Office Use Only

Project Code	
Project Type	

FINAL REPORT 2017

Applicants must read the *SAGIT Project Funding Guidelines 2017* prior to completing this form. These guidelines can be downloaded from www.sagit.com.au

Final reports must be emailed to admin@sagit.com.au as a Microsoft Word document in the format shown ***within 2 months*** after the completion of the Project Term.

PROJECT CODE	:	**MSF115**

PROJECT TITLE (10 words maximum)
Adopting Profitable Crop Sequences in the South Australian Mallee

PROJECT DURATION

*These dates **must** be the same as those stated in the Funding Agreement*

Project Start date	**April 2015**					
Project End date	June 2018					
SAGIT Funding Request	2014/15		2015/16		2016/17	

PROJECT SUPERVISOR CONTACT DETAILS

The project supervisor is the person responsible for the overall project

Title:	**First Name:**	**Surname:**
Mrs	Tanja	Morgan
Organisation:		
Mallee Sustainable Farming Inc.		
Mailing address:		

Telephone:	**Facsimile:**	**Mobile:**	**Email:**

ADMINISTRATION CONTACT DETAILS

The Administration Contact is the person responsible for all administrative matters relating to the project

Title:	**First Name:**	**Surname:**
Mrs	Tanja	Morgan
Organisation:		
As above		
Mailing address:		

Telephone:	**Facsimile:**	**Mobile:**	**Email:**

PROJECT REPORT

Provide clear description of the following:

Executive Summary (200 words maximum)

A few paragraphs covering what was discovered, written in a manner that is easily understood and relevant to SA growers. A number of key dot points should be included which can be used in SAGIT communication programs

The project commenced in 2015 comparing break crop performance across four soil types in the northern Mallee of SA. Trials were established from 2015 – 2017 at Waikerie and Loxton with two trials implemented at each site on contrasting soil types. The break crops trialed were field pea, vetch, chickpea, lentil, lupin and canola. Each treatment at each site was managed independently to ensure maximum potential. Gross Margins for each treatment were calculated using the January grain price from the year following each trial.

Key findings:

- The productivity of nine break crop options across three seasons and four Mallee soil types was similar. Season and soil type had a greater impact on productivity than crop choice.
- Season had the greatest impact on productivity with yields almost four times higher in a high rainfall (decile 8-10) year than in a low (decile 2-4) rainfall season.
- Break crop yields varied by up to 60 percent between soil types. Production on the deep sand was consistently poor with lentil, chickpea and faba bean yields approximately half of what was achieved on a nearby loam soil.
- The potential for high value pulses was demonstrated, with average lentil and chickpea gross margins of more than $600/ha for the three seasons
- The high yield and price variability highlights the need for a diversity of breaks crops to be available.

Project Objectives

A concise statement of the aims of the project in outcome terms should be provided.

Farmers in the low rainfall zone are looking to increase the proportion and diversity of broadleaved break crops in paddock rotations, however very little local information is available to support break crop selection and management in these environments. Furthermore, there is often extreme soil type variability within paddocks, which adds additional complexity when selecting an appropriate break crop for these farming systems.

To address these knowledge gaps, MSF with funding from SAGIT, commenced a three-year project in 2015 to compare broadleaved break crop performance across four soil types in the northern Mallee of South Australia (SA). This project compared break crop productivity and profitability on major soil types in this region to identify the most appropriate break crops for local farming systems. The aim of these trials was to provide farmers with information on the relative productivity and profitability of legume break crops for low rainfall.

Overall Performance

A concise statement indicating the extent to which the Project objectives were achieved, a list of personnel who participated in the Research Project including co-operators, and any difficulties encountered and the reasons for these difficulties.

This project has exceeded expectations in terms of the objectives and farmer engagement generated. Three very different seasons were experienced during the three project years which provides confidence that the data generated represents the lower and upper expectations of break crop productivity in the Mallee. This data has allowed us to develop productivity distributions for each crop which have been used to better understand the profitability expectations and risk of break crops grown in the Northern SA Mallee region.

We have also had the opportunity to value add to the trial sites by undertaking additional measurements through collaborating with other projects. For example, we have collaborated with Mark Peoples (CSIRO) to measure symbiotic N fixation at the Loxton flat site in 2015. We have also completed soil measurement of water, N and root disease at this same site with additional funding from Landcare.

Both trial sites at Loxton and Waikerie have been a focal point of field days and discussion by local farmers. The trials have been a drawcard at field days and crop walks organized at each site, however they have also been heavily utilized by visiting Ag Bureaus and local consultant groups who have visited the sites on private tours. Outcomes from the project have also been delivered not only at the local level but extended to the wider SA low rainfall region, for example to the southern Mallee and Eyre Peninsula region.

Overall a high quality project has been delivered through a large and effective project team. The trials were delivered by Moodie Agronomy (Michael Moodie and Todd McDonald) and SARDI (Dr Nigel Wilhelm and Peter Telfer) with support from RHO Environmentrics (Dr Ray Correll). Robin Shaefer the staff at Bulla Burra (Loxton) and Brenton Krohen (Waikerie) were also fantastic cooperating farmers who not only provided sites for the trials but helped to generate local exposure and impact with the local farming community.

Key Performance Indicators (KPI)

*Please indicate whether KPI's were achieved. The KPI's **must** be the same as those stated in the Application for Funding and a brief explanation provided as to how they were achieved or why they were not achieved.*

KPI	***Achieved (Y/N)***	***If not achieved, please state reason.***
Signing of contract and trial design completed with input from reference groups	Y	Reference group meetings held prior to trial design. Treatments consulted with industry experts. Design completed in collaboration with RHO Environmentrics
Trials sown 2015, 2016, 2017	Y	2015: Loxton, 28 April; Waikerie, 1 May 2016: Loxton, 26 May; Waikerie, 30 May

		2017: Loxton, 5 May; Waikerie, 9 May
Benchmark evaluation completed	Y	Evaluation completed with Loxton and Waikerie reference groups during year 1.
Field days 2015, 2016, 2017	Y	Field days hosted at Loxton site each year. Waikerie site visited by Lowbank Ag Bureau during winter and spring crop tours each season.
Year 1,2,3 findings presented to reference groups	Y	Findings presented to reference groups each season during Mallee Research Updates (MRU) and field days at site
Year 1,2,3 findings published in agricultural media and presented at regional forums	Y	Results published following each season in MSF R and D compendium and distributed to farmers and industry through website and MSF events (e.g. field days and conferences). Results also incorporated in Eyre Peninsula farming systems manual. Ad hoc farmer tours undertaken at trials (e.g. visiting ag Bureaus and consultant groups). Information included at various presentations within the Mallee and wider Mallee region (e.g. EPARF day and GRDC Updates).
Final report and evaluation completed	Y	Comprehensive final report completed. Evaluation undertaken with reference groups.

Technical Information (Not to exceed **three** pages)
Provide sufficient data and short clear statements of outcomes.

Methodology

Nine different broadleaved crop options were compared over three seasons (2015-2017) on four soil types commonly found in the northern Mallee region. Trials were located at Waikerie and Loxton and at each site trials were located on two contrasting soil types. A brief description of each of the four soil types is provided below:

- Loxton Flat: Red loam located in a swale
- Loxton Sand: Deep yellow sand located on the top of an east-west dune
- Waikerie Flat: Heavy red-grey soil with limestone from 20-30 cm below the surface
- Waikerie Sand: Red sandy loam located mid-slope

Table 1 shows the nine-crop type and variety treatments used in each trial. Each trial was sown after the break of the season into moist soil soon after the break to ensure successful inoculation. Trials were sown on the following dates in each season:
2015: Loxton, 28 April; Waikerie, 1 May
2016: Loxton, 26 May; Waikerie, 30 May
2017: Loxton, 5 May; Waikerie, 9 May

Each treatment at each site was managed independently to ensure that it had every opportunity to reach its potential. Agronomic management differences included herbicide choice, fertiliser rates and fungicide and pesticide applications. All trials were machine harvested across multiple dates in each season to ensure grain yield was measured soon after crops matured and to minimise losses.

Gross Margins were calculated for each treatment using the Rural Solutions Farm Gross Margin and Enterprise Planning Guide. Gross margins used the January grain price from the year following each trial (Table 1).

Table 1. Broadleaved crop and varieties compared in each trial and prices used for gross margin analysis in each season.

Crop	Variety	2015 Price ($/t)	2016 Price ($/t)	2017 Price ($/t)
Field Pea	PBA Wharton	550	350	285
Vetch	Rasina	850	300	506
Narrow-leaved Lupin	PBA Barlock	380	230	270
Albus Lupin	Luxor	380	230	270
Faba Bean	PBA Samira	560	270	315
Lentil	PBA Hurricane	1340	680	420
Desi Chickpea	PBA Striker	950	1350	800
Kabuli Chickpea	Genesis 090	1050	1450	900
Canola	Stingray	530	520	500

Productivity

Field pea production, averaged over both soil types and all three seasons, was the best with an average yield of 1.3 t/ha while albus lupins were consistently the worst yielding crop, producing an average yield of 0.6 t/ha (table 2). All other break crop option averaged between 0.8-1.1 t/ha over all seasons and soil types.

There was a high level of variation in break crop yields both between seasons and between soil types. For example, the average yield of all break crops in 2016 was nearly four times greater than in 2015 and 2017 (Table 2). The pattern of rainfall and temperatures within years was also important. In 2015, a hot and dry spring favoured crops with early maturity; field peas, vetch and lentils produced the highest average yield. In contrast frosts in August and September and significant rainfall in October 2017 favored later maturing crops with chickpea and lupins producing the highest yields.

Break crops were most productive on the loamy soil of the Loxton flat site with all break crop averaging 1.3 t/ha for the three seasons. However, average break crop yield on the sandy soil at Loxton was only 60 percent of that achieved on the loam, despite the sites being located just 250 meters apart. Lentils, chickpea and faba bean performed particularly poorly on the sandy soil, producing 50 percent of the grain yield achieved on the better soil type. At Waikerie the best production was on the sandy loam soil (Waikerie sand) with an average yield of 1 t/ha across all crops and seasons. In comparison, the average yield at the Waikerie flat site was 0.8 t/ha. However, performance at this site was highly variable with seasonal conditions, being almost as productive as the Loxton and Waikerie sand sites in 2016 but extremely poor in 2015 and 2017.

Table 2 Break crop grain yields (t/ha) on four northern SA Mallee soil types for three seasons (2015-2017)

Year	Site	Albus Lupin	Kabuli Chickpea	Canola	Desi Chickpea	Faba bean	Lentils	Narrow Lupin	Vetch	Field Pea
2015	Loxton Flat	0.3	0.4	0.5	0.5	0.8	1.0	0.7	0.8	0.6
	Loxton Sand	0.1	0.2	0.7	0.3	0.6	0.6	0.6	0.9	0.7
	Waikerie Flat	0.0	0.1	0.2	0.1	0.3	0.5	0.2	0.2	0.2
	Waikerie Sand	0.3	0.4	0.7	0.8	0.5	0.8	0.5	0.7	1.2
	Average (all sites)	**0.2**	**0.3**	**0.5**	**0.4**	**0.5**	**0.7**	**0.5**	**0.6**	**0.7**
2016	Loxton Flat	2.0	1.6	1.6	2.1	2.9	3.1	2.9	2.8	3.0
	Loxton Sand	0.6	0.6	1.0	0.9	1.5	0.9	2.1	2.0	1.7
	Waikerie Flat	1.0	1.2	1.5	1.6	1.6	2.5	1.8	1.8	3.6
	Waikerie Sand	1.0	2.5	1.6	2.4	1.7	1.9	1.5	2.2	3.2
	Average (all sites)	**1.2**	**1.5**	**1.4**	**1.8**	**1.9**	**2.1**	**2.1**	**2.2**	**2.9**
2017	Loxton Flat	0.7	1.0	0.7	1.0	0.9	0.9	1.3	0.8	0.7
	Loxton Sand	0.5	0.4	0.5	0.4	0.2	0.3	1.2	0.7	0.4
	Waikerie Flat	0.1	0.4	0.4	0.3	0.4	0.3	0.3	0.3	0.3
	Waikerie Sand	0.1	0.5	0.5	0.5	0.1	0.2	0.5	0.5	0.6
	Average (all sites)	**0.4**	**0.6**	**0.5**	**0.5**	**0.4**	**0.4**	**0.8**	**0.6**	**0.5**
	Average (all years)	***0.6***	***0.8***	***0.8***	***0.9***	***1.0***	***1.1***	***1.1***	***1.1***	***1.3***

Profitability

The standout outcome from these trials was the high profitability of chickpea and lentils (figure 3). Chickpeas (Desi and Kabuli) and lentils averaged more than $600/ha across the three seasons with these options averaging $1000-2000/ha in 2016 when high yield and prices coincided.

Vetch, field pea and canola also produced good gross margins over the three trial years with gross margins of $300, $250 and $200/ha respectively. Field pea had the most variable profitability of all crops, ranging from $700/ha in 2016 to -$50/ha the following season.

The profitability of narrow leaf lupin and faba beans was moderate, averaging approximately $100/ha. Despite producing nearly twice as much grain as lentils and chickpea on the Loxton sand, the overall profitability of lupins was only half of these crops at this site.

The benefit of high value crops was also evident in the lower rainfall seasons. In 2015, lentils produced a gross margin of over $700/ha despite moderate yields (0.7 t/ha across all sites) because their price was $1340/t at the time. However, lentils only just broke even in 2017 when their price had dropped from 2015 levels by nearly $1000/t.

Profitability varied by more the 50 percent between soil types. On the Loxton flat, the average gross margin across all crops for the three seasons was $500/ha which was 60 percent more than the gross margin of crops on the sandy soil. At Waikerie, the average gross margin of all crops on the sandy loam soil was $450/ha, which was 50 percent greater than the profitability of crops grown on the flat. Break crop profitability was highly variable on the flat with large gross margins produced by canola, field pea, lentil and chickpea in the favorable 2016 season,

however only lentils in 2015 produced a gross margin greater than $50/ha in the lower two rainfall years.

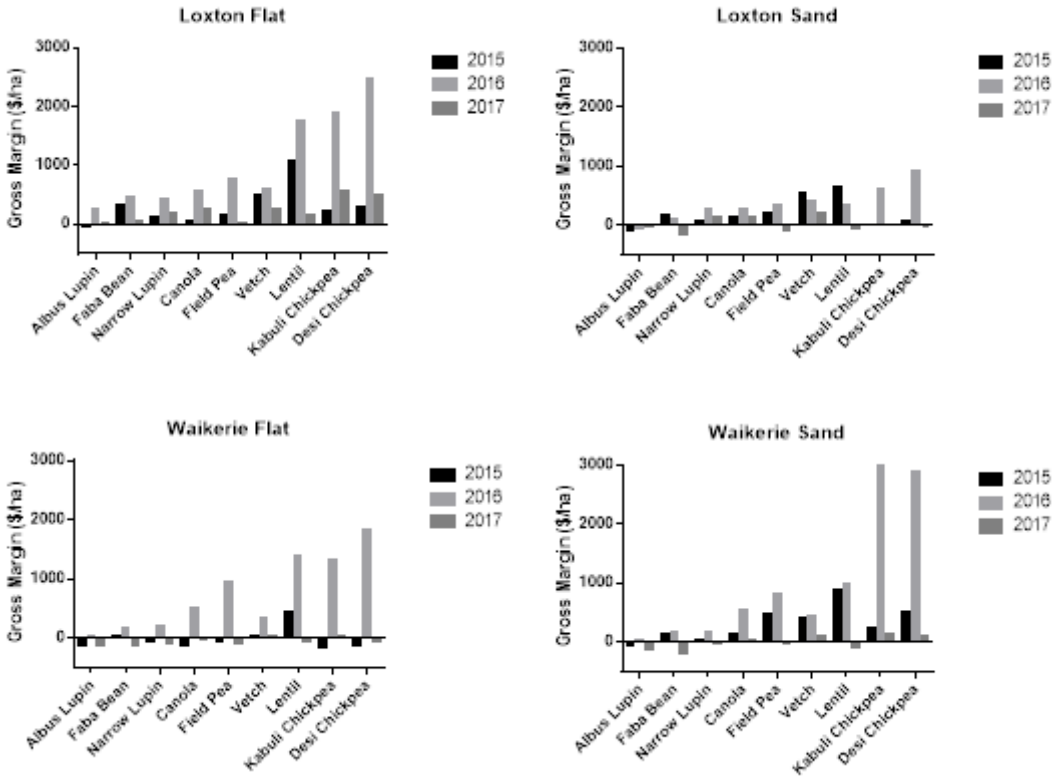


Figure 1 Break crop gross margins on four northern SA Mallee soil types for three seasons (2015-2017)

Conclusions Reached &/or Discoveries Made (Not to exceed one page)

Please provide concise statement of any conclusions reached &/or discoveries made.

This project highlights that a high level of diversity is desirable when integrating break crops. Overall, most break crops had similar productivity potential, however the yields achieved in any one season were highly influenced by seasonal conditions (e.g. amount and distribution of seasonal rainfall, frost and heat events) and soil type.

Season had the greatest impact on break crop productivity with yields almost four times more in a high rainfall (decile 8-10) year than in a low (decile 2-4) rainfall season. Break crop yields also varied by up to 60 percent between soil types. Production on the deep sand was consistently poor with some yields approximately half of what was achieved on a nearby loam.

In these trials, price had a greater influence on the profitability of the break crops than productivity. High prices received for lentils and chickpeas during the past three years resulted in some exceptionally high gross margins for these crops which demonstrated that high value crops have a fit in the low rainfall Mallee farming systems. However, farmers need to be mindful of the volatility of pulse crop markets, as demonstrated by lentils, whose price fluctuated by nearly $1000/ha over the duration of the trials.

To further understand the financial risk of growing break crops, a long-term gross margin analysis was undertaken using @Risk. Gama distributions were created for the grain yield of each crop using the 12-soil type x season yield outcomes that were generated during the

project. Price distributions were developed using long term (2003 – 2017) January grain prices from the Rural Solutions SA gross margin guide. The yield and price distributions were used to undertake 5000 iterations to generate a new gross margin distribution for each crop.

The @Risk simulations showed that lentils are not only the most profitable break crop but are also the least risky (Table 3). The average gross margin from lentils is $500/ha and a negative return from growing lentils is expected in only 14% of seasons. Lentils and chickpea both produced an average gross margin of more than $600/ha during the project, however the @Risk simulations show the probability of this outcome occurring again is much less for chickpea than lentils. The average chickpea gross margin from the 5000 iterations was $217/ha and the probability of exceeding $500/ha gross margin in anyone season is just 18%, which is 20% less than lentils.

Vetch was the next most profitable break crop with an average gross margin of $300/ha. However, caution is needed in interpreting the true value of vetch as grain is predominantly sold for seed to plant fodder and hay crops. Therefore, while there have been some high prices received for vetch in recent years, the grain market is limited and becomes easily flooded, which is not reflected in the @Risk simulation.

Field pea has similar profitability to chickpea, however has lower downside risk with a profitable gross margin expected in three out of four seasons (Table 3). Interestingly canola and lupin have a similar profitability and risk profile with both crops having a low percentage of years where a gross margin of more than $500/ha is achieved. Lupins rarely achieve high prices while canola is not able to maximize yield in high rainfall seasons as yield is capped by nitrogen inputs. Faba bean was both the lowest profitability and highest risk option with a average gross margin of just over $100/ha and would fail to break even in 44% of seasons.

Table 3. Mean gross margins for each crop generated with @Risk simulations. And the probability of gross margin which are less than $0/ha or greater than $500/ha.

Crop	Mean	Probability <$0/ha	Probability $0 - $500/ha	Probability >$500/ha
Lentil	498	14%	49%	38%
Vetch	300	16%	63%	22%
Chickpea	217	36%	47%	18%
Field Pea	212	25%	60%	15%
Canola	157	21%	73%	6%
Narrow Lupin	132	29%	66%	5%
Faba Bean	114	44%	46%	10%

Intellectual Property

Please provide concise statement of any intellectual property generated and potential for commercialisation.

Nil

Application / Communication of Results

A concise statement describing activities undertaken to communicate the results of the project to the grains industry. This should include:

- *Main findings of the project in a dot point form suitable for use in communications to farmers;*
- *A statement of potential industry impact*
- *Publications and extension articles delivered as part of the project; and,*
- *Suggested path to market for the results including barriers to adoption.*

Note that SAGIT may directly extend information from Final reports to growers. If applicable, attach a list of published material.

The grains industry has been keep well informed of the project objectives and outcomes. Trial results have been published each year in MSF R and D Compendium which is available for download from the MSF website and has been distributed at events such as field days and forums.

Regular presentations of project results were also completed at MSF Mallee Research Updates (MRU), Ag Bureau meetings and Ad hoc events such as GRDC updates. Furthermore, the project outcomes have been communicated not only in the northern SA Mallee but throughout the wider low rainfall zone of South Australia.

The trials have been the focal point of regional field days and crop walk with a formal event held at each site in each year. However there have been many other informal and ad hoc visits to the site with consultant groups and visiting Ag Bureaus regularly visiting the sites over the last three years.

Publication links

http://www.msfp.org.au/identifying-productive-profitable-break-crop-options-lrz
http://www.msfp.org.au/comparing-break-crop-performance-sa-mallee-2
http://www.msfp.org.au/comparing-break-crop-performance-in-the-sa-mallee

Key Messages

- The productivity of nine different break crop options across three seasons and four northern SA Mallee soil types was similar. Season and soil type had a greater impact on productivity than crop choice.
- Season had the greatest impact on break crop productivity with yields almost four times more in a high rainfall (decile 8-10) year than in a low (decile 2-4 varied) rainfall season.
- Break crop yields varied by up to 60 percent between soil types. Production on the deep sand was constantly poor with lentil, chickpea and faba bean yields approximately half of what was achieved on a nearby loam soil.
- The potential for high value pulses to be used by Mallee farmers was demonstrated by these trials, with average lentil and chickpea gross margins of more than $600/ha for the three seasons
- The high yield and price variability demonstrated in these trials highlights the need for a diversity of breaks crops to be available for northern SA Mallee farming systems.

Evaluation findings

A pre and post project evaluation was conducted with the same group of farmers to determine if there had been practice change over the life of the project. MSF was also keen to learn if the trial site activities had been worthwhile.

The results of the evaluation showed that:

- In 2015 legumes made up 16.8% of the cropping program compared to 22% in 2018. A larger percentage may have been recorded in 2018 with a better start to the season.
- The main break crops grown in 2015 were peas, vetch, canola and lupins and by 2018 chickpeas had been added to the rotation by 30% of growers.
- All respondents had visited the trial site at either Waikerie or Loxton or both and rated it 8.4/10 for usefulness in learning more about how to grow legume crops.
- Growers responded that in the future the percentage of crop area sown to legumes will average at 24.5% but the range is anywhere between 10-40%.

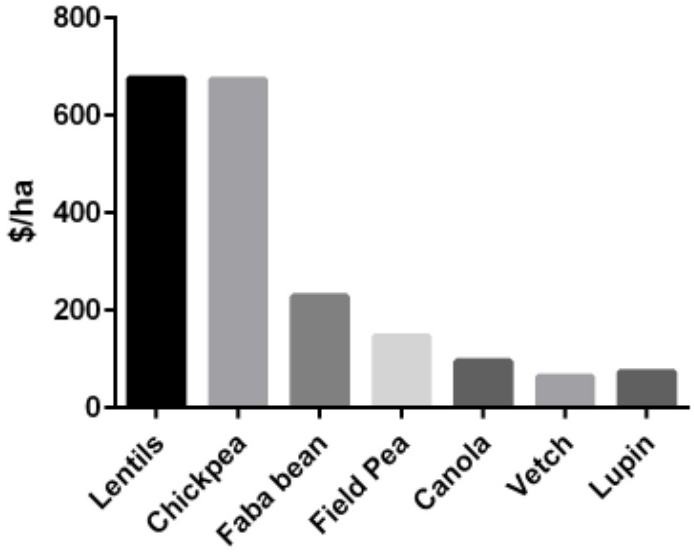
POSSIBLE FUTURE WORK

Provide possible future directions for the research arising from the project including potential for further work and partnerships.

As the area of break crops such as lentils and chickpeas expand in the northern SA Mallee region, farmers are finding that productivity is extremely poor on the regions deep sandy soils which often comprise a significant (e.g. 30%) portion of Mallee paddocks. In the three years of trials at Loxton, the productivity on the deep sandy soil within the paddock was approximately half of what was achieved on a nearby loam soil. This led to large profitability differences between the two soil types with lentils and chickpea gross margins averaging $675/ha less on the deep sandy soil than on the loamy soil within the same paddock (Figure 2)

We have consulted with researchers, consultants and farmers to identify a range of opportunities to increase break crop production on sand. These options include genetic traits, herbicide management, improved inoculation, seeding systems, soil amelioration strategies and nutrition strategies. More work needs to be done with break crop performance on sands to ensure growers are not deterred from growing break crops due to sandy soil variation in paddocks.

Figure 2. Average difference in gross margin between loam and deep sand soils at Loxton over three seasons (2015-2017)



AUTHORISATION
Name: Tanja Morgan
Position: Program Manager
Signature:
Date: 28.8.18

Submit report via email to admin@sagit.com.au as a Microsoft Word document in the format shown ***within 2 months*** after the completion of the Project Term.