ECONOMIC IMPACT OF FERAL PIGS ON AGRICULTURAL PRODUCTION IN NW NSW

Final report including 2022-23 seasonal analysis

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Final report: Economic impact of feral pigs on agricultural North West NSW

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Executive Summary

The agricultural impact of feral pigs has been estimated to have risen for three consecutive years in the productive agricultural region of North West NSW. This final study in a series of three has estimated that from July 2022 to June 2023 (Winter 2022 and Summer 2022-23) agricultural production experienced a $62 million loss attributed to feral pigs, a 32% increase on the first study year.

The analysis looked at 12 of the highest value agricultural enterprises in the region prone to feral pig damage and considered seasonal inputs including regional yields, commodity prices and estimated damage caused by feral pigs. The seasonal data was underpinned by a survey of landowners (see Section 2) and agronomists in the region. The enterprises included within the survey, key inputs and the mean results are shown in in Table 1.

Table 1: Analysis results by enterprise and mean inputs (and change from previous years analysis)

Enterprise	Economic loss ($/ha)	Key mean inputs			Economic loss (NW NSW Region) ($ million)
		Anticipated damage by feral pigs (% of yield)	Regional yields	Commodity prices	
Barley for grain	*35* ↑	*3.25* ↑	*2.92 t/ha* ↓	$371/t ↑	5.65 ↓
Canola	*23* ↓	*1.53 =*	*2.0 t/ha* ↓	$763/t ↓	2.45 ↑
Chickpeas	*23* ↓	*2.92* ↑	*1.25 t/ha* ↓	$641/t ↑	2.14 ↓
Cotton lint (irrigated)	*50* ↓	*0.63* ↓	*12.33 bales/ha* ↑	$642/bale ↓	7.78 ↓
Cotton lint (dryland)	*12* ↓	*0.63* ↓	*3.04 bales/ha* ↓	$642/bale ↓	1.76 ↓
Faba beans	*33* ↑	*3.42* ↑	*2.3 t/ha* ↓	$414/t ↑	1.31 ↑
Grain in storage (bags & bunkers)	*4* ↓	*2.09* ↓		$455/t ↑	2.51 ↓
Hay	*19* ↓	*3.40* ↓	*2.5 t/ha* ↓	$222/t ↑	0.25 ↓
Maize for grain	*79* ↑	*1.65* ↑	*10.5 t/ha* ↑	$320/t ↑	0.74 ↑
Oats for grain	*12* ↑	*2.62 =*	*1.38 t/ha =*	$330 ↑	0.36 ↑
Sheep for meat & wool	-	*12.0* ↑	94% weaning rate	Lambs $171/hd ↓	10.16 ↑
Sorghum for grain	*55* ↑	*3.44* ↑	*4.0 t/ha* ↑	$402/t ↑	10.41 ↑
Wheat for grain	*17* ↑	*1.30* ↑	*2.85 t/ha* ↓	$447/t ↑	16.84 ↑
Total regional losses Winter 2022 & Summer 2022-23					**$62.35 million** ↑

The method considered the high level of variability by using @Risk where inputs used are a probability distribution rather than a fixed value. Appendix 1 outlines each input distribution.

The region experienced another strong season with summer yields in the study period higher across all enterprises, winter yields slightly lower (but still above average) due to an unusually wet winter including widespread late season flooding. Feral pig losses were estimated higher for most enterprises (barley, chickpeas, faba beans, maize, sorghum, sheep and wheat). Commodity prices remained higher than average for all crops other than canola and cotton. The study's results indicated that the highest per hectare enterprise losses would be incurred for the Summer 2022-23 irrigated crop of maize returning a loss of $79 /ha attributed to feral pigs, up to six times higher than the other crops. The result is attributed to the high commodity value, high per hectare yields of the crop combined with the modest yield loss sustained from feral pigs. The oats enterprise had the lowest per hectare economic loss of $12, attributed to the relatively low commodity price, and modest yield and loss associated with feral pigs.

Wheat experienced relatively low per hectare losses due to feral pigs, but accounted for 27% of regional losses as a result of half the cropping area being planted to wheat. Regionally, sorghum, sheep and cotton also experienced significant losses. These results highlight that regionally feral pigs are causing large economic losses not just in high value crops.

Regionally, lamb losses in sheep enterprises were estimated at just over $10 million. This was calculated using a 12% lamb loss rate from the farmer surveys and an opportunity cost of $171 /hd for each lamb lost. The regional loss was calculated using estimated lamb numbers for the region. Per hectare or individual enterprise losses vary depending on flock size and stocking rates, hence per hectare losses were not tabled.

Regional losses are expected to fluctuate from year to year depending on hectares planted, yields and commodity prices; however, the three year trend has shown increased losses.

Results of the studies annual primary survey with rural land holders in the region indicated a marked increase in feral pig abundance during the 3-year project period. In Winter 2020, 90% of respondents (n=67) reported feral pig presence on their properties with 19% reporting a *High* feral pig abundance, by Summer 2022-23, 100% of respondents (n=49) had feral pigs present on their properties and 63% reported the abundance as *High*. The increased abundance is in line with DPI feral pig mapping (Figure 1).

100% of respondents attempted to control feral pigs during the final study period using an increased range of control methods. The consistent message from respondents was that despite a concerted increase in feral pig control activities the population had continued to grow and expand. Respondents noted the success of LLS managed control programs in reducing feral pig numbers and requested further government resourcing to continue fighting the increasing issue of feral pigs.

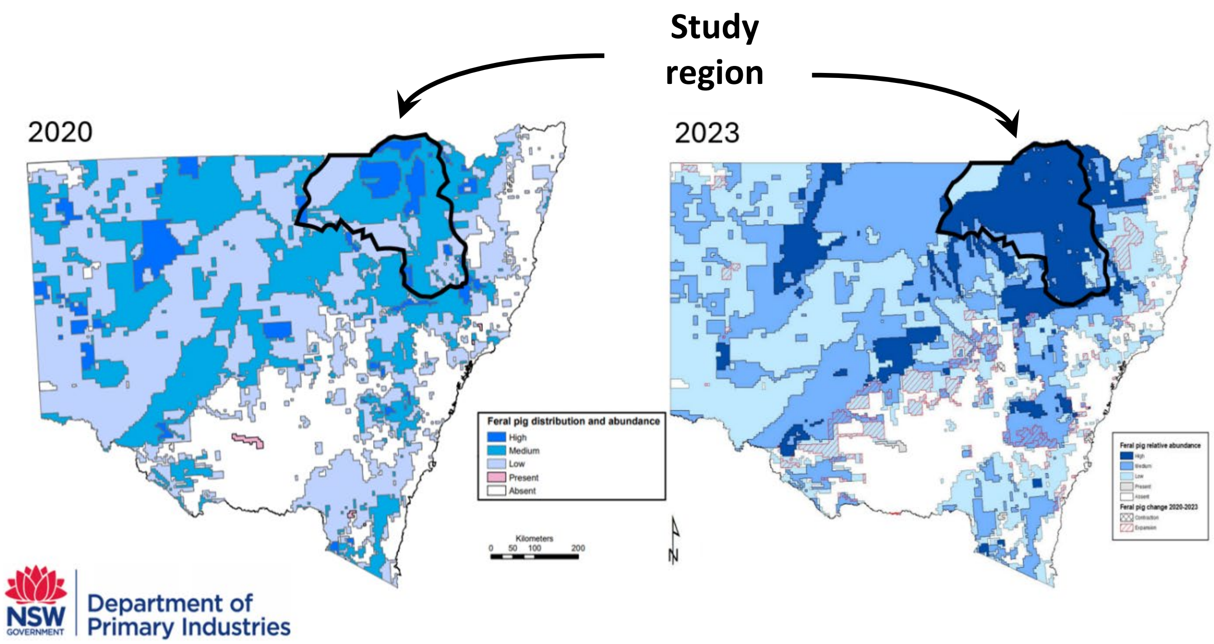
Contents

Background

In 2020, LLS commissioned a three-part series on the annual economic impact of feral pigs to agricultural production in North West NSW. This is the third and final report in the series that includes analysis considering economic losses specifically for the Winter 2022 and Summer 2022-23 seasons in the study area of North West New South Wales Natural Resource Management Region (NW NSW), and a final discussion on the trends and findings across the three year analysis.

NSW DPI periodically creates maps for key vertebrate pests including feral pigs. Feral pig abundance mapping for NW NSW at the beginning of the three year study (2020) indicated feral pigs were generally present in medium to high abundance, with some of the southern area experiencing low feral pig abundance (Figure 1). At the end of the study (2023) feral pig abundance had increased significantly, with abundance reported as 'High' across most of the NW NSW region. The increase in population can be attributed to three consecutive wetter than normal seasons, creating an abundance of food, water and shelter. Under these favourable conditions, breeding can occur throughout the year and sows can produce two weaned litters every 12 months, with up to ten piglets per litter. Sows can breed from six months of age, meaning in consecutive good seasons (such as 2020-2023) the population can explode.

Figure 1: Feral pig distribution and relative abundance (DPI 2020 and DPI 2023)



The increase in feral pig population increases the potential for economic loss to the regions agriculture. Agricultural enterprises in NW NSW are dominated by broadacre cropping of cereal, pulse and lint as well as grazing enterprises. Feral pigs cause yield loss in both winter and summer crops by consuming the crop itself or by using the crop as a habitat, where they often root, trample and wallow, destroying the plants.

Within livestock enterprises, feral pigs compete for food sources such as hay, pastures and grains and also pose a biosecurity threat as a host and carrier of disease, including endemic and also exotic threats such as foot-and-mouth disease (if it were to reach Australia). ABARES has estimated the cost of a multi-state outbreak of the highly infectious disease (that affects cloven-hoofed animals such as cattle, sheep, pigs and goats) to be around $80 billion over 10 years (ABARES, 2022). Within sheep enterprise, losses attributed to feral pigs come predominately in the form of lamb losses due to pig predation.

Under the Biosecurity Act 2015 framework, biosecurity is a shared responsibility where government, industry and the people of NSW work together to protect the economy, environment and community from the impacts of pest animals.

This shared responsibility means:

- public, private and Aboriginal land managers all have a shared and equal responsibility to eliminate and minimise biosecurity risks across land in NSW.
- a key focus of the RSPAMP is to encourage engagement and participation across all land tenures to enhance the participation and delivery of coordinated pest animal management activities for improved outcomes.
- government plays a key role in the coordination and regulation for pest animal management under the legislative framework. NSW DPI have a lead role in managing terrestrial and freshwater aquatic pest incursions. LLS supports the delivery of pest animal management activities and also has a regulatory role under the NSW Biosecurity Act 2015.

Key roles of LLS in relation to invasive species include:

- providing capacity building and technical advice
- facilitating the planning, implementation and review processes from appropriate entities as a method of stakeholder consultation for strategic planning
- distributing the vertebrate pesticide 1080 (sodium fluoroacetate) and providing associated training for land managers
- coordinating large-scale across-tenure pest animal control programs with associated land manager communication and compliance activities as necessary
- supporting applied research and extension of latest research results.

SECTION 1: Economic impact of feral pigs on agricultural production in North West NSW, Winter 2022 & Summer 2022-23.

Method

The method used for this analysis reflects that of *Cost benefit analysis of feral pig control in North West NSW* (Powell et al., 2020) and the following two seasonal analyses *Economic impact of feral pigs on Agriculture in North West NSW: 2020-21* (Powell and Revell, 2021) and *Economic impact of feral pigs on Agriculture in North West NSW: 2021-22* (Powell and Revell, 2023). This analysis continues the study by focusing on the Winter 2022 and Summer 2022-23 timeframe.

The top agricultural enterprises in the study area by value (affected by feral pigs) in 2020-21 (the most recent available data) were wheat, cotton (irrigated and dryland), cattle, barley, chickpeas, sorghum, sheep (wool and meat), canola, hay, faba beans and oats (ABS, 2021). The largest threat of feral pigs to cattle enterprises is their potential to host and spread disease, however this complex issue has not been valued, so cattle enterprises were excluded from this analysis. Table 2 outlines the enterprises included in the analysis, average regional yields, commodity price, hectares estimated within NW NSW and the subsequent losses associated with feral pigs. As this is the third analysis in a series of three, arrows indicate if the values are higher or lower than the second report.

The modelling approach incorporated @RISK (a risk analysis package for excel), that captures the high level of potential variation in underlying inputs by using a distribution in place of a static value. The distribution reflects the range of possible values and the probability of them occurring. @Risk uses Monte Carlo stochastic simulation which allows the model to sample random numbers from the distribution to generate results. The model repeated this process twenty thousand times to create a probability distribution for each result that displays the range of possible values and the probability of them occurring.

This report focuses retrospectively on the 12 months from July 2022 to June 2023. The variables modelled (and their data sources) are listed below, their distribution graphs and statistics can be found in *Appendix 1: @RISK model input distributions.*

- NW NSW regional yields Winter 2022, Summer 2022-23 (data sourced from local farms and agronomists, Cotton Australia and Digital Agricultural Services (DAS, 2023) and ABARES (2023). Noting widespread and prolonged flooding in the region reduced yields for Winter 2022.
- NW NSW estimated pig damage Winter 2022, Summer 2022-23 (data sourced from the grower survey in Section 2 and local agronomist surveys)

- Commodity prices during the study period (data sources; barley, canola, chickpeas, faba beans, hay, maize, sorghum & wheat – *The Land commodity prices*. Cotton lint – *mixed cotton merchants,* lamb – MLA)
- Hectares planted to each enterprise within the region. Due to changes in reporting, ABS cropping data for the region was no available, Digital Agricultural Services (DAS, 2023) was engaged to provide these estimates.
- Effectiveness of each control method (data from (Powell et al., 2020))
- Cost of each control method was increased by 15% from the previous year.

Table 2: Analysis inputs: mean enterprise yield, price, regional ha's and estimated loss attributed to feral pigs. Arrows indicate increase or decrease compared to the previous year's analysis).

Enterprise	**Yield^**	**Estimated loss (% of yield)^**	**Commodity price****	**HA in NW NSW Region#**
Barley for grain	*2.92 t/ha* ↓	*3.25* ↑	$371/t ↑	160,000 ↓
Canola	*2.0 t/ha* ↓	*1.53 =*	$763/t ↓	105,000 ↑
Chickpeas	*1.25 t/ha* ↓	*2.92* ↑	$641/t ↑	92,000 ↓
Cotton lint (irrigated)	*12.33 bales/ha* ↑	*0.63* ↓	$642/bale ↓	156,000 ↑
Cotton lint (dryland)	*3.04 bales/ha* ↓	*0.63* ↓	$642/bale ↓	144,000 ↓
Faba beans	*2.3 t/ha* ↓	*3.42* ↑	$414/t ↑	40,000 =
Grain storage (bags & bunkers)		*2.09* ↓	$455 /t ## ↑	
Hay	*2.5 t/ha* ↓	*3.40* ↓	$222 /t ↑	13,000 ↓
Maize for grain	*10.5 t/ha* ↑	*1.65* ↑	$320/t ↑	9,000 ↓
Oats	*1.38 t/ha =*	*2.62 =*	$330 ↑	30,000 =
Sheep enterprises	94% weaning rate	*12.0* ↑	Lambs $171 /hd ↓	600,000 lambs ↑ marked in NW NSW
Sorghum for grain	*4.0 t/ha* ↑	*3.44* ↑	$402/t ↑	188,000 ↑
Wheat for grain	*2.85 t/ha* ↓	*1.30* ↑	$447/t ↑	1,016,000 ↓

Information source:
^Local agronomists, farmers, Digital Agricultural Services (DAS, 2023) and ABARES (2023). Noting widespread and prolonged flooding in the region reduced yields for Winter 2022.
^^ Grower survey (Section 2)
***The Land commodity prices (accounting for freight differentials to NW NSW), MLA and mixed cotton merchants.*
 # Digital Agricultural Services (DAS, 2023), MLA
An average grain price of (wheat, barley, faba beans, chickpeas and sorghum) used for stored grain.

Grain lost to feral pigs in temporary storage such as bags and bunkers is incurred when feral pigs chew holes in tarps and grain storage bags to eat the grain. Losses include the grain that is eaten, but more significantly the grain that is weather damaged (it becomes rotten when rain enters through the holes). Survey respondents (Section 2) reported the total tonnage of grain in storage and the estimated tonnage lost due to feral pig damage. Estimated losses were 2.09% of total grain stored. To value the stored grain, an average grain price was applied derived from; wheat, barley, faba beans, chickpeas and sorghum. The value of the stored grain losses was divided by the total cropped hectares of respondents within the survey that used grain bags to give an estimated per hectare value to stored grains losses.

The calculations in this study are based on information (regional yields and estimated pig damage) obtained from agricultural businesses that responded to the survey. However, since not all businesses in the region provided data, the estimates are subject to sampling variability; that is, they may differ from the figures that would have been produced if information had been collected from all operating businesses.

Calculations used

The following formulas were applied to the analysis to derive economic loss and benefits of control outcomes:

Cropping economic loss (per ha) $= yield\ loss\ attributed\ to\ feral\ pigs\ x\ commodity\ price$

Grain storage loss (per ha) = $\frac{tonnage\ loss\ attributed\ to\ feral\ pigs\ x\ stored\ grain\ price}{total\ hectares\ of\ farms\ using\ temp\ grain\ storage}$

Sheep enterprise regional economic loss =$yield\ loss\ attributed\ to\ feral\ pigs\ x\ opportunity\ cost$

Where *sheep enterprise opportunity cost* $=\ lamb\ price\ x\ 23kg\ x\ lambs\ in\ the\ region$

Benefit of control (per ha)

Yield benefit

$$= enterprise\ yield\ x\ (losses\ attributed\ to\ feral\ pigs\ x\ control\ method\ effectiveness)$$

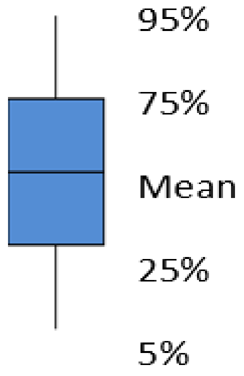
Economic benefit of control

$$= (Yield\ benefit\ x\ commodity\ price) - cost\ of\ control\ method$$

To understand the potential regional economic losses, the enterprise economic losses were multiplied by the estimated hectares within the region for each enterprise found in Table 2. In the 2020 and 2021 impact reports (Powell and Revell, 2021, Powell et al., 2020) ABS cropping data was available at a *Statistical Area Level 2* (that closely reflected LGA level data), for this 2022-23 model ABS cropping data was no available, so Digital Agricultural Services (DAS, 2023) was engaged to provide estimated areas planted to each crop.

The analysis results are displayed in box and whisker plots to reflect the reality of variable results between farms; these graphs highlight the range and probability of a result occurring. The box and whisker plot (Figure 2) displays the results that fall between the 5th and 95th percentile. These plots exclude the upper and lower "tails" which are more likely to contain outliers (i.e. there is a 90% probability that the result will occur within this range). The box and whisker plots also show the 75th and 25th percentiles, and the mean (average) result. Inputs and results displayed in the summary tables are the mean results.

Figure 2: Box whisker plot example



By considering the full range of potential values for each input variable, @RISK can clearly identify the extent to which the results are sensitive to each model variable.

Results

Modelling results indicated a range of estimated economic losses attributed to feral pig damage. Table 3 outlines by enterprise the mean economic losses per hectare and an estimated absolute regional economic loss by enterprise for winter 2022 and summer 2022-23 seasons.

Table 3: Mean economic losses by enterprise. Arrows indicate increase or decrease compared to the previous year's analysis.

Enterprise	Economic loss ($/ha)	Commodity loss (NW NSW Region)	Economic loss (NW NSW Region) ($ million)
Barley for grain	*35* ↑	15,000 t ↓	5.65 ↓
Canola	*23* ↓	3,000 t ↑	2.45 ↑
Chickpeas	*23* ↓	3,000 t ↓	2.14 ↓
Cotton lint (irrigated)	*50* ↓	12,000 bales =	7.78 ↓
Cotton lint (dryland)	*12* ↓	3,000 bales ↓	1.76 ↓
Faba beans	*33* ↑	3,000 t =	1.31 ↑
Grain in storage (bags & bunkers)	*4.5* ↓	52,000 t ↑	2.51 ↓
Hay	*19* ↓	1,000 t ↓	0.25 ↓
Maize for grain	*79* ↑	2000 t ↑	0.74 ↑
Oats for grain	*12* ↑	1000 t =	0.36 ↑
Sorghum for grain	*55* ↑	23,000 t ↑	10.41 ↑
Sheep for meat & wool	-	70,000 lambs ↑	10.16 ↑
Wheat for grain	*16.5* ↑	38,000 t ↑	16.84 ↑
REGIONAL TOTAL			**$62.35 million** ↑

The 'in-crop' economic losses per hectare ranged from $12 to $79 and were influenced by a combination of the yield loss incurred due to feral pigs, the yield of the enterprise and the commodity price. Within the region, maize is a high yielding, high value crop. Even with a relatively low per hectare yield losses attributed to feral pigs (1.65%), the value of losses in irrigated maize (79 /ha) were up to 6 times that of other enterprise losses. Cotton, also a high yielding irrigated crop, but with lower yield losses (0.63%) attributed to feral pigs than Maize, experienced losses of $50 /ha. The oats enterprise had the lowest per hectare economic loss of $12 /ha. This is attributed to the relatively low commodity price, modest yield and loss associated with feral pigs. Losses associated with grain storage were calculated to be valued at $4.50 /ha and accounted for grain lost (due to feral pigs) in temporary storage such as grain bags and bunkers.

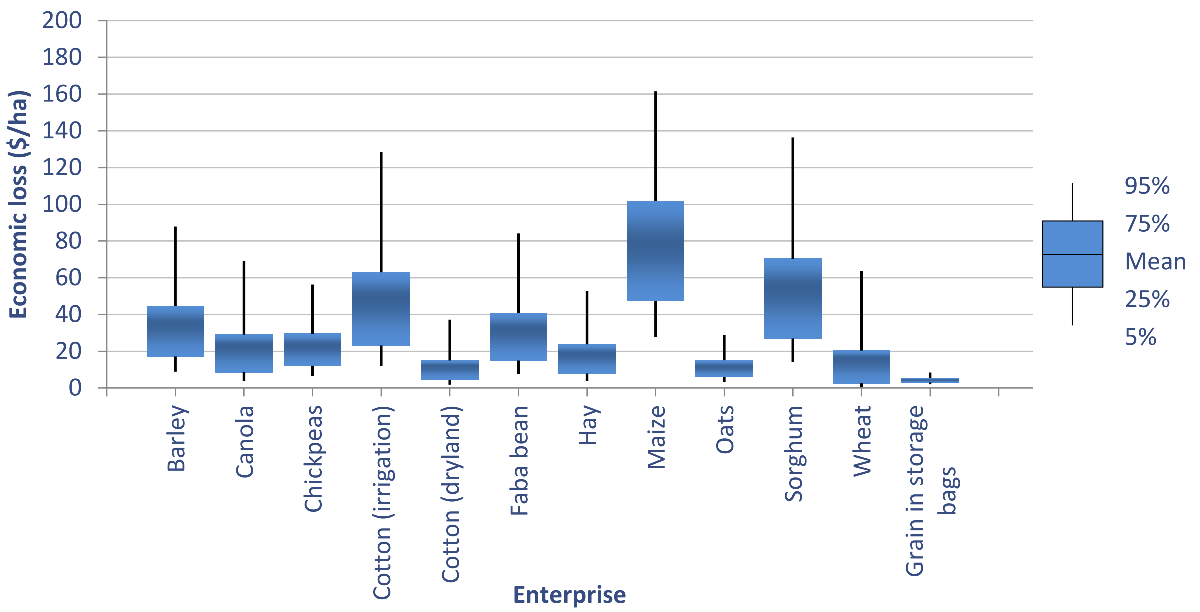
Regional commodity losses are in terms of total tonnes estimated to be lost due to feral pig (except for cotton which is expressed as bales per hectare and sheep expressed as total number of lambs lost). Wheat production experienced the largest absolute commodity losses during the 2022-23 season.

Building on the 'in-crop' losses, the regional commodity losses were also sensitive to the area planted to the crop during the study period. Wheat was estimated to be planted to just over 1 million ha during the season equating to 50% of land in the region used for cropping. Across the enterprises included within the study, regional commodity losses were calculated to be 93,000 tonnes of grain 'in crop' and 44,000 tonne of grain in storage plus, 15,000 bales of cotton and 70,000 lambs.

Economic losses at a regional level attributed to feral pig damage was calculated to be $62 million for NW NSW in the 12 months that included Winter 2022 and Summer 2022-23 cropping. During the analysis period, cotton (both irrigated and dryland) accounted for 15% of regional losses, lambs 16% and wheat 27%. The regional losses by enterprise are most sensitive to the prevalence of the enterprise in the region and the value of the crop.

When the potential range of inputs (yield, yield loss and commodity price) are considered, results are displayed as a probability distribution. The distribution of the per hectare economic loss are displayed in Figure 3. On a per hectare basis, the results are most sensitive to changes in the actual yields achieved in the region and the estimated losses attributed to feral pigs. A wide range is expected in both variables due to differing environmental aspects across farms. These include farming rotations, rainfall, disease pressures and abundance of feral pigs. Economic losses are lowest (along the lower tail) when crops achieving poor yields, prices, or experience low levels of feral pig damage. Economic losses are highest (along the upper tail) when crops achieve above average yields, commodity prices and/or experience high damage from feral pigs.

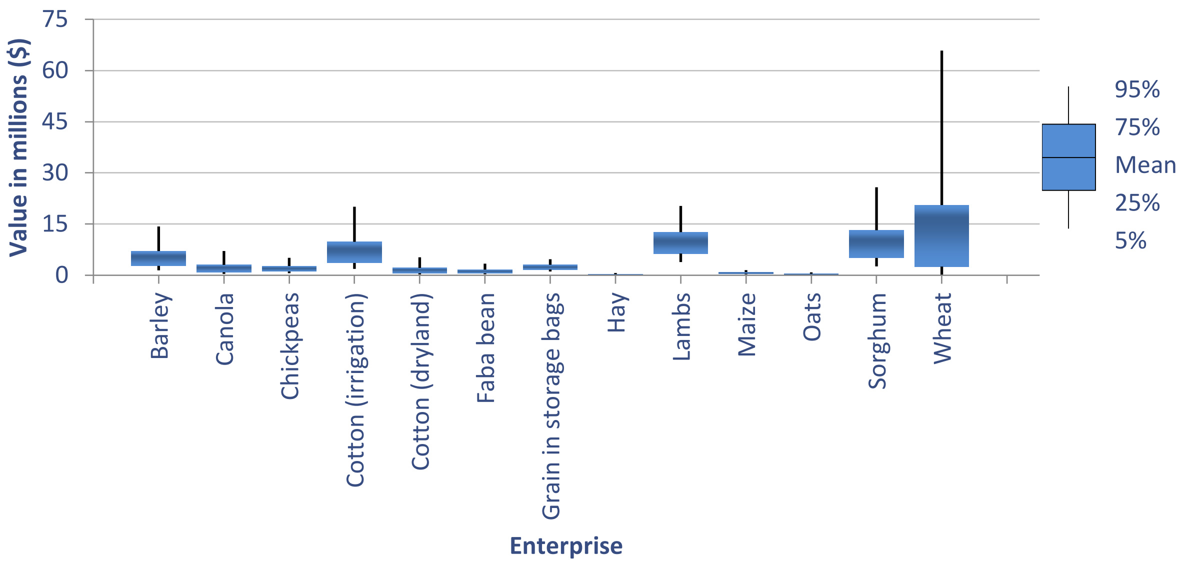
Figure 3: @RISK results. Agricultural losses ($/ha), box whisker chart



The high yielding irrigated maize was the standout enterprises with the largest range of per hectare estimated losses and 90% of results between $28 to $161. Experiencing the next largest ranges were the summer enterprises of sorghum and irrigated cotton, with 90% of results between $14 and $136 /ha economic loss. With a lower range of losses barley, canola, chickpea, cotton (dryland), faba beans, hay and wheat reported 90% of results between $0.10 and $88 /ha economic loss.

With stored grain, 90% of estimated losses were between $2 to $8 /ha. There is a higher degree of uncertainty for this part of the analysis as several assumptions were made based on the survey data that may not accurately reflect the regional average. For example, the number of hectares associated with each stored tonne of grain and the number of hectares that would utilise grain bags or bunkers.

Figure 4: @RISK results (regional economic losses), box whisker chart

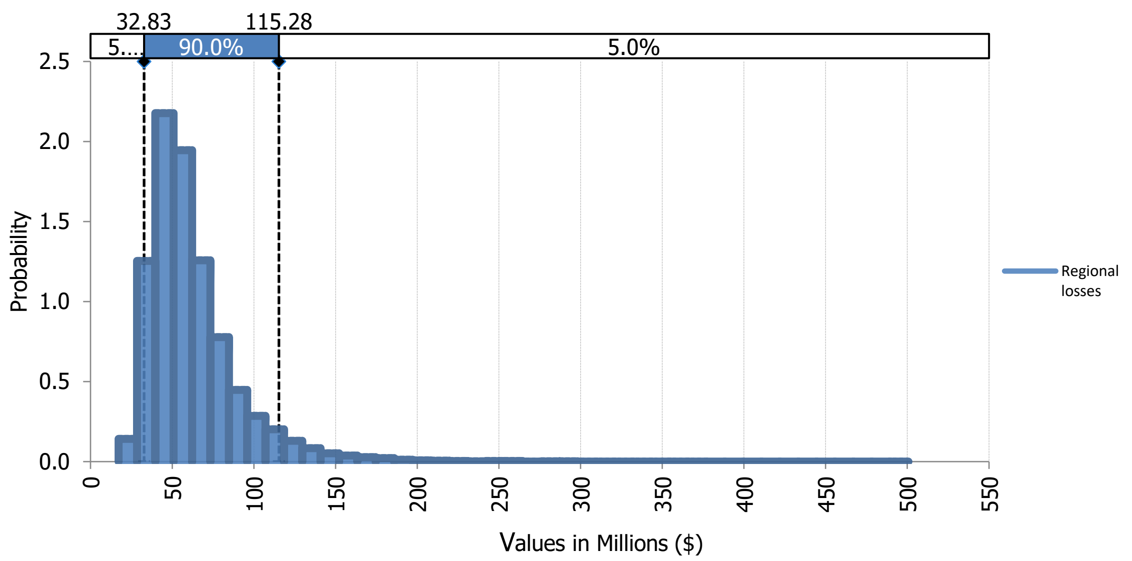


Total economic losses at a regional level (Figure 4) were calculated combining the per hectare losses with the area planted to an enterprise during the study period. In the case of lambs, it was the number of marked lambs for the year. Wheat experienced relatively low per hectare losses (1.3%), however due to its dominance in the cropping landscape (50% of cropping ha's), in terms of regional losses wheat was calculated to have the highest loss at $17 million and the highest range of losses, with 90% of results falling between $0.13 million to $65 million, higher than the previous season due to an increase in wheat prices. Sorghum, planted to 10% of the region's cropping area had the next largest range of total regional economic losses with 90% of results falling between $3 million to $26 million. An opportunistic summer crop within the region, Sorghum hectares were higher than average due to high soil moisture levels in the planting window. As expected, the enterprises with the lowest total planted hectares (canola, chickpeas, faba beans, hay, maize and oats) had the lowest regional losses.

Regional losses of lambs in sheep (wool and meat) enterprises were estimated at $10 million. 90% of modelled results fell between $4 million and $20 million. This loss was calculated using a 12% lamb loss rate from the farmer surveys (n=15) and an opportunity cost of $171 /hd for each lamb lost, using estimated marked lamb numbers for the region. Per hectare or individual enterprise losses would vary depending on flock size and stocking rates.

The mean result for total regional economic losses was $62 million, when input pricing variability was considered, 90% of probable results fell between $33 million and $115 million. The potential range of results is presented in Figure 5. Results indicated a 1% probability of regional losses falling below $17 million and a 50% probability of results to be between $44 million and $72 million. The long tail of the distribution indicated an 8.6% probability of regional losses occurring over $100 million, with occurrence due to an alignment of the highest potential yields at the same time as the highest commodity prices and feral pig losses.

Figure 5: @RISK results of total regional economic losses



Benefits of feral pig control vary depending on the control method (or methods) used and the scope of the control program. A long-term, routine control program implemented strategically, using varied methods across an area wide landscape has the highest effectiveness. This was acknowledged in the 2021 survey (Powell and Revell, 2021), with 100% of respondents agreeing that area wide management of feral pigs resulted in larger and longer-term benefits than individual farm programs.

No control method is 100% effective. The cost of control also needs to be considered; therefore the net benefit of control will never equal the economic losses. As the 2020 study found, the economic benefits per hectare of feral pig control varied depending on the effectiveness and cost of control. The feral pig control methods and their effectiveness in this study reflect those in Powell et al. (2020).

Aerial shooting and 1080 baiting were found to be the most cost-effective methods across all enterprises, with ground shooting and exclusion fencing broadly the least cost-effective (Powell et al., 2020). However, each control method when used in a strategic targeted approach can be highly effective.

The benefit of regional control across NW LLS, was considered by applying the average cost of control ($5.92 /ha) across 2,000,000 ha. With an effectiveness of 50%, the resulting net economic benefit was $17 million. When the effectiveness of control is increased to 60%, which is the estimated effectiveness of both 1080 baiting and aerial shooting (but also potentially achievable on an area wide scale by using a range of strategically targeted measures in a long-term control program) the net benefit of control increases to $23 million. These findings highlight the potential avoided losses on a regional scale if strategically selected control measures were implemented across the entire NW LLS region.

Discussion and Conclusion

This is the last of three consecutive seasonal reports to estimate agricultural economic losses attributed to feral pigs in the North West NSW LLS region. The report estimated that regional in-crop and storage losses across 12 enterprises for the Winter 2022 and Summer 2022-23 seasons were $62 million and when considering the range of model inputs, a 50% probability of regional losses between $44 million and $72 million.

Per hectare losses were calculated for each cropping enterprise by multiplying regional yields by losses attributed to feral pigs and the value of each commodity. Mean per hectare losses ranged from $79 /ha for irrigated maize down to $12 /ha for oats and dryland cotton enterprises.

Enterprise losses attributed to feral pigs were both lower and higher in 2022-23, compared to the previous year. The region experienced another strong season with summer yields in the study period higher across all enterprises, winter yields slightly lower (but still above average) due to an unusually wet winter including widespread late season flooding. Feral pig yield losses were estimated higher for most enterprises (barley, chickpeas, faba beans, maize, sorghum, sheep and wheat) and lower in others (cotton, hay and grain in temporary storage). Commodity prices remained higher than average for all crops except canola and cotton. Combined, these inputs resulted in both higher and lower per hectare losses compared to 2021-22. Enterprises with higher per hectare losses included barley, faba beans, maize, oats, sorghum and wheat. Enterprises with lower per hectare losses included canola, chickpeas, cotton and hay.

At a regional level, enterprise losses were also mixed compared with 2021-22, influenced primarily by the estimated tonnes of grain in the region (a combination of hectares planted and yields). Economic losses attributed to feral pigs in wheat and barley contributed to 36% of losses respectively due to the large proportion of cropping area dedicated to these enterprises. Wheat had the highest increase in estimated regional losses compared to the last analysis due to both an increase in estimated tonnes within the region and an increased unit loss (from 0.92% to 1.3%). The high yielding, high value crop of cotton contributed to 15% of regional losses (including dryland and irrigated enterprises). The regional economic losses for sheep enterprise attributed to feral pigs (via lamb loss) was valued at $10 million (16% of total regional losses). The regional economic losses of each enterprise was most sensitive to the area dedicated to the enterprise, or in the case of sheep, the increased size of the flock within the region. Combining these results, total regional losses were up 12% to $62 million.

Yield losses were based on the results of the farmer and agronomist survey (Section 2). As discussed in the method, survey results can be influenced by the survey sample, and farmer-estimates when not specifically measured may result in overstated losses due to the cognitive bias towards loss aversion. To combat this bias, additional questions were asked around yield loss from the second year of surveying, with the resulting estimates thought to be more accurate. Also, outputs as distributions still highlight the potential range of results. For example, total economic regional losses attributed to feral pigs remained high with 90% of results falling between $33 million and $115 million.

Losses associated with cattle enterprises and infrastructure losses were collected within the survey, however the value of these losses were not included within the analysis due to the low amount and quality of regional data.

In addition to informing the analysis, the survey results (Section 2) also provided insight into the practices and attitudes of respondents towards feral pig management. Respondents reported an increasing abundance of pigs, for the first time feral pigs were present on 100% of surveyed properties. 77% of respondents observed increased feral pig abundance on their farms with a 36% increase in the reporting of a ‘High’ rating for feral pig presence rating (*Many animals seen at any time and much sign of activity, significant sign of animals on more than 80% of occasions)*.

100% of respondents attempted to control feral pigs during the study period using a broad range of control methods. The consistent message from respondents was that despite a concerted increase in feral pig control activities the population had continued to grow and expand. Despite the increase in population, some survey respondents noted the success of LLS managed control programs in reducing feral numbers and requested further government resourcing to continue these efforts.

SECTION 2: 2022-2023 Survey results

A primary survey was conducted to understand the experience farmers within the North West LLS region had with feral pigs during the Winter 2022 and Summer 2022-23 timeframes.

Survey distribution

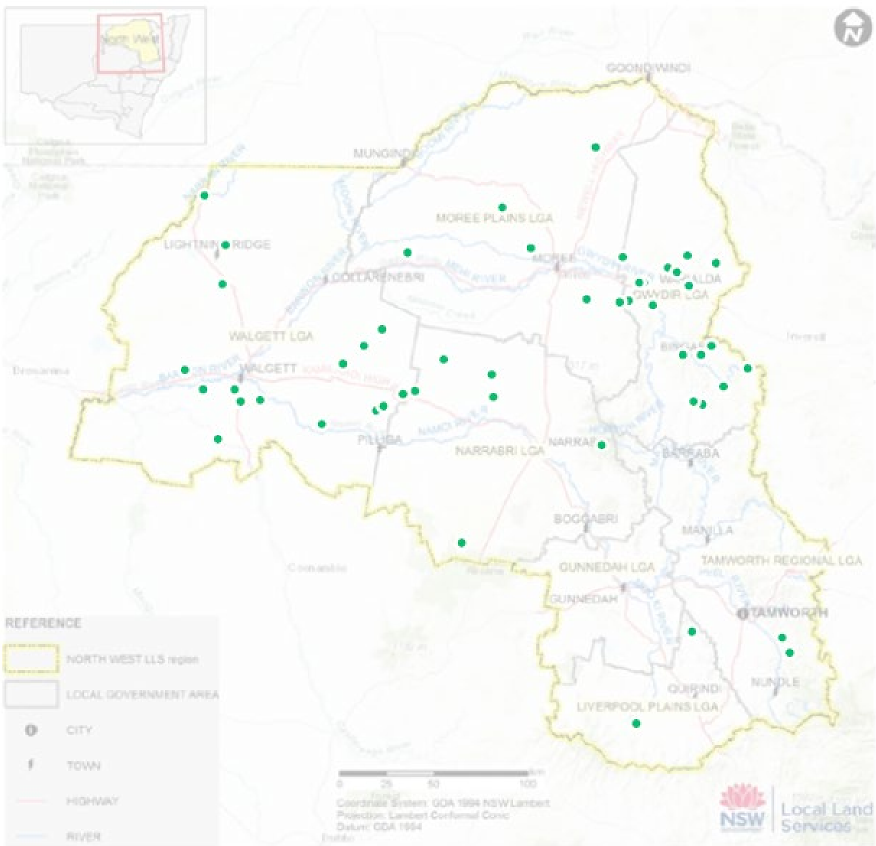
The survey, distributed in August 2023, covered livestock and both the Winter 2022 and the Summer 2022-23 cropping periods.

The survey was distributed via social media, direct e-mails (Ag Econ and LLS) and e-mails via several third-party agricultural organisations. The survey was targeted at farm owners or managers.

The survey had 49 responses covering a total of 466,304 ha in the NW LLS area. 88,000 ha of cropping land, 109,000 grazed, 269,000 support area (unutilised timber / scrub / riparian). 30 of these respondents also completed the 2022 surveys.

The location of respondents within the study region can be seen in Figure 6.

Figure 6: Map indicating the location of survey respondents



Feral pig presence and abundance

Respondents were asked if pigs were present on their properties. The survey found **pigs were present on 100% of properties surveyed.** This result was up 4% from last season, an expected result considering the ideal pig breeding conditions of above normal rainfall and abundant food and shelter.

Those with pig presence were asked about the abundance of feral pigs on their farms during the study period. The response categories were based on the DPI abundance mapping (Figure 1). Table 4 and Figure 6 present these results.

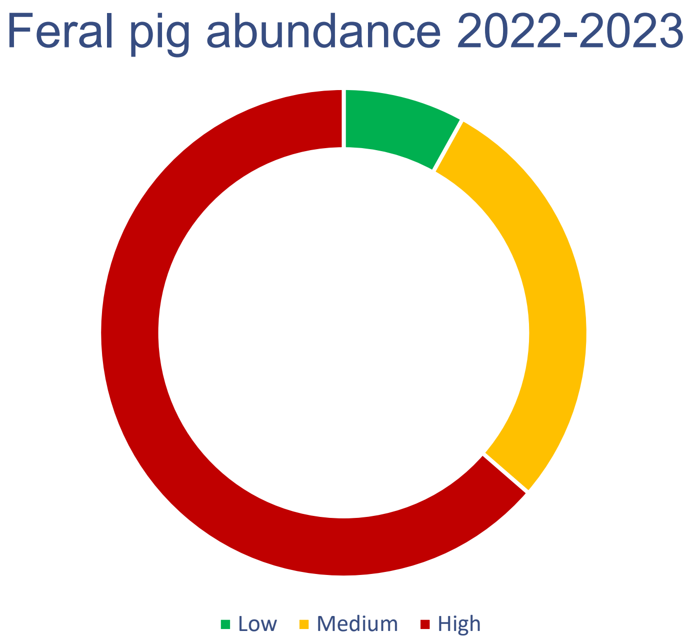
77% of respondents observed increased feral pig abundance on their farms. 19% of respondents stated that pig density stayed the same and 4% responded that feral pig pressure had decreased. Although the respondents and their location within the NW LLS area changes from survey to survey, these results indicate a second season of a strong trend in higher abundance of feral pigs across the region.

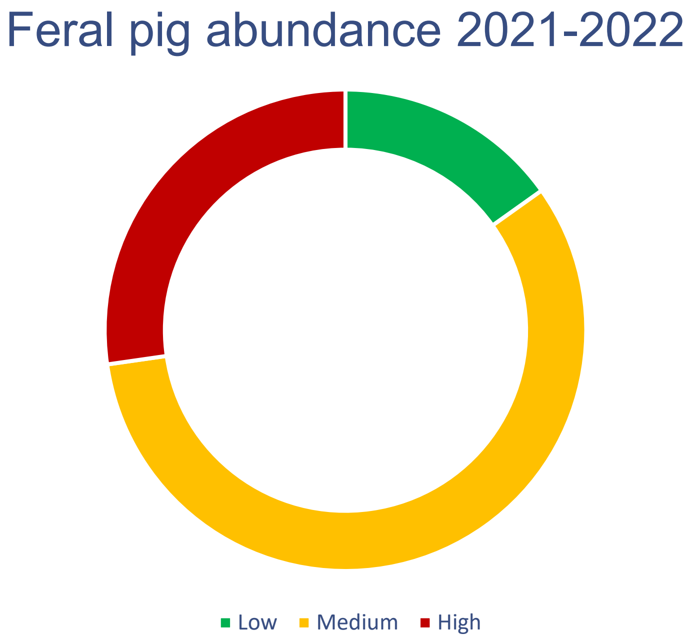
Table 4: Survey responses on Feral pig abundance in the NW LLS

Feral pig abundance	Responses (change from last survey)
Low *(Few sightings, little active sign)*	**8%** (-7%)
Medium *(Some animals seen at almost any one time, much active sign - significant sign of animals 50-80% of the time)*	**28%** (-29%)
High *(Many animals seen at any time and much sign of activity - significant sign of animals on more than 80% of occasions)*	**63%** (+36%)

The results that feral pigs have increased in intensity across the region is in-line with DPI mapping. Figure 7 gives a visual depiction of the decreasing 'low abundance' and increasing 'high abundance' compared to the survey 12 months pervious.

Figure 7: Abundance of feral pigs on respondent farms.

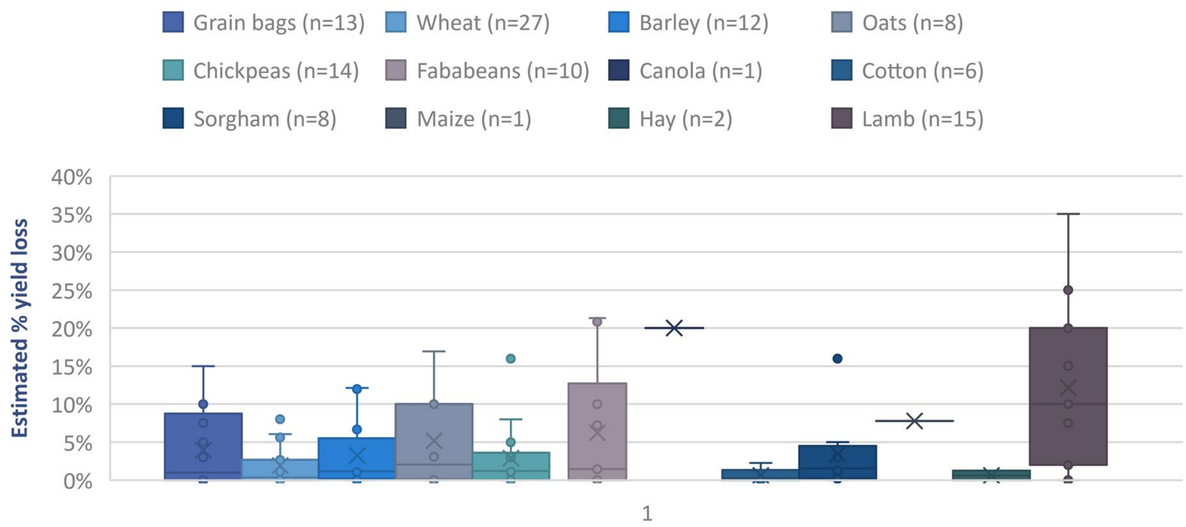




Enterprise loss attributed to feral pigs

Respondents were asked for their best estimate of feral pig damage to specific agricultural enterprises including damage to infrastructure and crops see Figure 8. Some enterprises had low. The lowest losses were reported in cotton, wheat and hay. The highest losses were reported for canola, maize and faba beans. Maize, hay and sheep enterprises were reported as higher estimated losses than last year, with all other enterprises reporting lower losses. The graph key indicates the number of responses for each enterprise. Some enterprises such as maise, hay and canola had very few responses. Further validation of the data was achieved by surveying agronomists in the region to refine yield loss ranges for the model.

Figure 8: Grower estimated yield loss as a result of feral pig damage



Cattle enterprises

15 respondents reported a loss within their cattle enterprises as a direct result of feral pigs. The most commented on damage was damage to pastures and grazing crops (digging up roots resulting in yield loss). Additionally, the potential of disease (e.g. leptospirosis) being spread by feral pigs and the resulting requirement for vaccination was also noted. The range in estimated reduction of enterprise income ranged from 0 to 10% with one respondent reporting their losses are estimated at close to $500,000.

Infrastructure losses

23 respondents outlined infrastructure losses from feral pig damage, at an estimated value of $295,000. Fences were the most damaged infrastructure at an estimated damage value of $143,000. An estimated $56,000 for land formation and $96,000 for water or irrigation infrastructure.

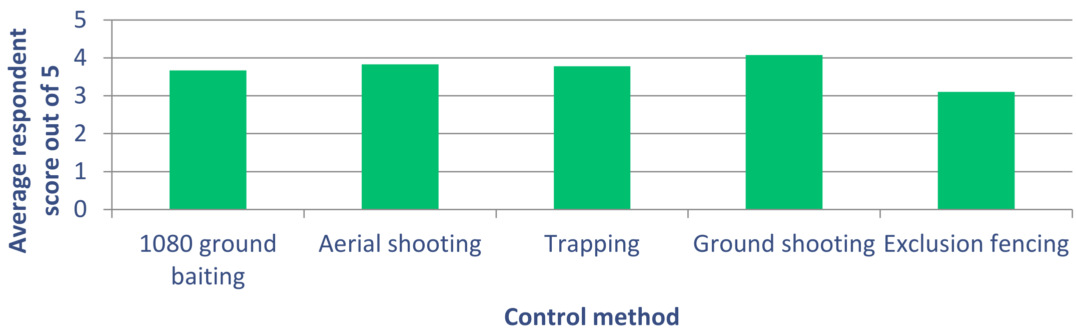
Feral pig control

95% of respondents attempted to control feral pigs during the study period.

This high participation in control indicates the extent of the feral pig problem and that farmers understand the general benefits of control.

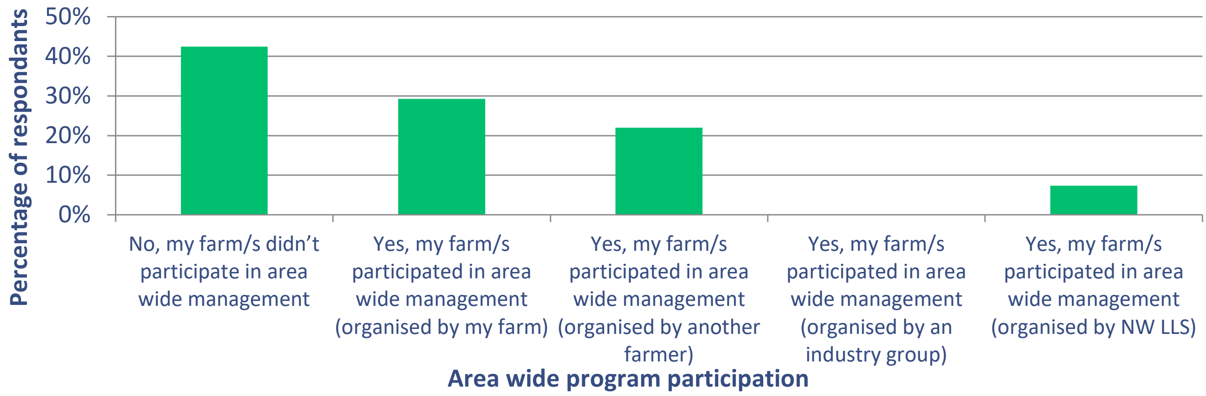
Respondents were surveyed on the feral pig control methods they relied on most for their farms. Figure 8 indicates that farmers were essentially equally reliant on all methods. The average number of control methods relied upon was 3 (as was the previous year), with most relying upon at least three control methods and some relying on up to five methods. The more methods a respondent utilised could indicate that they understand that different methods provide the highest benefits in varied situations, the sustain use of varied methods of control may also reflect the increasing abundance of feral pigs in the area.

Figure 9: Control methods most relied on in Winter 2022 & Summer 2022-2023



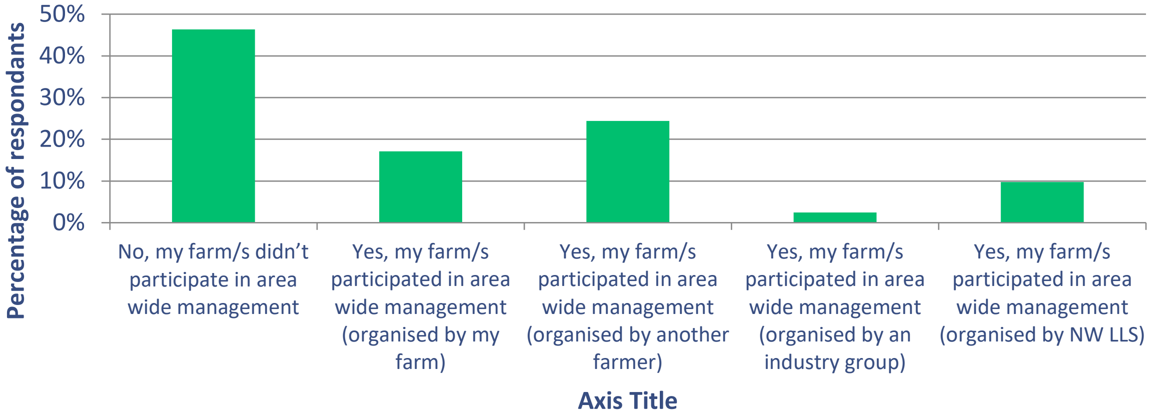
59% of respondents participated in area wide management programs for feral pigs during Winter 2022. The area wide programs were mostly organised by the individual farmers or their neighbours Figure 10.

Figure 10: Respondent participation in area wide management of feral pig control, Winter 2022



54% of respondents participated in area wide management programs for feral pigs during Summer 2022-3 The area wide programs were mostly organised by the individual farmers or their neighbours Figure 11.

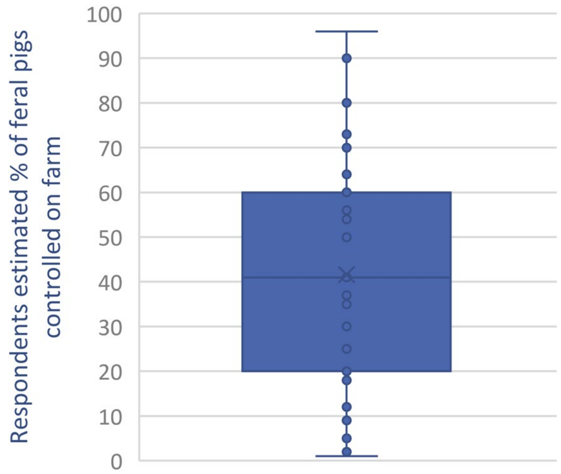
Figure 11: Respondent participation in area wide management of feral pig control, Winter 2022



Estimated % of feral pigs controlled

Respondents were asked to estimate the percentage of feral pigs they have controlled on their farm in the last 12 months. On average respondents estimated they had controlled 42% of pigs on their farms. The box whisker plot in Figure 12 outlines the respondents estimates. The responses ranged from just 2% of feral pigs controlled to 96%.

Figure 12: Box whisker plot of respondents estimated % of feral pigs on their farm that were controlled



Attitudes on how to improve feral pig control

Respondents were given an opportunity to comment on their ideas on how to improve feral pig control. 17 of the respondents left comments with most of the comments centred around the themes of co-ordinated area wide control. Many of the comments centred around co-ordinated area wide control.

Table 5: Respondents final survey comments

Theme	Sample comment	Respondents
Increased Government funding	*"Either partially, or fully, government subsidized aerial shooting programs on groups of private landholdings, combined with ground shooting, trapping and 1080 baiting. More Government donated traps to aid farmers in controlling the remaining population after a successful aerial shoot."* *"The Pest Animal Group grants offered through NSW LLS were great but limited. We received pig traps but due to limited funds were not able to get the cameras. It is great that we have a local group focussing on the problem but the resources are limited. More funding would be great."* *"Aerial shooting is expensive but effective. The armed forces need to be actively helping."* *"The area wide management baiting scheme with the LLS delivered great results."*	**8**
Area wide program with multiple forms of control	*"A co-ordinated program of aerial culling and baiting would help immensely."*	**4**
Increase Aerial shooting	*"Continued Aerial and trapping programs. Our business has spent well over $20,000 on aerial and traps in the last financial year. If we miss an aerial cull numbers significantly increase and we find it hard to get back on top of."*	
Allowing farmers to assist with aerial shooting & utilise local knowledge	*"CAT D gun license availability for feral pig control"* *"Encourage landholders to continue to work together on an area based control. Make it easier to access resources(funding) and the ability for landholders to shoot from the air in their area they know. local knowledge is key to keeping numbers down."*	**2**
Meat baits	*"1080 meat baits for pigs. This is done elsewhere and works well. It can be used in the same paddocks as stock without fear of poisoning them. For those without access to grain this is a preferred method and very effective."*	**1**

Final comments

Respondents were given an opportunity to make final comments. 11 respondents left comments which are listed below.

"Local shooters, trappers and local LLS baiting programs need to be coordinated together. Giving landholders more power to coordinate these programs in their local area with neighbours regularly would have a huge impact on keeping pig numbers down."

"In a ten week period we destroyed 1200 pigs across three properties and upward of 2000 year to date. It has been a nightmare with huge lamb losses despite this level of control. Fresh mobs just keep moving in from the Gwydir river corridor."

"We are very grateful for the support and information provided by David Lindsay through our local LLS."

"MORE funding please. feral pigs alone will spread foot and mouth like wild fire!!!"

"We shot approximately 900 pigs on our farm that year and that wasn't all of them."

"Helicopter shooting and 1080 baits are very effective in cropping areas. 15000 pigs have been shot east of the Newell in Moree Shire."

"There has been a very Large increase in feral pig numbers observed on larger neighbouring properties."

"Despite our best efforts. The pigs in our area are completely out of control."

"National parks and Aboriginal land needs to do more controlling of feral animals."

"LLS reluctance to utilise 1080Meat baits for pigs is allowing populations to flourish. It is easier and more convenient than using baited grain, whilst also controlling foxes and wild dogs."

SECTION 3: Three season discussion

The agricultural economic losses attributed to feral pigs in the North West NSW LLS region have been estimated to increase for three consecutive years. Findings for the region were reported annually in this three year, LLS funded project. Year 1, inclusive of Winter 2020 and Summer 2020-21 reported an estimated $47 million loss attributed to feral pigs, year 2 (Winter 2021 and Summer 2021-22) a $56 million loss and finally year 3 (Winter 2022 and Summer 2022-23) a $62 million loss, 32% higher than the first year.

The modelled results were driven by the size of the enterprise within the region, commodity prices and estimated yield loss attributed to feral pigs. Cropping area in Year 3 was 25% higher than Year 1, likely reflecting improved seasonal cropping conditions. Commodity prices were thought to be an accurate representation, calculated using reported pricing for each season. Prices across all enterprises increased, on average by 37% comparing Year 1 to Year 3. Yield loss attributable to feral pigs was reported as mixed (both up and down) across the three year study. Derived from land manager estimates, yield loss was the variable with the highest uncertainty. Estimates when not specifically measured may result in overstated losses due to cognitive bias towards loss aversion. The risk of overstated yield losses was reduced with changes to the survey in the second year. Including an agronomist survey added more impartial opinions from those with a macro view of the regions cropping.

The project coincided with wetter than average seasons, ideal conditions for feral pig breeding. Results of the projects annual primary survey with rural land holders in the region indicated a marked increase in feral pig abundance during the project period. In Winter 2020, 90% of respondents (n=67) reported feral pig present on their properties with 19% reporting a *High* feral pig abundance, by Summer 2022-23, 100% of respondents (n=49) had feral pigs present on their properties and 63% reported the abundance as *High*. The increased abundance is in line with DPI mapping (Figure 1) and could be expected to result in increased agricultural damages.

The increased feral pig population saw land holders increase their control efforts. The need to control this pest animal was already well understood within the region evident by an impressive 93% of respondents participating in some type of feral pig control on their properties and 49% participating in area wide management programs from the first survey at the beginning of the project. These efforts increased by the end of the project to 95% of respondents attempting to control feral pigs on their farms and 59% of respondents participating in area wide feral pig control programs. The range of control method used on average by each respondent increased from 2.5 to 3. Control methods included within the analysis were 1080 ground baiting, aerial shooting, ground shooting, trapping and exclusion fencing.

Beneficial seasonal conditions have meant that despite increased control, the feral pig population has continued to increase. While regional losses are expected to fluctuate from year to year depending on hectares planted, yields and commodity prices, the three year trend has been increased losses.

Each year survey respondents made suggestions on how to improve feral pig control with increased government intervention in the form of co-ordinated area wide feral pig control programs i.e shooting, trapping, baiting combination – with one farmer suggesting these programs should have mandatory participation. Farmers as the land managers generally want to be part of the solution with further suggestions around Category D gun licences for farms who can use their local knowledge for helicopter shoots, additional training workshops on effective pig control and the allowance of meat baits specifically for feral pig control.

The study and loss estimates could be considered conservative as they did not include survey respondents estimates of infrastructure losses or additional losses to livestock enterprises such as losses from pigs eating grain out of feeders, reduced breeder productivity from disease or reducing pasture yield of grazing areas and damage to fencing, dams or environmental assets in the NW NSW LLS region. These values were not included due to the level of uncertainty around their values. Further improvements to the study could be made by incorporating population dynamics and seasonal forecast scenarios to project future losses.

Impact assessments of past or current LLS feral pig control programs that included environmental benefits and population forecasting would be ideal for informing decisions around future government intervention and funding.

This study provides a good three year baseline and retrospective analysis to understand the economic losses attributed to feral pigs and how it may vary between seasons. The findings can be helpful in planning and promoting further control programs for the highest economic benefit. The authors recommend an update to the report every 5 years.

References

ABARES. 2022. *Direct economic impacts of foot-and-mouth (FMD) disease incursion in Australia* [Online]. Available from: https://www.agriculture.gov.au/abares/research-topics/biosecurity/biosecurity-economics/fmd-update-of-2013-estimate. Available: https://www.agriculture.gov.au/abares/research-topics/biosecurity/biosecurity-economics/fmd-update-of-2013-estimate [Accessed 2022].

ABARES 2023. *Australian Crop Report: March 2023*. Canberra: ABARES.

ABS 2021. Value of Australian Commodities Produced, Australia States and Territories and NRM regions 2020-21. *In:* AUSTRALIAN BUREAU OF STATISTICS (ed.) *Cat. no 7303.0.* Canberra.

COWLED, B. D., LAPIDGE, S. J., HAMPTON, J. O. & SPENCER, P. B. S. 2006. Measuring the Demographic and Genetic Effects of Pest Control in a Highly PersecutedFeral Pig Population,. *The Journal of Wildlife Management,* 70**,** pp.1690-1697.

DAS 2023. National Crop Identification and Monitoring Program, reported 8th March 2024. *In:* DIGITAL AGRICULTURAL SERVICES (ed.).

GENTLE, M. & POPLE, A. 2013. Effectiveness of commercial harvesting in controlling feral-pig populations. *Wildlife Research,* 40**,** pp. 459-469.

HONE, J. & ATKINSON, B. 1983. Evaluation of Fencing to Control Feral Pig Movement. *Wildlife Research,* 10**,** 499-505.

HONE, J. & PEDERSEN, H. 1980. Changes in a feral pig population after poisoning.

LAPIDGE, S. J. 2003. *Proceedings of the Feral Pig Action Agenda : 2 - 4 June 2003, James Cook University, Cairns,* Canberra, ACT, Pest Animal Control Cooperative Research Centre.

LOCKREY, T. & MARSHALL, D. 2019. Feral Pig (Sus Scrofa) Damage, Monitoring and Management in Australian Cotton - A Call for Research. *AACS 2019 Australian Cotton Research Conference.* Armidale: Unpublished.

MCLEOD, R. & NORRIS, A. 2004. *Counting the cost : impact of invasive animals in Australia, 2004,* Canberra, Cooperative Research Centre for Pest Animal Control.

POWELL, J. W. & REVELL, G. B. 2021. Economic impact of feral pigs on agricultural production in North West NSW: 2020-21. Ag Econ.

POWELL, J. W. & REVELL, G. B. 2023. Economic impact of feral pigs on agricultural production in North West NSW: 2021-22. Ag Econ.

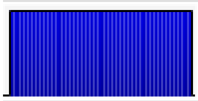
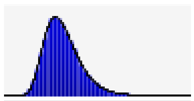
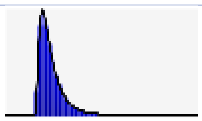
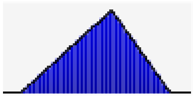
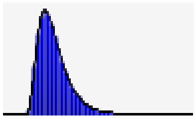
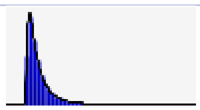
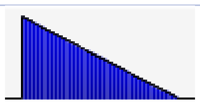
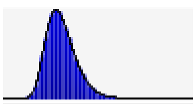
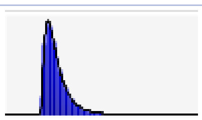
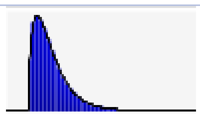
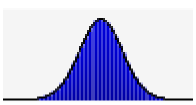
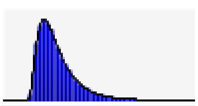
POWELL, J. W., WELSH, J. M., MARSHALL, A. & REVELL, G. B. 2020. Cost benefit analysis of feral pig control in North West NSW. Ag Econ.

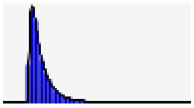
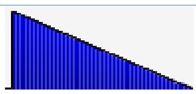
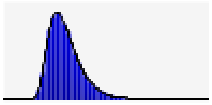
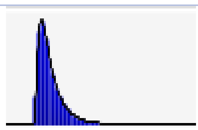
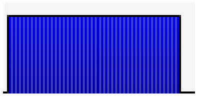
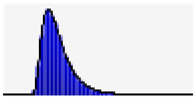
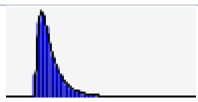
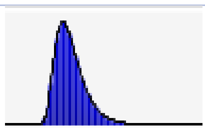
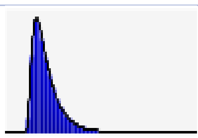
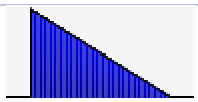
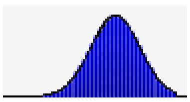
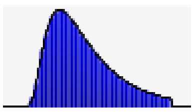
SAUNDERS, G. 1993. Observations on the effectiveness of shooting feral pigs from helicopters. *Wildlife Research,* 20**,** 771-776.

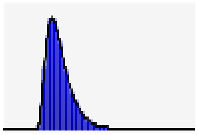
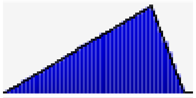
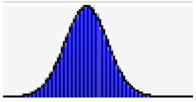
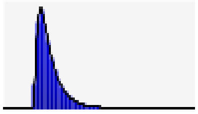
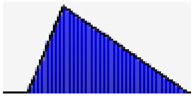
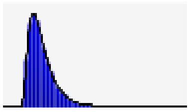
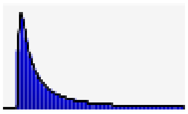
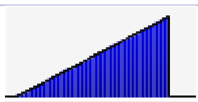
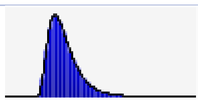
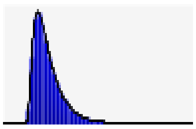
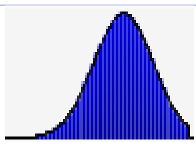
SAUNDERS, G., KAY, B. & NICOL, H. 1993. Factors Affecting Bait Uptake and Trapping Success for Feral Pigs (Sus Scrofa) in Kosciusko National Park. *Wildlife Research,* 20**,** 653-665.

TWIGG, L., LOWE, T., MARTIN, G. & EVERETT, M. 2005. Feral pigs in north-western Australia: basic biology, bait consumption, and the efficacy of 1080 baits. *Wildlife Research,* 32**,** 281-296.

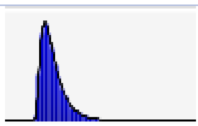
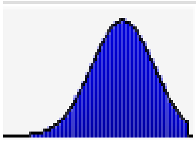
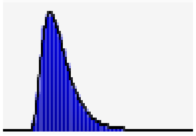
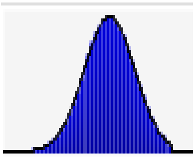
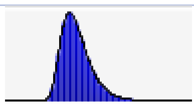
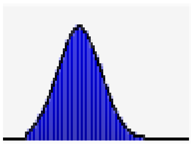
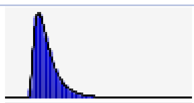
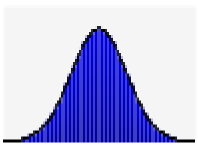
Appendix 1: @RISK model input distributions

Cropping Enterprises					
Input	**Data distribution graph**	**Mean**	**10%**	**90%**	**Data sources**
Barley price		**$372 /t**	**$318 /t**	**$425 /t**	**The Land**
Barley yield		**2.9 t/ha**	**1.9 t/ha**	**4.0 t/ha**	**DAS, ABARES 2023 & Agronomist survey[1]**
Barley yield loss from pigs		**3.3%**	**1.2%**	**6%**	**Survey (Section 2)**
Canola price		**$763 /t**	**$672 /t**	**$846 /t**	**The Land**
Canola yield		**2 t/ha**	**1.1 t/ha**	**3.2 t/ha**	**DAS, ABARES 2023 & Agronomist survey[1]**
Canola yield loss from pigs		**1.5%**	**.4%**	**3.1%**	**Survey (Section 2)**
Chickpea price		**$641 /t**	**$589 /t**	**$705 /t**	**The Land & mixed brokers**
Chickpea yield		**1.3 t/ha**	**0.9 t/ha**	**1.7 t/ha**	**ABARES 2023 & Agronomist survey[1]**
Chickpea yield loss from pigs		**2.9%**	**1.1%**	**5.3%**	**Survey (Section 2)**
Cotton price		**$642 /bale**	**$605/bale**	**$690 /bale**	**Mixed cotton merchants**
Cotton (irrigated) yield		**12.3 bales/ha**	**10.0 bales/ha**	**14.6 bales/ha**	**Cotton Australia & Agronomist survey[1]**
Cotton (dryland) yield		**3 bales/ha**	**1.2 bales/ha**	**5.4 bales/ha**	**Cotton Australia & Agronomist survey[1]**

Cotton yield loss from pigs		**0.63%**	**0.2%**	**1.2%**	**Survey (Section 2)**
Faba bean price		**$413 /t**	**$389 /t**	**$443 /t**	**The Land**
Faba bean yield		**2.3 t/ha**	**1.3 t/ha**	**3.5 t/ha**	**ABARES 2023 & Agronomist survey[1]**
Faba bean yield loss from pigs		**3.42%**	**1.24%**	**6.4%**	**Survey (Section 2)**
Hay price		**$223 /t**	**$185 /t**	**$262 /t**	**The Land**
Hay yield		**2.5 t/ha**	**1.2 t/ha**	**4.1 t/ha**	**ABARES 2023 & Agronomist survey[1]**
Hay yield loss from pigs		**3.4%**	**1.2%**	**6.4%**	**Survey (Section 2)**
Oat price	No price variation reported in the land for 12 months	**$330 /t**	**$330 /t**	**$330 /t**	**The Land**
Oat yield		**1.4 t/ha**	**0.8 t/ha**	**2.1 t/ha**	**ABARES 2023 & Agronomist survey[1]**
Oat yield loss from pigs		**2.6%**	**1.1%**	**4.7%**	**Survey (Section 2) & Agronomist survey[1]**
Maize price		**$457 /t**	**$443 /t**	**$475 /t**	**The Land**
Maize yield		**10.5 t/ha**	**8.2 t/ha**	**12.8 t/ha**	**ABARES 2023 & Agronomist survey[1]**
Maize yield loss from pigs		**1.6%**	**0.7%**	**2.8%**	**Survey (Section 2) & Agronomist survey[1]**
Stored grain (bags & bunkers) Price	Average of typically stored grains (wheat, faba, chickpea, barley, sorghum)	**$271 /t**	**$240 /t**	**$308 /t**	

Stored grain (bags & bunkers) Yield loss		2.1%	1.1%	3.3%	Survey (Section 2)
Sorghum price		$402 /t	$360 /t	$436 /t	The Land
Sorghum yield		4.0 t/ha	2.7 t/ha	5.3 t/ha	ABARES 2023 & Agronomist survey[1]
Sorghum yield loss from pigs		3.4%	1.3%	6.5%	Survey (Section 2)
Wheat price (H2)		$447 /t	$417/t	$484 /t	The Land
Wheat yield		2.9 t/ha	1.3 t/ha	4.8 t/ha	DAS, ABARES 2023 & Agronomist survey[1]
Wheat yield loss from feral pigs		1.3%	0.07%	3.56%	Survey (Section 2)
Sheep: lamb price		613 c/kg	416 c/kg	771 c/kg	MLA
Sheep: lamb losses		12%	6%	19%	Survey (Section 2)
Control methods					
Input	**Data distribution graph**	**Mean**	**10%**	**90%**	**Data sources**
Aerial shoot cost		$1.85 /ha	$1.24 /ha	$2.64 /ha	(Lockrey and Marshall, 2019, Saunders, 1993, Cowled et al., 2006) (Personal Communication, GVIA [1])
Aerial shoot effectiveness		59%	37%	81%	(Lockrey and Marshall, 2019, Cowled et al., 2006, Saunders, 1993)

[1] Gwydir Valley Irrigator's Association, emails and phone communication, May 2020

					(Personal Communication [2])
Baiting cost		**$1.6 /ha**	**$0.71 /ha**	**$2.7 /ha**	**(Lockrey and Marshall, 2019)**
Baiting effectiveness		**59%**	**37%**	**82%**	**(Lapidge, 2003, Saunders et al., 1993, Twigg et al., 2005, Hone and Pedersen, 1980) (Personal Communication[2])**
Exclusion fence cost		**$17.4 /ha**	**$9.1 /ha**	**$27.7 /ha**	**(Hone and Atkinson, 1983, Lockrey and Marshall, 2019)**
Exclusion fence effectiveness		**70%**	**55%**	**85%**	**(Hone and Atkinson, 1983, Lockrey and Marshall, 2019) (Personal Communication[2])**
Ground shoot cost		**$7.0 /ha**	**$4.4 /ha**	**$10.1 /ha**	**(Lockrey and Marshall, 2019)**
Ground shoot effectiveness		**20%**	**10%**	**30%**	**(McLeod and Norris, 2004, Gentle and Pople, 2013, Lockrey and Marshall, 2019) (Personal Communication [2])**
Trapping cost		**$1.75 /ha**	**$0.74 /ha**	**$3.10 /ha**	**(Lockrey and Marshall, 2019)**
Trapping effectiveness		**45%**	**25%**	**65%**	**(Lockrey and Marshall, 2019, Saunders, 1993, Lapidge, 2003) (Personal Communication[2])**

[2] Dave Lindsay, Local Land Services, emails and phone communication, June 2020