of success. He had slight improvements using spreading of hay/chaff/straw, spreading of sand, only sowing after wet season opening and planting specific crops/varieties. Deep ripping/soil amelioration, spreading gypsum and planting specific pastures/varieties has not worked. He responded that now only cropping around these areas and establishing to trees/shrubs has worked well to manage the issue.

The main management options farmers had tried in the area were spreading of hay/chaff/straw with some success and only sowing after wet season opening with mixed results.

Most were unsure of what to do and/or who to ask and need more information, support further research and are willing to be involved in some way.

*Comments in survey:*
"Chaff dumps help. Need a better plan - depth of chaff - results in more ryegrass which is adding to biomass. Iceplant exacerbates the problem - not easy to control over summer. Wonder about ripping. Suspect no till is worse than min till."

"We have concluded that if we get a wet autumn (early season rain) there tends to be less patches, crop germinate better. I have considered too deep (150mm) rip some patches for an experiment. That depends on rock under the surface though."

## 5.2 Mid West (Chandada, Cungena, Minnipa, Streaky Bay, Port Kenny)

This district (16 farmer responses) has low annual average rainfall (275-350mm) and has mainly calcareous soils and shallow sandy loams.

These farmers generally attributed their dry saline land issues to varying levels across both clay/clay loams, shallow stony ground and to a lesser degree 'other' soil types. The growth of affected areas was mainly gradual.

All but two thought that if nothing was done these areas will continue to be farmed with increasing production losses. The average areas affected was 83ha, this ranged between 5ha to 400ha per farm. The average loss of income was $32,000 over the last 10 years.

Management options that have generally worked well: spreading of hay/chaff/straw, spreading of sand. Slight improvement: only sowing after wet season opening. Has not worked: deep ripping/soil amelioration. None had tried only cropping around these areas, establishing to trees/shrubs or planting specific pastures/varieties. 5 cited that doing anything was too expensive or too many resources required to fix.

Most were unsure of what to do and/or who to ask and need more information, support further research and are willing to be involved in some way.

*Comments in survey:*
"Grass free medic pastures aren't growing enough bulk to keep cover on the ground."

"I reckon anything and everything should be tried. I suggest someone like Jack Desbiolles for area of tillage row research. Try sand at different rates. Hay too but suspect that any hay benefit won't last."

## 5.3 Central EP (Yaninee, Wudinna, Kyancutta, Warramboo, Lock)

This district (8 farmer responses) has low annual average rainfall (320 mm) and has mainly sand over clay and calcareous loam soils.

These farmers generally attributed their dry saline land issues to varying levels across both clay/clay loams, shallow stony ground and to a much lesser degree 'other' soil types. The growth of affected areas was evenly split between gradual and significant/very significant.

Four thought that if nothing was done these areas will continue to be farmed with increasing production losses, 3 stated that the patches will reduce with better rainfall years and one thought paddocks/areas may become too patchy for cropping. The average farm areas affected was 52ha, ranging between 10ha and 200ha. The average loss of income was $42,000 over the last 10 years.

Management options that have generally worked well: spreading of sand. Slight improvement: only sowing after wet season opening. Has not worked: doing nothing, deep ripping/soil amelioration.

Some were unsure of what to do and/or who to ask and need more information, three thought it was not a big enough problem yet, but support further research and are willing to be involved in some way.

*Comments in survey:*
"We have spread sand 10 years ago and still noticeable both on sat maps and visual and in both phases crop and pasture keen to keep spreading sand with a scraper."

"Most of my worst areas are on low lying gypsum flats, this country looked the same during the 2006-08 years and slowly recovered as seasons changed. I think it looks worse this time round and I am worried about recovery time. We need to do something different and soon."

## 5.4 Kimba/Buckleboo

This district (10 farmer responses) has low annual average rainfall (325 mm) and has mainly red brown earths (often with poorly structured subsoil clays) and deep sands.

These farmers generally attributed their dry saline land issues to varying levels across both clay/clay loams, shallow stony ground and to a much lesser degree 'other' soil types. The growth of affected areas was considered mainly gradual.

Five thought that if nothing was done these areas will continue to be farmed with increasing production losses, 3 stated that the patches will reduce with better rainfall years and two thought paddocks/areas may become too patchy for cropping. The average areas affected was 352ha, this ranged between 30ha to 2,500ha per farm. The average loss of income was $125,500 over the last 10 years.

Management options that have generally worked well: spreading of sand. Slight improvement: spreading of hay/chaff/straw, only sowing after wet season opening. Has not worked: doing nothing, deep ripping/soil amelioration. Spreading of gypsum had very mixed results!

Some were unsure of what to do and/or who to ask and need more information, all were looking for answers and support further research and most were willing to be involved in some way.

*Comments in survey:*
"We have tried a lot of things over many years but mostly the salt just comes back to the top in dry seasons and nothing but ice plant actually grows."

"To date it has been an annoying issue but small enough that it hasn't warranted spending too much time & money on rectifying. That is starting to change as it has increased."

## 5.5 Eastern EP (Rudall, Cleve, Cowell)

This district (6 farmer responses) has low annual average rainfall (320 mm) and has mainly red brown earths and sand over clay soils.

These farmers generally attributed their dry saline land issues to varying levels across both clay/clay loams and shallow stony ground. The growth of affected areas was considered mainly gradual, with four of the six mildly concerned and two very concerned.

All thought that if nothing was done these areas will continue to be farmed with increasing production losses. The average areas affected was 88ha, this ranged between 10ha to 200ha per farm. The average loss of income was $133,750 over the last 10 years.

Management options that have not worked were doing nothing, and not many options have been tried to address the issue, due to being unsure of what to do or who to ask – all were all were looking for answers to know what to do and most were willing to be involved in some way.

*Comments in survey:*
"We have taken salt creek flats out of production and planted saltbush on them."

"Dry spring in 2017 and drought conditions for 3 consecutive years has been the catalyst for increased scalds. Dry sowing or sowing on marginal moisture results in very poor emergence and surviving plants die with dry conditions as salinity increases. Drought has reduced biomass/ cover on saline areas which increases wicking of moisture and leaves more salt on soil surface."

## 5.6 Lower EP (Yeelanna, Tumby Bay)

This district (2 farmer responses) has medium annual average rainfall (330-425 mm reported). Lower EP has predominantly ironstone sandy loams and sand over clay soils.

They contrasted in responses – one was in a higher rainfall area and was mildly concerned and impacted by a small area (1ha), and paddocks will continue to be farmed with little impact, whereas the lower rainfall farmer was very concerned with 150ha impacted and estimated $50,000 loss over 10 years, and paddocks will continue to be farmed with increasing production losses.

Both had spread chaff/straw with slight improvements, gypsum spreading had not worked for the farmer that tried it. The lower rainfall farmer had several other management actions with slight improvements. Both are looking for more information and willing to be involved in some way.

# 6 Recommendations

The results from this survey clearly indicate that the land degradation issue of dry saline land presents a growing issue across a wide scope of landscapes of the Murray Mallee and Eyre Peninsula, affecting a very large number of farmers, causing a significant financial burden to their businesses. There are also many farmers within these regions that are currently experiencing smaller impacts, but are mildly to very concerned about losing more productive land to this issue in the future. Early preventative action could prove to be vital in these situations.

As reported, this survey has indicated that famers are unsure of what do to about this issue, are looking for answers but don't know who to ask or where to find the information. There is still a lack of understanding as to what the underlying causes of the problem is, how these are expressed within a variety of landscapes and what practical solutions can be applied. Farmers have tried a number of management approaches with varying levels of success. Many of these involve the addition of organic matter or sand to the topsoil. These are other suggested strategies require further substantiation and analysis and possible development, particularly if they are to be applied on a larger scale.

It is strongly recommended that funding be sort for a large project involving both investigative and applied research and extension, across both the Murray Mallee and Eyre Peninsula regions. It is vital that this occurs within these low rainfall environments where the farm scale is large, seasons are variable, soils in the landscape can be challenging, risks are high and the effects of changing climatic patterns may well be exacerbating the issue.

The new project would need to undertake work to:

- Better understand the key dynamics, drivers and influences of this issue within a range of landscapes, soil types and rainfall areas, involving key researchers, consultants and farmers;
- Investigate and measure existing farmer sites where problems occur and where management strategies have been implemented;
- Set up well designed trial sites exploring practical and innovative management strategies which, if proved successful, can then be expanded and developed and demonstrated on farm, utilising readily available farming resources;
- Produce farmer case studies of on-the-ground experiences and practical solutions;
- Provide relatable cost / benefit analysis to all research and case study extension material;
- Engage with extension networks through farmer groups and industry bodies, websites and social media, to maximise farmer input, ownership and adoption of positive outcomes.

The project would need to last for at least 3 growing season to be able to set up and adequately analyse soil dynamics over a variety of seasonal conditions with a selection of treatment options and to promote the positive impact of successful management strategies.

It is recommended that the initial team of stakeholders, including agronomists, soil scientists, farmers, industry group, PIRSA and Landscape Board representatives, along with representative from possible funding bodies, consider the findings of this survey and continue to meet to develop this proposal as discussed.

# 7 References

Kennewell, B. M. (1999). Investigations into the Managemtnt of Dry Saline Land, PIRSA. **Technical Report Number 272**.

McDonough, C. (2020). Northern Mallee Stony Soil Degradation Investigation Project Report, SA NDB NRM.