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PDS - Implementation of Producer Demonstration Sites to increase research adoption and practice change in the Kimberly and Pilbara

PDSWA001 - Investigating the practicality of regenerating degraded pastoral land on Larrawa station

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Abstract

A Producer Demonstration Site (PDS) to *investigate the practicality of regenerating degraded pastoral land* has been completed in the Kimberley, Western Australia. The PDS began in 2009 and five different types of mechanical regeneration were demonstrated; these include closed and open water ponds, water spreader banks, crocodile plough and opposed disc plough. The most cost effective method at increasing groundcover and slowing down water flow was the construction of open water ponds with a 16G (grader) machine.

On a per hectare basis the cost to rehabilitate 1 hectare was $148.52, with a 16G machine. This included the construction of two 210 m ponds, two rips (50 m long) on the inside of each pond to roughen the surface of the soil and seeding with forage sorghum seed (Sweet Jumbo) at 2 kg per ha.

Executive summary

Kevin and Wendy Brockhurst from Larrawa station in the East Kimberley have recently completed a Producer Demonstration Site (PDS) to *investigate the practicality of regenerating degraded pastoral land.* The area being regenerated was eroded early in the 1970s due to overgrazing, causing the loss of topsoil and the formation of a small gully. The site was in poor condition with no perennial and minimal annual vegetation present. While subsequent management strategies, such as excluding stock, have resulted in some regeneration of native species, few palatable and perennial species have returned.

Five different types of mechanical regeneration were demonstrated; these include closed and open water ponds, water spreader banks, crocodile plough and opposed disc plough.

The demonstration site was on a severely degraded and eroded hard spinifex plain pasture in Collis Creek paddock.

Results and discussion

Open water ponds were the most effective method of increasing annual groundcover and providing a niche for recruitment of perennial grasses. Ponds were built with a Caterpillar model 16G and a model 12G grader. Data collected during 2011 indicated that a 16G grader was more economical at water pond construction than a 12G machine. Table 1 displays the median cost per metre and approximate cost to build a 210 m pond using both 16G and 12G machines.

Data collected for a 16G and 12G grader to construct a 210 m water pond

	16G	12G
Machine cost per hr (with operator and without fuel)	$175.00	$150.00
Diesel used per hour (litre)	22.5 L	22.5 L
Median cost to build pond per metre	$0.32	$0.49
Approx. cost to build 210 m pond	$67.00	$102.90

The cost to construct a pond includes x2 rips along borrow area, to loosen the soil prior to pond construction, and x2 rips inside of pond to roughen the soil surface. Cost of diesel was $1.48/litre.

Ferry of a 16G to Larrawa from Kununurra was $1000 each way (not included in above costs). Forage sorghum seed (Sprint) was used to ensure some germinable seed was present and cost $7.26/kg; approximately 2 kg was used per hectare. The estimated cost to build two ponds on 1 hectare is $148.52 (construction, ripping and seeding). This includes x2 ponds at $67 each and 2 kg of forage sorghum seed was $14.52. It should be noted that the cost of surveying is not included. The cost of a professional to survey the area and mark out ponds is unknown, as surveying was completed by Ray Thompson (Central West Catchment Management Authority, NSW) at no charge. The current rate of a professional to survey ponds is $690.00 per day; including wages, laser hire and vehicle hire. On an average day approximately 100 water ponds will be surveyed covering an area of 50 hectares.

Five range condition monitoring sites were installed and monitored between November 2009 and April 2012 at the demonstration site. Two monitoring sites were installed where the crocodile and opposed disc plough were demonstrated. No increase in perennial groundcover was recorded at either site; a slight increase in annual groundcover was recorded where the opposed disc plough was demonstrated, however not the crocodile plough.

Two sites were installed where open water ponds were constructed; no annual or perennial plants were recorded at either site during installation. At the time of reassessment in April 2012, some annual groundcover was recorded in all quadrats (25) at each site where open water ponds were demonstrated. At the control site where no regeneration activities were undertaken, no change in perennial or annual groundcover was recorded; this site remained bare throughout the demonstration.

Field observations where water had ponded were that the soil was spongy under foot and small cracks (2–4 mm) appeared after the subsurface clay layer had swelled and cracked. These observations were not noted at any other demonstration sites where water had not ponded. At the time of reassessment, no improvement in land condition was recorded, however an increase in groundcover was observed, attributable to increased soil moisture and a sign of improved ecological function.

It is expected that due to improved soil moisture retention and the creation of niches (cracks and groundcover) for seed capture and germination, recruitment of perennial grasses will occur over time. Perennial grasses growing outside the regeneration area which are expected to colonise within the regeneration area are hard spinifex (*Triodia intermedia*) and buffel grass (*Cenchrus ciliaris*).

Key knowledge gained:

- A 16G was more economical than a 12G to build water ponds ─ won more dirt per pass.
- Banks built with the opposed disc plough were too small to be effective at ponding water.
- Surveying for ponds is best completed by a professional experienced in surveying ponds.
- An experienced machine operator is essential to get full value out of ‘machine hire’.

Photo A: *Aerial view of the Larrawa station regeneration site, covered in open water ponds.*

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Background

During a Grazing Land Management workshop in 2009, producers in the Kimberley in Western Australia identified areas on their properties that had historical, unsustainable grazing practices. One such area where this has occurred is Larrawa station, via Fitzroy Crossing. The site is an area of approximately 60 hectares that was eroded early in the 1970s due to overgrazing, causing the loss of topsoil and the formation of a small gully. A station photo taken in 1972 shows that the soil surface has continued to erode over the decades, the rate of erosion is of concern to the pastoralist. While subsequent management strategies, such as excluding stock, have resulted in some regeneration of native species, few palatable, perennial species have returned. It is also feared that the rate of gully erosion and soil loss will continue to increase if no intervention takes place.

While relatively small in area in comparison to both the paddock and lease scale of Larrawa, this degraded area is only one of several such areas on the lease, each one affecting the capacity to graze the entire paddock in which it occurs as the cost of individually fencing such areas is expensive. Destocking of the entire paddock, while feasible, is expensive because of the timeframe required for natural regeneration. The Producer Demonstration Site (PDS) was discussed at a Kimberley Beef Research Committee Meeting (November 2010) and supported to proceed. A PDS was established with 3 producer members (Appendix A) to look at the practicality of regenerating areas considered to be severely degraded and eroded.

This problem is not only confined to Larrawa station. Similar areas of land in poor condition are not uncommon across the Kimberley; where cattle continuously graze areas or pockets of palatable grasses until all perennial and annual grasses are removed.

Project objectives

The project objectives were:

1. Evaluate different erosion control techniques, including; crocodile plough, opposed disc plough, closed and open water ponds and water spreader banks.

2. Evaluate the economic cost of undertaking pasture regeneration on severely degraded pastoral land.

Methodology

The Producer Demonstration Site was selected by Kevin Brockhurst, lessee of Larrawa station, on a severely degraded and eroded hard spinifex plain pasture in Collis Creek paddock. Soil texture was class 4 (Clayey Sand).

Cattle were destocked from the regeneration area over the 2009–10, 2010–11 and 2011–12 wet seasons, to minimise damage on completed earthworks. The area was stocked over the 2011 dry season. At the completion of the PDS in April 2012, stock were introduced back into Collis Creek paddock. Future management of Collis Creek paddock will involve wet season spelling every second year and stocking with sale cattle over the dry season.

Surveying was completed on foot with a Dual Grade GL700 Laser. The initial surveying tasks completed on-site were: (1) mark contour lines on a survey map which show the direction of water flow, natural watercourses and potential areas for ponds to be built, roads and fences; and (2) once surveyed, draw each pond on map. In addition, a survey book was kept, recording each pond number and the amount of water each pond was designed to pond.

An area of approximately 20 ha was used as part of the demonstration. Five regeneration methods were trialled over a three-year period. Table 1 outlines the methods trialled.

Table 1: Regeneration methods trialled during the Larrawa station PDS

Mechanical regeneration	Description
Pits gouged by crocodile plough	Pits gouged in soil were 15 cm in diameter and 10 cm deep. A contour line was not followed.
Ridges formed with opposed disc plough	Ridges 40 cm high were constructed in a brickwork pattern with two rippers followed by two opposed discs.
Closed ponds constructed with grader	Ponds were 50 m in diameter with 65 cm high banks, 2 m wide bases and were built on a flat surface with a slope of 0.3% (30 cm in 100 m).
Open ponds constructed with grader	Banks were up to 250 m long, 65 cm high and were 2 m wide at the base. The ends were surveyed to give a maximum ponding depth of 7–15 cm.
Waterspreaders constructed with grader	Banks were 65 cm high, base 2 m wide and had a break/100 m. A sill is used to spread overland flow across the landscape away from existing gullies.

Sprint sorghum (*Sorghum sudanense* X *Sorghum sudanense*) was spread over disturbed areas to ensure viable seed was present to germinate once sufficient soil moisture was available. Sprint sorghum was chosen because it is a sterile hybrid (will not produce a seed), a requirement by the Pastoral Lands Board, on crown land in Western Australia.

The crocodile and opposed disc ploughs were pulled by a 70 hp John Deere tractor. Engine running time was recorded to rehabilitate 1 hectare. No data was recorded regarding fuel usage ─ this was estimated from previous work completed in Kununurra. Ridges built were completed as per *A guide to mechanical rangeland regeneration* (Addison 1997).

Open water ponds were constructed using a Caterpillar model 16G and a model 12G grader and were built as per *Earthmovers Training Course* (Thompson 1991). The model 16G grader is significantly larger and more powerful than the model 12G. Larrawa station uses a model 12G grader for road and fence line maintenance and construction; this machine was used as part of the PDS. The preferred machine for water pond construction in central western NSW is a model 16G. This type of machine was also demonstrated at the PDS to ascertain the most efficient model grader to build ponds. Engine running time to construct earthworks and fuel usage were recorded for both 16G and 12G graders during construction of open water ponds. The amount of water ponded at each pond ranged between 7 cm and 15 cm. Data were collected on pond length, ponded height and time to construct.

For the construction of two waterspreader banks, only the 16G machine was used; the 12G machine was not demonstrated due to budget limitations. Engine running time to construct two waterspreader banks was recorded during construction. Waterspreader banks were built as per *Waterspreading to Restore Native Grasslands* (Mitchell 2011).

Range condition monitoring (RCM) sites were installed where the crocodile plough, opposed disc plough and open water ponds were built to monitor changes in perennial and annual vegetation frequency. A monitoring site where no regeneration activities were undertaken (control site), was also installed. No RCM sites were installed within the area rehabilitated with closed ponds due to the small number of ponds built and similarly for the area rehabilitated with waterspreaders. Sites were installed and monitored as per the DAFWA *Monitoring Manual for Rangeland Condition Monitoring* (Warburton 2011). The effectiveness of each treatment was assessed on annual and perennial groundcover increases.

Results

Seasonal conditions: the estimated long-term average rainfall (mm) for Larrawa station since 1921 is:

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Ave.	125	123	71	17	10	6	6	2	2	8	22	63	455

Wet season rainfall exceeded the long-term average (November–April: 455 mm) in only one of the three years the PDS was operating. The 2009–10 wet season was well below average, with an estimated 235 mm of rainfall received at the homestead. However, good out-of-season rainfall was received in May (50 mm) and July (52 mm) 2010, providing relief from dry conditions. Rainfall over the 2010–11 wet season was well above average with an estimated 652 mm received and rainfall over the 2011–12 wet season was slightly below the average with an estimated 416 mm received. It is believed seasonal conditions did not play a significant part in the final result because all regeneration methods were replicated over two years—receiving at least one season of well above average rainfall.

Results were calculated based on works completed between October 2009 and April 2012. The cost of a professional to survey the area and mark out ponds is unknown as surveying was completed by Ray Thompson (Central West Catchment Management Authority) at no charge. Therefore, surveying costs are not included in the results below.

Crocodile plough

On average the speed of travel for the crocodile plough was 7 km/h. It took approximately half an hour to plough 1 hectare with a 3 m wide plough and the machine was costed out at $95 per hour (fuel and operator inclusive). The operator was not required to follow the natural contour line.

Table 2: **Data collected for a 70 hp tractor pulling a 3 m crocodile plough**

Area (ha)	**Construct time (min.)**	**Cost to plough/ha ($)**	**Comment**
1	28.5	45.12	Contour line not followed

Opposed disc plough

Surveying ridges was done manually, i.e. on foot with staff and a laser level. It took approximately 15 minutes to survey 1 hectare.

On average the speed of travel for the opposed disc plough was 5 km/h. It took approximately 20 minutes to cover 1 hectare in brickwork pattern. The opposed disc plough was under load for 5 m then released for 5 m and under load for another 5 m—this pattern was repeated. Each row of ridges was approximately 6 m apart. The machine was costed out at $95 per hour (fuel and operator inclusive) and the operator was required to follow the natural contour line.

Table 3: Data collected for a 70 hp tractor pulling an opposed disc plough

Area (ha)	Construct time (min.)	Cost to cover/ha ($)	Comment
1	19.92	31.47	Ridges follow contour line

No data (engine hours or fuel consumption) was recorded on the cost to build ponds with the opposed disc plough. This was due to only a few ponds holding water post the 2009–10 wet season.

Water ponds

Surveying ponds was done manually, i.e. on foot with staff and a laser level. It took approximately 12 hours to survey 89 ponds.

The cost to construct a pond includes x2 rips along borrow area to loosen the soil prior to pond construction, and x2 rips inside of pond to roughen the soil surface. Cost of diesel was $1.48/litre. Ferry of 16G to Larrawa from Kununurra was $1000 each way (not included in costs below). Forage sorghum seed (Sweet Jumbo) cost $7.26/kg; approximately 2 kg was used per ha.

The estimated cost to build two open ponds on 1 hectare using a 16G is:

- surveying (not included)
- x2 ponds at $67 each
- 2 kg of forage sorghum seed was $14.52.

Total cost is $148.52 per hectare (construction, ripping and seeding).

The estimated cost to build two open ponds on 1 hectare using a 12G is:

- surveying (not included)
- x2 ponds at $102.90 each
- 2 kg of forage sorghum seed was $14.52.

Total cost is $220.32 per hectare (construction, ripping and seeding).

Table 4: **Data collected for a 16G and 12G grader to construct a 210 m water pond**

	16G	12G
Machine cost per hr (with operator and without fuel)	$175.00	$150.00
Diesel used per hour (litre)	22.5 L	22.5 L
Median cost to build pond per metre	$0.32	$0.49
Approx. cost to build 210 m pond	$67.00	$102.90

No data (engine hours or fuel consumption) was recorded on the cost to build closed ponds due to the small number of closed ponds built (x4). This was due to the slope of the land within the demonstration area being > 0.4% (40 cm in 100 m). Ideally closed ponds are built on land with a slope < 0.3% (3 cm in 100 m).

Photo B: Casting forage sorghum on inside of bank to ensure germinable seed is present

Water spreader banks

Two water spreader banks were constructed during November 2011 with a 16G machine. Surveying was done manually, i.e. on foot with staff and a laser level. It took approximately 12 minutes to survey a 250 m pond.

Table 5: Summary of data collected from 16G, building x2 water spreader banks

Water spreader No.	Length (m)	Construct time (min.)	Cost to build ($)	Cost to build/metre ($)	Comment
1	270	135	465.75	1.73	Ripping (x2)
2	250	90	310.5	1.24	Ripping (x2)

The cost to build a water spreader bank was approximately $1.49/m.

Range condition monitoring

Five range condition monitoring (RCM) sites were installed and monitored between November 2009 and April 2012 at the demonstration site.

At the RCM site (control site LAR REG 1) where no regeneration activities were completed, no increase in perennial or annual groundcover was recorded from the time the site was installed in November 2009 until the time of reassessment in November in 2011. Soon after (November 2011) this site had an open water pond built directly behind it and rip line cut through the middle.

At the RCM site (LAR REG 3) where the crocodile plough was demonstrated, no increase in perennial or annual groundcover was recorded from the time it was installed in November 2009 until the time of reassessment in November 2011. There was no recorded increase in annual groundcover—groundcover remained nil post-treatment.

At the RCM site (LAR REG 2) where the opposed disc plough was used to build ridges, no increase in perennial groundcover was recorded from the time it was installed in November 2009 until the time of reassessment in November 2011. An increase in annual goathead burr (*Slerolaena bicornis*) was recorded. Of the 25 quadrats made in 2009, six recorded goathead burr; at the time of reassessment in 2011 goathead burr frequency had increased to 16.

Two RCM sites (LAR REG 4 and 5) were installed where open water ponds were constructed in November 2011. No annual or perennial plants were recorded at either site during installation. At the time of reassessment in April 2012 all quadrats (25) at both sites recorded some annual groundcover. Pigweed (*Portulaca* sp.) provided the majority of groundcover recorded; Kimberley couch (*Brachyachne convergens*) and sprint sorghum (*Sorghum sudanense* X *Sorghum sudanense*) were also recorded on site.

Photo C: Larrawa station regeneration monitoring site no.4 November 2011 (pre works)

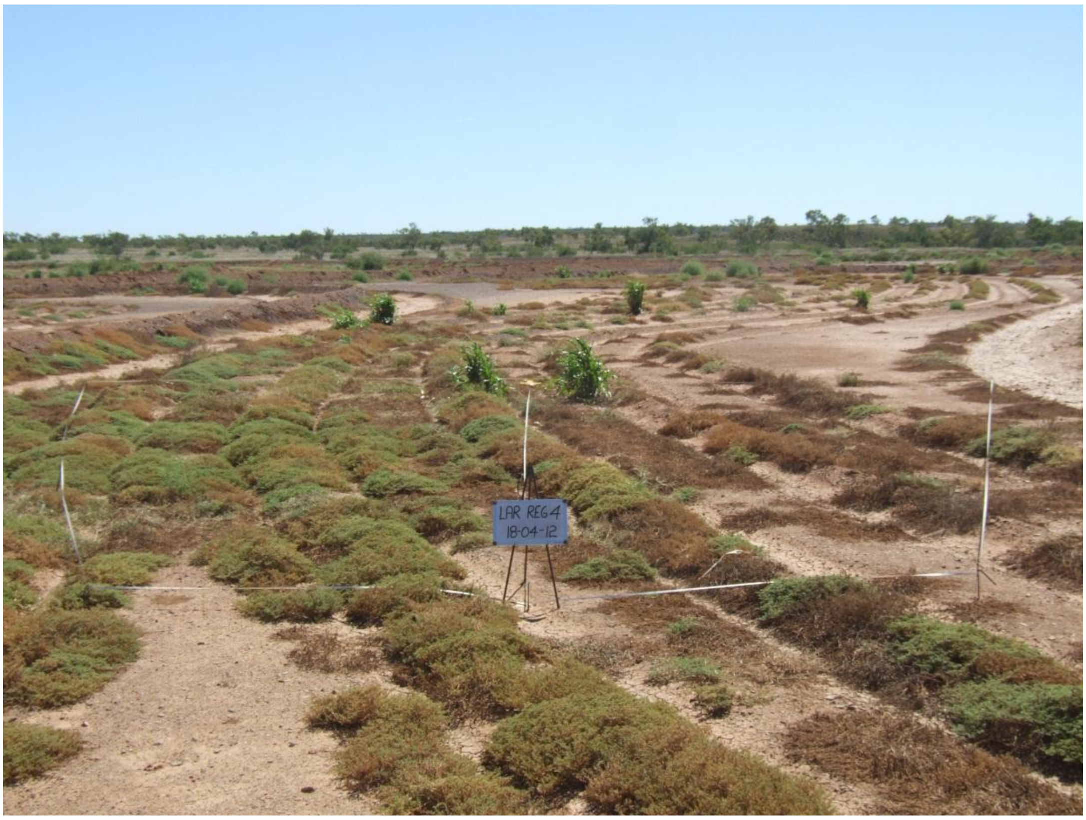

Photo D: Larrawa station regeneration monitoring site no.4 April 2012 (post works)

Discussion/conclusion

Time spent surveying could have been reduced if modern techniques, such as a vehicle-mounted receiver, were used. However, due to the small scale of the demonstration area, the added expense of transporting such equipment to Larrawa could not be justified. The cost of a professional to survey the area and mark out ponds is unknown, as surveying was completed by Ray Thompson (Central West Catchment Management Authority, NSW) at no charge. The current rate of a professional to survey ponds is $690.00 per day; including wages, laser hire and vehicle hire. On an average day approximately 100 water ponds will be surveyed covering an area of 50 hectares.

The crocodile plough was trialled in 2009. The benefit of using the crocodile plough was that no surveying was required. An operator could simply hook-up and drive off. Due to the hard surface crust of the demonstration area (up to 15 cm) the crocodile plough was unable to delve into the soil and create a large enough divot to hold moisture and promote plant growth. Ideally divots would have been the size of a rockmelon, however the crocodile plough only managed a small divot about the size of a cricket ball. Post 2009–10 wet season, there was no difference in perennial or annual groundcover between the area that had been rehabilitated with the crocodile plough and the control area which was not rehabilitated. It is believed the crocodile plough is more suited to softer soil types, for example, river frontage. Alternatively a larger and heavier plough is required to delve deeper into the soil.

Photo E: Soil crust at Larrawa regeneration site

The opposed disc plough was trialled in 2009 to build ponds, surveyed along a contour line. Ponds were designed to pond 7 cm of water, were on average 30 m long and constructed to a height of 40 cm and a base width of 80 cm. Post 2009–10 wet season, only a few ponds held water—the majority had blown out; too much water. It was concluded that the opposed disc plough was unsuitable for water pond construction at the demonstration site due to a lack of bank width and height.

In 2010 and 2011 the opposed disc plough was used to build ridges between water ponds and water spreaders (built by a grader). In this trial the ridges were protected from overland flow that had been slowed from ponds and water spreaders upslope. Ridges followed the contour line in a brickwork pattern and provided an effective barrier to overland flow. Germination of goathead burr and sprint sorghum along the ridge edge was observed where water had pooled. An increase in frequency (10) of goathead burr was recorded at LAR REG 2 from the time the site was installed in 2009 until the time of reassessment in 2011. It was encouraging to see an increase in groundcover.

The construction of open water ponds was demonstrated with 16G and 12G machines in 2010 and 2011; all ponds constructed were surveyed. A significant increase in annual groundcover was recorded at both LAR REG 4 and LAR REG 5 after one wet season. The increase was more than that recorded at any other RCM site. Field observations where water had ponded were that the soil was spongy under foot and small cracks (2–4 mm) appeared after the subsurface clay layer had swelled and cracked. These observations were not noted at any of the other RCM sites. At the time of reassessment, no improvement in land condition was recorded, however an increase in groundcover was observed—attributable to increased soil moisture and a sign of improved ecological function.

It is expected that due to improved soil moisture retention and the creation of niches (cracks and groundcover) for seed capture and germination, recruitment of perennial grasses will occur over time. Perennial grasses growing outside the regeneration area which are expected to colonise within the regeneration area are hard spinifex (*Triodia intermedia*) and buffel grass (*Cenchrus ciliaris*).

Both machines built water ponds to specification, however the 16G machine was much more economical, building a 210 m long water pond at a cost of $67 compared to $102.90 using the 12G machine. On a per hectare basis the 16G machine cost $148.52 and the 12G machine cost $220.32.

Water spreader banks were surveyed on the boundary where the vegetated landscape stopped and scalds began. Water spreader banks at Larrawa were not designed to pond water but to slow down overland flow and spread water out before it reached the ponds and ridges further downslope. It is believed the average cost (time) to build a water spreader bank could have been significantly reduced if more water spreaders were built, resulting in more experience being gained. Water spreader banks have been built for $0.70/m in the Nyngan area of NSW – personal communication (paddock discussion) 10 November 2011, Ray Thompson (Central West Catchment Management Authority, Nyngan, NSW).

Constructing open water ponds proved to be the most effective method of increasing groundcover on a previously degraded and eroded landscape. The opposed disc and crocodile plough were unable to demonstrate any increase in groundcover in their own right. However, in conjunction with open water ponds, ridges formed by the opposed disc plough showed some potential. The most economical method to build a water pond was with a 16G grader due to its increased horsepower—able to win more dirt per pass.

It is too early to make an assessment regarding financial return through increased stock numbers; able to be run post water ponding in April 2012. Due to an absolute lack of desirable perennial grass recruitment, no return on investment has been achieved so far. It was cost prohibitive to purchase native perennial grasses to speed up recruitment. For example, black spear grass (*Heteropogon contortus*) was quoted at $115/kg (with no seed germination information available). Land managers are not permitted to plant buffel grass on crown land in Western Australia's rangelands. Further monitoring will be carried out after the 2013–14 wet season to measure change in perennial grass frequency.

Quantifying financial return from on-ground works in terms of community-wide benefits is challenging. Benefits from the demonstration so far are: increased groundcover protecting the soil from erosion; reducing sediment load flowing into King Sound (Indian Ocean) via the Fitzroy River, Christmas Creek and Lumbar Creek; biodiversity, both aquatic and non-aquatic, would also benefit with less sediment filling natural pools in creeks and rivers between the point of erosion until discharging into King Sound.

Key knowledge gained

- A 16G was more economical than a 12G to build water ponds – won more dirt per pass.
- Banks built with the opposed disc plough were too small to be effective at ponding water.
- Surveying for ponds is best completed by a professional experienced in surveying ponds.
- An experienced machine operator is essential to get full value out of 'machine hire'.

Photo F: Soil on the left covered in pigweed has been ripped and bare soil on the right was left undisturbed. Due to a lack of soil moisture there was no plant growth on the right

Extension and communication

As part of the PDS a number of extension and communication activities were carried out. These mainly concentrated on WA specific activities such as ABC radio interviews, *Rangelands Memo* articles and a paddock walk. Two articles were contributed to MLA's *Feedback* magazine for producers across Australia to be informed of the results. A poster paper was also presented at the 2012 Australian Rangelands Society Conference in Kununurra. All extension materials completed as part of the PDS are listed in Appendix B.

Acknowledgments

Kevin and Wendy Brockhurst from Larrawa station are thanked for their commitment to making this demonstration happen – it was appreciated. The significant contributions of Melanie McDonald (Rangelands NRM WA) and Ray Thompson (Central West CMA, NSW), planning field work and in the field, are acknowledged.

Footnote

Since the completion of the PDS, a further 1001 ponds have been constructed on neighbouring stations. Using knowledge gained from the PDS (using a 16G grader, professional surveying and experienced operator), Christmas Creek, Yougga Walla, Gogo and Larrawa stations participated in a Rangelands NRM WA managed project (Christmas Creek, Yougga Walla, Gogo and Larrawa stations rangeland regeneration project).

References

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Appendices

Appendix A - PDS Producer Group Members

Appendix B1 - *Rangelands Memo* article, April 2011

Appendix B2 - *Rangelands Memo* article, December 2011

Appendix B3 - *Rangelands Memo* article, December 2012

Appendix B4 - MLA *Feedback* article, May 2011

Appendix B5 - MLA *Feedback* article, July 2012

Appendix B6 - ABC radio interview, November 2011

Appendix B7 - ABC radio interview, April 2012

Appendix B8 - Paddock walk infonote, April 2012

Appendix B9 - Paddock walk poster, April 2012

Appendix B10 - Australian Rangeland Society Conference poster, September 2012

Appendix B11 - Australian Rangeland Society Conference paper, September 2012

Appendix A – PDS Producer Group Members

- Kevin and Wendy Brockhurst: “Larrawa”, Fitzroy Crossing WA
- Haydn Sale: “Yougga Walla”, Halls Creek WA
- Mervyn Wortley: “Ruby Plains”, Halls Creek WA
- Brian Fielder: “Christmas Creek”, Fitzroy Crossing WA

Appendix B1 – *Rangelands Memo* article, April 2011

RANGELANDS MEMO APRIL 2011

LARRAWA STATION PRODUCER DEMONSTRATION SITE – UPDATE

Kevin Brockhurst, Larrawa Station and Matthew Fletcher, Kununurra

Kevin and Wendy Brockhurst from Larrawa station in the east Kimberley are participating in a Producer Demonstration Site (PDS) to *investigate the practicality of regenerating degraded pastoral land.* The area attempting to be regenerated became degraded due to overgrazing early in the 1970s, resulting in the loss of topsoil and the formation of a small gully. The site is in poor condition with no perennial and minimal annual vegetation present (see photo A). While subsequent management strategies, such as excluding stock, have resulted in some regeneration of native species, few palatable perennial species have returned.

The PDS began in 2009 and five different types of mechanical regeneration (as outlined in the table below) have been trialled. A combination of mechanical regeneration methods has proven successful at holding up water flow and providing conditions favourable for perennial and annual grass establishment and growth.

Mechanical regeneration	Description
Pits gouged by crocodile plough	Pits gouged in soil were 20 cm in diameter and 10 cm deep. A contour line was not followed.
Ridges formed with agro-plough along contour line	Ridges 50 cm high were constructed in a brick work pattern with two rippers followed by two opposed discs.
Closed ponds constructed with grader	Ponds were 50 m in diameter with 65 cm high banks, 2 m wide bases and were built on flat surface with a slope of 0.4% (40cm in 100m)
Open ponds constructed with grader along contour line	Bank were up to 200 m long, 65 cm high and were 2 m wide at the base. The ends were surveyed to give a maximum ponding depth of 7 cm.
Waterspreaders constructed with grader along contour line	Bank 65 cm high, base 2 m wide and had a break/100 m. There is a sill on the downslope to hold water and spread evenly when full.

No recruitment of perennial vegetation was recorded in areas where the crocodile plough was used. Due to the hard and impermeable nature of the soil surface this plough was unable to create large enough soil pits to trap sufficient water. The use of a crocodile plough heavier than the one currently being used could overcome this problem.

Ridges, and more specifically the furrows created by the agro-plough, provided an ideal environment for seedling recruitment. This was most evident following the 2010/11 wet season (see photo B).

At the time of writing, the closed ponds looked like rice paddies. Because rainfall run-off is only harvested within the ponds themselves the ponds are unable to catch overland flow. Due to an above average 2010/11 wet season, rainfall in each pond has been sufficient to initiate and maintain pasture growth. Depending on the wet season this may not always prove to be the case.

Due to the simple construction method adopted open ponds were quick to build (45 minutes) and were able to pond a significant amount of water (see photo C).

Water spreader banks were used in the transition areas where the vegetated landscape stopped and scalds began. Water spreader banks did not trap the same amount of water as an open pond, however they are of a more robust design and were used to spread out and slow down the overland water flow before it reached the other earth works.

Sterile forage sorghum (Sprint) was spread in selected areas to assess if it would germinate and provide groundcover. Plant frequency and vigour following the 2009/10 wet season was low when compared to that following the 2010/11 wet season. This was attributed to the difference in the two wet seasons. Over the period December 2009–March 2010, 12 days recorded rainfall over 5 mm compared to the period December 2010–March 2011 when approximately 27 days recorded rainfall over 5 mm. Where sorghum was used satisfactory groundcover was recorded (see photo B). Other plants that have colonised the mechanically disturbed areas are buffel grass (*Cenchrus ciliaris*) button grass (*Cynodon dactylon*) and tar vine (*Boerhavia spp*).

Although results following the 2010/11 wet season have been positive, the real trick will be to achieve sufficient perennial cover before some of the installed earthworks are too diminished to be effective.

The PDS on Larrawa station is jointly funded by Meat and Livestock Australia and the Department of Agriculture and Food. A field day at Larrawa station is planned for early 2012. This will be a great opportunity for interested land managers and the community members to visit and discuss the Larrawa station PDS.

Photo A *Larrawa station rangeland regeneration monitoring site at start of project in November 2009.*

Photo B *Annual forage sorghum growing in furrows created by agro-plough.*

Photo C *Open pond holding water on either side of bank .*

Further reading

Invasive Native Scrub Case Study: Waterspreading and restoring native grasslands on 'Florida'; Central West & Western Catchment Management Authority publication.

Addison, J 1997, A Guide to Mechanical Rangeland Regeneration, Department of Agriculture and Food.
[Email matthew.fletcher@agric.wa.gov.au for a copy.]

Appendix B2 – *Rangelands Memo* article, December 2011

RANGELANDS MEMO DECEMBER 2011

LARRAWA STATION PRODUCER DEMONSTRATION SITE – UPDATE

Matthew Fletcher, Kununurra

In November 2011 the final round of field work on Larrawa station was completed as part of a producer demonstration site (PDS) to *investigate the practicality of regenerating degraded pastoral land.* Works completed in 2011 focussed on comparing the costs of using a 16G versus 12G grader to construct open ponds (to pond water to 10 and 15 cm depth respectively), and 250 m long water spreading banks. The difference in earthmoving capacity between the two machines is that the 16G has a 16 ft blade and the 12G has a 12 ft blade; and the 16G also has 86 kilowatts more power.

The PDS on Larrawa station is jointly funded by Meat and Livestock Australia, Rangelands NRM and the Department of Agriculture and Food. A field day at Larrawa station is planned for early 2012.

Larrawa regeneration monitoring site No.4 (pre-works) – photo taken 7 November 2011.

Larrawa regeneration monitoring site No.4 (post-works) – photo taken 10 November 2011.

Aerial view of a section of works in Collins and Lumbar paddocks on Larrawa station.

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Appendix B3 – *Rangelands Memo* article, December 2012

RANGELANDS MEMO DECEMBER 2012

WATER PONDING ON LARRAWA STATION, NOVEMBER 2011

Matthew Fletcher[A], Kevin Brockhurst[B], Melanie McDonald[C] and Ray Thompson[D]

[A]Department of Agriculture and Food WA, Kununurra; [B]Larrawa station, Halls Creek WA;
[C]Rangelands NRM WA, Broome; [D]Central West Catchment Management Authority, Nyngan NSW

On-ground works completed at Larrawa station producer demonstration site in 2011 focussed on building open water ponds and collecting data on their cost($) to construct. Water ponding is a proven regeneration technique developed in western New South Wales, acting/ helping to slow down overland water flow and increase infiltration, thereby increasing soil moisture available for plant growth.

Ninety ponds were built at Larrawa station in 2011. The amount of water ponded at each pond ranged between 10 cm and 15 cm. Data were collected on pond length, ponded height and time to construct. Two permanent Rangeland Condition Monitoring sites were installed. Two different sized machines (road graders) were compared; 16G and 12G. The model 16G grader is significantly larger and more powerful than the model 12G.

Data collected during 2011 indicated that a 16G grader was more economical at water pond construction than a 12G machine. Table 1 displays the median cost per metre and approximate cost to build a 210 m pond for both 16G and 12G machines.

Table 1 **Data collected for a 16G and 12G grader**

	16G	12G
Machine cost per hr (with operator and without fuel)	$175.00	$150.00
Diesel used per hour (litre)	22.5 L	22.5 L
Median cost to build pond per metre	$.32	$.49
Approximate cost to build 210 m pond	$67.00	$102.90

Other costs

- Cost to construct a pond includes x2 rips along borrow area and x2 rips inside of pond.
- Cost of diesel was $1.48/litre.
- Ferry of 16G to Larrawa from Kununurra was $1000 each way (not included in above costs).
- Forage sorghum seed (Sprint) cost $7.26/kg, approximately 2 kg used per ha.

The estimated cost to build two ponds on 1 hectare is:

- Surveying (not included).
- x2 ponds at $67 each.
- 2 kg of forage sorghum seed was $14.52.

Total cost is $148.52 per hectare (construction, ripping and seeding).

Field observations where water had ponded were that the soil was spongy under foot and small cracks (2–4 mm) appeared after the subsurface clay layer had swelled and cracked.

It is expected that due to improved soil moisture retention and the creation of niches (cracks and groundcover) for seed capture and germination, recruitment of perennial grasses will occur over time. Perennial grasses growing outside the regeneration area which are expected to colonise within the regeneration area, are hard spinifex (*Triodia intermedia*) and buffel grass (*Cenchrus ciliaris*).

It was too early to make an assessment regarding financial return through increased stock numbers; able to be run post water ponding in April 2012. Due to an absolute lack of desirable perennial grass recruitment, no return on investment has been achieved thus far. It was cost prohibitive to purchase native perennial grasses to speed up recruitment, for example black spear grass (*Heteropogon contortus*) was quoted at $115/kg (with no seed germination information available). Land managers are not permitted to plant buffel grass on crown land in Western Australia's rangelands. Further monitoring will be carried out after the 2013/14 wet season to measure change in perennial grass frequency.

Quantifying financial return from on-ground works in terms of community-wide benefits is challenging. Benefits from the demonstration so far are: increased groundcover protecting the soil from erosion; reducing sediment load flowing into King Sound (Indian Ocean) via the Fitzroy River, Christmas Creek and Lumbar Creek; biodiversity, both aquatic and non-aquatic, would also benefit with less sediment filling natural pools in creeks and rivers between the point of erosion until discharging into King Sound.

Larrawa regeneration site No. 4, recorded no annual or perennial plants during site installation

*At the time of reassessment in April 2012 all quadrats (25) at Larrawa regeneration site No. 4 recorded some annual groundcover. Pigweed (*Portulaca *sp.) provided the majority of groundcover recorded; Kimberley couch (*Brachyachne convergens*) and sprint sorghum (*Sorghum sudanense X Sorghum sudanense*) were also recorded on site. At the time of reassessment, no improvement in land condition was recorded, however an increase in groundcover was observed – attributable to increased soil moisture and a sign of improved ecological function.*

Appendix B4 – MLA *Feedback* article, May 2011

NORTHERN REGIONAL FOCUS

Doing the groundwork on pasture regeneration

WA producers Kevin and Wendy Brockhurst are investigating the practicality of regenerating degraded pastoral land through a MLA producer demonstration site (PDS) on Larrawa station in the east Kimberley.

The Brockhursts have been working with Department of Agriculture and Food Development Officer, Matthew Fletcher, on the PDS since 2009, attempting to regenerate an area that became degraded due to overgrazing early in the 1970s.

The degradation resulted in the loss of topsoil and the formation of a small gully with no perennial and minimal annual vegetation. Subsequent management strategies have regenerated some native species, however few palatable perennial species have returned.

The PDS is trialling different types of mechanical regeneration: pits gouged by a crocodile plough, ridges formed with an agro-plough along contour line and grader-constructed closed ponds, open ponds along a contour line and water spreader banks.

Results so far

According to Mr Fletcher, a combination of mechanical regeneration methods has proven successful at holding up water flow and providing conditions favourable for perennial and annual grasses.

No regeneration of perennial vegetation was recorded in areas where the crocodile plough was used.

"The hard and impermeable nature of the soil surface meant the crocodile plough was unable to create large enough soil pits to trap sufficient water, although a heavier plough may have overcome this problem," Mr Fletcher said.

"At the end of March, the closed ponds looked like rice paddies."

The ridges and furrows created by the agro-plough provided an ideal environment for seedling recruitment by harvesting rainfall run-off. This was most evident following the 2010-11 wet season.

"At the end of March, the closed ponds looked like rice paddies," Mr Fletcher said.

"An above average 2010-11 wet season meant that rainfall in each pond had enough water to initiate and maintain pasture growth but this may not always be the case."

However, he said open ponds only took 45 minutes to build, due to the simple construction method used, and were able to pond a significant amount of water.

Water spreader banks were used in the transition areas where the vegetated landscape stopped and scalds began. They did not trap the same amount of water as an open pond, but were used to slow down overland water flow.

Sterile forage sorghum (Sprint) was spread in selected areas to assess if it would germinate and provide groundcover.

Plant frequency and vigour following the 2010–11 wet season was much greater than the previous year, in line with the additional 15 days of rainfall greater than 5mm received.

Where sorghum was used satisfactory groundcover was recorded (see photograph 2). Buffel grass, button grass and tarvine have also colonised the mechanically disturbed areas.

"Although results following the 2010–11 wet season have been positive, the real trick will be to achieve sufficient perennial cover before some of the installed earthworks are too diminished to be effective," Mr Fletcher said.

The PDS on Larrawa station is jointly funded by MLA and the WA Department of Agriculture and Food.

MLA Manager Northern Beef, Rodd Dyer, said the PDS program supported producer groups and extension staff to demonstrate, develop and adopt MLA research findings and technologies on property.

"It provides a practical environment in which producers can either explore opportunities from new R&D knowledge or apply and validate existing research. They can share their experiences while looking for R&D solutions to problems in the paddock," Mr Dyer said.

"These sites are really valuable for promoting practical change on property because it enables local groups to address the issues that affect them, provides opportunities to improve skills and knowledge and can shorten the time lag between technological innovation and adoption of beneficial research findings."

A field day is planned for early 2012, which will be a great opportunity for interested land managers and the community members to visit and discuss the project.

MORE INFORMATION

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Further reading: *A Guide to Mechanical Rangeland Regeneration*, J Addison, 1997, Department of Agriculture and Food. Email mathew.fletcher@agric.wa.gov.au for a copy.

Photograph 1: The Larrawa station rangeland regeneration monitoring site at start of project in November 2009.
Photograph 2: Annual forage sorghum growing in furrows created by agro-plough.
Photograph 3: An open pond holding water on either side of a bank.

2 feedback – May 2011

Appendix B5 – MLA *Feedback* article, July 2012

Ponding returns soil health

An aerial view of the Larrawa waterponding and water spreading producer demonstration site.

Key findings from the Larrawa PDS to improve soil health:

- → Mechanical regeneration, including water ponds, ridges and banks, can work and a combination of methods has proven most successful.
- → Professional surveyor advice is a good idea for pond establishment.
- → Ponds can be constructed quickly with a grader along contour lines.
- → The right bank height and width will increase longevity and at Larrawa banks were up to 200m long, 65cm high and 2m wide at the base.
- → Water spreader banks are best used in transition areas where vegetation stops and scalds begin to slow overland water flow.
- → At Larrawa these were constructed with a grader and had bank heights of 65cm, a base 2m wide and a break every 100m.

A soil conservation technique, not used for some time, has been reintroduced with success in the Top End.

There is growing interest in the use of waterponding to revitalise areas of unproductive pastoral land in WA's east Kimberley region.

A producer demonstration site (PDS) set up on Larrawa station near Fitzroy Crossing has shown waterponding can improve land condition, water and soil nutrient retention, and potentially boost returns from increased forage production.

At the PDS, waterponding was used to hold water where it fell to reduce soil erosion and silt build-up in the nearby Christmas Creek. The open ponds allowed this water to soak into the soil and become available as soil moisture to promote vegetation growth.

"Within one year the waterponding area changed from being classed as severely degraded and eroded to a significantly improved poor land condition (D)," said Department of Agriculture and Food WA Development Officer Matthew Fletcher, who ran the trial.

"It now has capacity to improve to C condition in the next few years."

Making comparisons

The PDS was a joint effort between the Brockhurst family, MLA, Rangelands NRM WA, Central West Catchment Management Authority (CMA) NSW and the Department of Agriculture and Food WA (DAFWA).

Matthew said open water ponds at the site were the most successful at slowing water movement, allowing time for it to soak into the soil and facilitating establishment of perennial and annual groundcover.

He said through the PDS, local pastoralists had seen the importance of using a level to ensure ponds were well designed, getting bank height and width right to increase longevity and the potential for this method to be used on a range of soil types.

The cost to rehabilitate one hectare at Larrawa with two water ponds – each 210 metres long – was about $150 in ripping and construction with a 16G grader and seeding hybrid sorghum. This equated to 32 cents per metre of dirt moved.

Other techniques

Water spreader banks constructed with a grader along contour lines also showed potential, especially for spreading concentrated water flow on sloping country. But these were more expensive to construct than ponds, at about $1.49/metre.

Matthew said an opposed disc and crocodile plough used to build pits and ridges at the Larrawa site were less successful than other rehabilitation techniques trialled because they were unable to increase groundcover.

***NOTE: Grants may be available to WA pastoralists wanting to undertake soil conservation and land rehabilitation projects on their properties. For further information contact Mel McDonald, Rangelands NRM Regional Landcare Facilitator, T: 08 9192 5212, E: melaniem@rangelandswa.com.au*

$150/ha
cost of rehabilitating land with waterponding

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Appendix B6 – ABC radio interview, November 2011

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Features » Bringing bare earth back to life in the Kimberley

Bringing bare earth back to life in the Kimberley

By Matt Brann Monday, 14 November 2011

2

Aerial view of the landcare work being done on Larrawa Station, WA. (DAFWA)

If you've got patches of hard, bare, scalded country on your station... then waterponding might be the answer.

The method is being trialed on Larrawa Station in the far north of Western Australia.

Matt Fletcher from the WA Department of Agriculture and Food says the idea of ponding is to slow down run-off water, and give it an opportunity to soak into the soil and promote vegetation.

"Water has just been running off this country and into the creek, so we're not trying to stop it, we're just want to slow it down and give it every opportunity to soak into the soil," he said.

"That'll give coloniser plants a chance to germinate and create some organic matter, and from there hopefully we'll see more biomass on the ground."

Ray Thompson from the Central West Catchment Authority in NSW has been lending his years of experience to the Larrawa project.

He says the technique has been working wonders on scalded claypans.

"With this technique we've been converting country with nil ground cover to 85 - 90 per cent cover in five years," he said.

"By holding water on the claypan, it makes the clay swell from underneath, busts the top crust open and that allows more moisture and seed to go in and that's how you get germination and things start to happen."

To learn more about the Larrawa trial, click on the audio link.

PHOTO GALLERY

Click image for larger version:




AUDIO

Matt Brann jumps into a grader to check out the ponding project on Larrawa Station

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Appendix B7 – ABC radio interview, April 2012

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Features » Landcare technique bringing bare earth back to life in the Kimberley

Landcare technique bringing bare earth back to life in the Kimberley

By Matt Brann Monday, 23 April 2012

4

Kimberley pastoralists gathered at Larrawa Station for a field day to learn more about ponding. (Matt Brann)

If you've got patches of hard, bare, scalded country on your station... then waterponding might be the answer.

The method is being trialed on Larrawa Station in the far north of Western Australia and the results have been impressive.

Matt Fletcher from the WA Department of Agriculture and Food says the idea of ponding is to slow down run-off water, and give it an opportunity to soak into the soil and promote vegetation.

"Water has just been running off this country and into the creek, so we're not trying to stop it, we're just want to slow it down and give it every opportunity to soak into the soil," he said.

"That'll give coloniser plants a chance to germinate and create some organic matter, and from there hopefully we'll see more biomass on the ground."

The department has calculated this type of work costs around $150 a hectare.

Kevin Brockhurst from Larrawa Station says it's money well spent and he will be doing more waterponding on his station.

"If you don't do anything you're certainly not going to go forward, so you've got to look at the long term returns on it, not just the short term, and look at what the value of this land is once it's productive again over 10 years,

"We certainly hope to do more of this, because there's more areas that need doing and I think we've got to stop the country from going down the river."

The Department of Agriculture says some of the key things learnt from the Larrawa trial have been:

* A 16G (grader) was more economical than a 12G to build waterponds, and won more dirt per pass.
* Banks built with the opposed disc plough were too small to be effective at ponding water.
* Surveying for ponds is best completed by a professional experienced in surveying ponds.
* An experienced machine operator is essential to get full value out of "machine hire".

PHOTO GALLERY

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AUDIO

Field day on Larrawa Station to discuss ponding

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Appendix B8 – Paddock walk infonote, April 2012

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Infonote RANGELANDS

COST OF REGENERATION AT LARRAWA

The costs below are based on on-ground works completed between 2009 and 2011. An area of approximately 20 ha was used for the demonstration. A diversification permit to carry out these activities cost $250.

Surveying

Surveying ponds was done manually, i.e. on foot with staff and a laser level. It took approximately 12 hours to survey 89 ponds. The cost of a professional to survey the area and mark out ponds is unknown; as surveying was completed by Ray Thompson (Central West Catchment Management Authority) at no charge. The cost to hire a laser level per day was $50.

Survey time could have been reduced if modern techniques such as a vehicle mounted receiver were used. However, due to the small scale of the demonstration area, the added expense of transporting such equipment to Larrawa could not be justified.

Cost to build water ponds and water spreader banks

Water ponds

Table 1 **Data collected for a 16G and 12G grader**

	16G	12G
Machine cost per hr (with operator & without fuel)	$175.00	$150.00
Diesel used per hour (litre)	22.5 L	22.5 L
Median cost to build pond per metre	$.32	$1.49
Approx. cost to build 210 m pond	$67.00	$312.90

Other

- Cost to construct a pond includes x2 rips along borrow area and x2 rips inside of pond.
- Cost of diesel was $1.48/litre.
- Ferry of 16G to Larrawa from Kununurra was $1000 each way (not included in above costs).
- Average pond length for 16G was 244 metres.
- Forage sorghum seed (Sweet Jumbo) cost $7.26/kg, approximately 2 kg used per ha.

The estimated cost to build two ponds on 1 hectare is:

- Surveying (not included).
- x2 ponds at $67 each.
- 2 kg of forage sorghum seed was $14.52.

Total cost is $148.52 per hectare (construction, ripping and seeding).

Author: Matthew Fletcher

Water spreader banks

Two water spreader banks were constructed during November 2011 with a 16G machine.

Table 2 **Summary of data collected from 16G, building x2**

Water spreader No.	Length (m)	Construct time (min.)	Cost to build ($)	Cost to build/metre ($)	Comment
1	270	135	465.75	1.73	Ripping (x2)
2	250	90	310.5	1.24	Ripping (x2)

Water spreader banks were surveyed on the boundary where the vegetated landscape stopped and scalds began. Water spreader banks at Larrawa were not designed to pond water but to slow down overland flow and spread water out before it reached the ponds further down slope. The cost to build a water spreader bank was approximately $1.49/m and the cost to build a water pond was $0.32/m. The higher cost of water spreader bank construction is due to bank dimensions (see Table 3). It is believed the average cost (time) to build a water spreader could have been significantly reduced if more water spreaders were built, resulting in more experience being gained. Water spreader banks have been built for $0.70/m in the Nyngan area of NSW.

Table 3 **Open pond and water spreader bank dimensions**

	Height	Bank base width
Open pond	60 cm	2 m
Water spreader	60 cm	3 m

Other techniques trialled

Opposed disc and crocodile plough

Both the opposed disc and crocodile plough were pulled by a 70 hp tractor. The opposed disc plough was used in 2009 to build water ponds. Ponds were surveyed along the contour line, designed to pond 5 cm of water, and were on average 30 m long and constructed to a height of 40 cm. Post the 2009/10 wet season (well above average), only a few ponds held water – the majority had blown out; too much water. It was concluded that the opposed disc plough was unsuitable for water pond construction at the demonstration site due to the higher grade slopes.

The crocodile plough was also trialled in 2009. The benefit of using the crocodile plough was that no surveying was required. An operator could simply hook-up and drive off. Due to the hard surface crust of the demonstration area (up to 15 cm) the crocodile plough was unable to delve into the soil and create a large enough divot. Ideally divots would have been the size of a rockmelon, however the crocodile plough only managed a small divot about the size of a cricket ball. Post the 2009/10 wet season, there was no difference in perennial or annual groundcover between the area that had been rehabilitated with the crocodile plough and the control area which was not rehabilitated. It is believed the crocodile plough could be more suited to softer soil types, for example, river frontage.

Key knowledge gained

- **A 16G was more economical than a 12G to build water ponds – won more dirt per pass.**
- **Banks built with the opposed disc plough were too small to be effective at ponding water.**
- **Surveying for ponds is best completed by a professional experienced in surveying ponds.**
- **An experienced machine operator is essential to get full value out of 'machine hire'.**

Appendix B9 – Paddock walk poster, April 2012

Designing an open water pond — to last

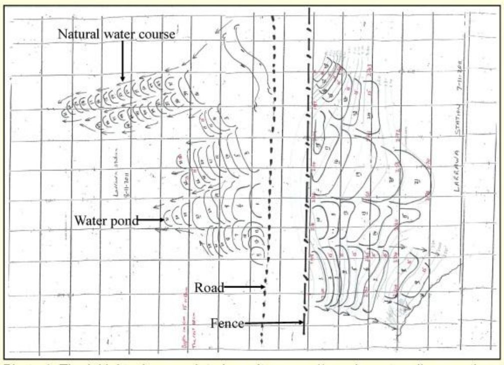

Photo 1. The initial tasks completed on-site were: 1) mark contour lines on the map which show the direction of water flow, natural watercourses and potential areas for ponds to be built, roads and fences; and 2) once surveyed draw each pond on the map (see above).

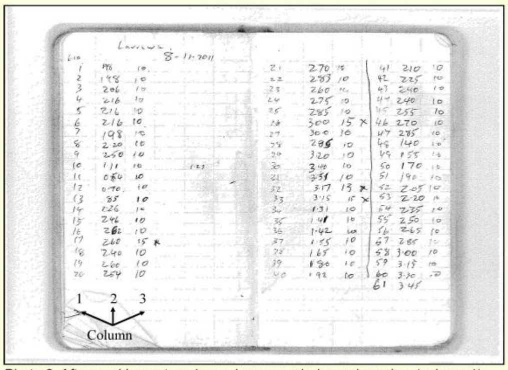

Photo 2. After marking out each pond we recorded: pond number (column 1); pond height (column 2) – this measurement was taken from the laser level; and the amount of water each pond was designed to pond (column 3). As an example, pond 16 was designed to pond 10 cm of water and pond 17 was designed to pond 15 cm of water.

Photo 3. The bank has been constructed to a height of 70 cm. The borrow area slopes away from the bank which is essential. This prevents the grader blade from undercutting the bank.

Photo 4. The borrow area is approximately 2 m wide. During construction one wheel of the grader will run along the base of the bank, the other wheel will run on undisturbed soil above the borrow area (see wheel tracks).

Photo 5. The bank base is 2 m wide and the top is domed. Having a wide base is an important aspect of the design criteria, providing a strong foundation that will reduce the incidence of soil slumping (banks subsiding).

Photo 6. This bank is not domed at the top. This is undesirable, as water will pool between peaks, blow out at the weakest point, and cause the bank wall to wash away.

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Appendix B10 – Australian Rangeland Society Conference poster, September 2012

Larrawa station—producer demonstration site

Photo story of works completed November 2011

Matthew Fletcher[A], Kevin Brockhurst[B], Melanie McDonald[C] and Ray Thompson[D]
[A]Department of Agriculture and Food WA, Kununurra
[B]Larrawa station, Halls Creek WA
[C]Rangelands NRM WA, Broome
[D]Central West Catchment Management Authority, Nyngan NSW

Photo 1. Larrawa station regeneration monitoring site No.4 (pre works).

Photo 2. Ripping before bank construction with 16G grader.

Photo 3. Soil crust post ripping.

Photo 4. Collecting markers between rip lines before building bank. The non-ripped area between rip lines will form the bank base.

Photo 5. Taking first blade of soil to form bank, starting on outside of pond.

Photo 6. Taking second blade of soil (rolling onto existing bank) on inside of pond.

Photo 7. Completed bank. The domed top will allow rainfall to flow away, minimising pooling on bank top.

Photo 8. Casting forage sorghum on inside of bank to ensure germinable seed is present.

Photo 9. Larrawa station regeneration monitoring site No.4 (post works).

Photo 10. Aerial shot of regeneration area.

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Appendix B11 – Australian Rangeland Society Conference paper, September 2012

Water ponding on Larrawa station, November 2011: a photo story

Matthew Fletcher[A], Kevin Brockhurst[B], Melanie McDonald[C] and Ray Thompson[D]

[A]Department of Agriculture and Food WA, Kununurra
[B]Larrawa station, Halls Creek WA
[C]Rangelands NRM WA, Broome
[D]Central West Catchment Management Authority, Nyngan NSW

Key words: water pond, grader and cost.

Introduction

On-ground works completed at Larrawa station producer demonstration site in 2011 focussed on building open water ponds and collecting data on their cost($) to construct. Water ponding is a proven regeneration technique developed in western New South Wales, acting/helping to slow down overland water flow and increase infiltration, thereby increasing soil moisture available for plant growth.

Ninety ponds were built at Larrawa station in 2011. The amount of water ponded at each pond ranged between 10 cm and 15 cm. Data were collected on pond length, ponded height and time to construct. Two permanent Rangeland Condition Monitoring sites were installed. Two different sized machines (road graders) were compared; 16G and 12G. The model 16G grader is significantly larger and more powerful than the model 12G.

Results and Discussion

Data collected during 2011 indicated that a 16G grader was more economical at water pond construction than a 12G machine. Table 1 displays the median cost per metre and approximate cost to build a 210 m pond for both 16G and 12G machines.

Table 1 **Data collected for a 16G and 12G grader**

	16G	12G
Machine cost per hr (with operator & without fuel)	$175.00	$150.00
Diesel used per hour (litre)	22.5 L	22.5 L
Median cost to build pond per metre	$.32	$.49
Approx. cost to build 210 m pond	$67.00	$102.90

Other costs

- Cost to construct a pond includes x2 rips along borrow area and x2 rips inside of pond.
- Cost of diesel was $1.48/litre.
- Ferry of 16G to Larrawa from Kununurra was $1000 each way (not included in above costs).
- Forage sorghum seed (Sprint) cost $7.26/kg, approximately 2 kg used per ha.

The estimated cost to build two ponds on 1 hectare is:

- Surveying (not included).
- x2 ponds at $67 each.
- 2 kg of forage sorghum seed was $14.52.

Total cost is $148.52 per hectare (construction, ripping and seeding).

Two Range Condition Monitoring sites were installed where open water ponds were constructed in November 2011. No annual or perennial plants were recorded at either site during installation. At the time of reassessment in April 2012 all quadrats (25) at site four (LAR REG 4) recorded some annual ground cover. No data was collected for site 1 (LAR REG 1), however visual observations indicated a similar increase in annual ground cover. Pigweed *(Portulaca* sp.*)* provided the majority of ground cover recorded; Kimberley couch *(Brachyachne convergens)* and sprint sorghum *(Sorghum sudanense X Sorghum sudanense)* were also recorded on site. At the control site (LAR REG 3) where no regeneration activities were undertaken no change in perennial or annual groundcover was recorded, the site remained bare at the time of re-assessment in April 2012.

At the time of reassessment, no improvement in land condition was recorded, however an increase in groundcover was observed — attributable to increased soil moisture and a sign of improved ecological function.

Key knowledge gained

- A 16G was more economical than a 12G to build water ponds — won more dirt per pass.
- Surveying for ponds is best completed by a professional experienced in surveying ponds.
- An experienced machine operator is essential to get full value out of 'machine hire'.

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