Spear Grass Seeding Trials and Results at Moorunde

John Endersby – 28 May 2014

Part One

"It's as interesting as watching grass grow."
– Anonymous

Obviously, whoever originally made the above claim, and those that repeat it, don't have a vested interest in growing grass; unlike farmers who plant pastures for the benefit of their livestock. And now, since the advent of wombats being found on Moorunde Wildlife Reserve dying of either starvation or eating poisonous introduced weeds (since early 2011), a number of members of the Natural History Society have also taken an interest in watching Spear Grass (and Wallaby Grass) growing on the Reserve.

Even on the original 2,000 hectares of Moorunde there is now precious little of it to be seen germinating, and most of what does gets quickly eaten off before it has a chance to seed down – despite this area now having been free from sheep grazing for 46 years and the rabbits virtually eliminated for 20 years. In November 1995 I erected a number of enclosures, just a few hundred metres south west of the campsite – each 25 x 25 metres. One of these excluded all the grass-grazing animals and by the following winter (1996) it was a "carpet" of Spear Grass; and by spring, seed stalks were knee high. It also had a fair smattering of Wallaby Grass too – see Figure 1. So within 12 months, it demonstrated a complete recovery.

Figure 1: *A thick "carpet" of Spear Grass growing in the 25 x 25 metre total-exclusion enclosure.*

That was in 1995-96. However, any enclosures erected since 2010 are still in a state of recovery four years later and indications are that they will not be recovered for some years to come. This indicates that the "seed bank" of these grasses has diminished considerably within 15 years and is still in decline. With the situation even worse on the Twelve Mile Plain section of the reserve, that the Society only acquired in 2007. That is, an area only seven years free from grazing by sheep and regularly baited to control the rabbits. This in fact should have been ample time for the grass to recover - as demonstrated by the vast quantity and density of grass that grew on both the original area of Moorunde and Portee Station (now referred to as the Twelve Mile Plain) in the early 1970s; as a response to a year of good rains (see Figures 2 and 3). That was only several years after Moorunde was purchased and separated from Portee Station following the devastating drought of 1967, when the ground over the entire area was laid completely bare. The grasses recovered on a good year back then – but they can't now!

So what has happened? It's not the sheep, because they are gone; and it's not the rabbits as they are virtually gone too, due to the Society's annual baiting program. It's not the wombats either, because regular surveys (on Moorunde) have shown stability in their numbers; and observations (supported by some evidence) indicate a decline in numbers on the Twelve Mile Plain.

That only leaves the kangaroos as the likely suspects, and "holding the smoking gun"; and in fact their numbers (both Red and Grey Kangaroos) increased significantly since 2008-2009, to the point where they now represent the same (or similar) grazing pressure on the grasses that the sheep applied on the Twelve Mile Plain up until 2006. So that by 2012, hundreds of wombats were suffering, as illustrated in Figure 4 and eventually ended up as illustrated in Figure 5.

Figure 2: *"After establishing Moorunde Wildlife Reserve, rain fell in 1970. Berna Clements on Moorunde amongst the Spear Grass (Stipa species), 1970". Photo by Alwin Clements.*

Figure 3: *"View of northern boundary fence, Moorunde left, Portee right, 1974". The original access track around Moorunde was on the Portee side of the fence. Photo: Alwin Clements*

This relatively sudden increase in the kangaroo population has probably been caused, not just by the removal of sheep, but also the cessation of kangaroo shooting (primarily using the practice of "spot-lighting") conducted or allowed by the original Portee Station owner. In 2007, the Twelve Mile Plain suddenly

became a “safe haven” for the kangaroos to “lie up” in; and as they are capable of travelling up to 50km to reach and return from a foraging area[1], they can congregate here (in relative safety) even after the reserve itself is grazed out. And of course they will (and do) graze it out first, before venturing out to the wider district; to the detriment of the wombats and other wildlife that have to stay on and also need the reserve.

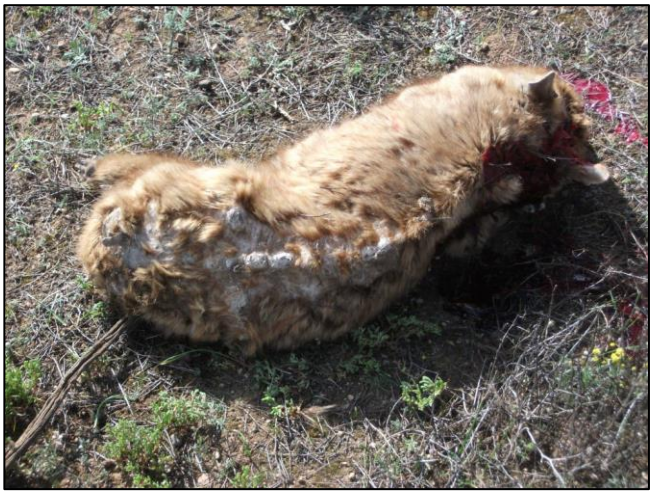

Figure 4: *Premature death of a wombat (euthanized), February 2012. This emaciated wombat was starving and suffering organ damage from a forced diet of introduced toxic weeds.*

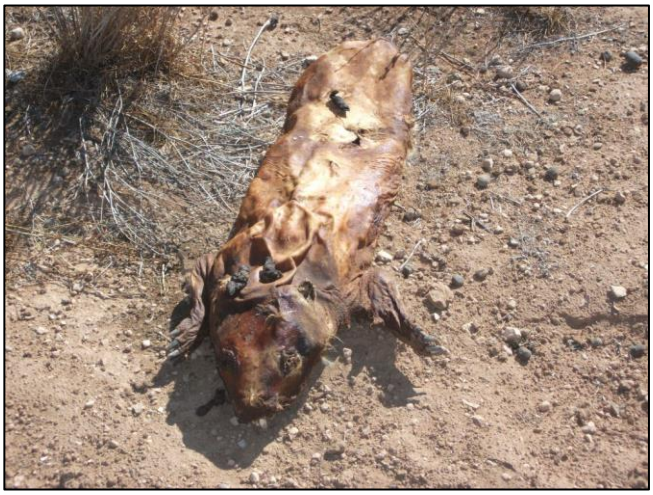

Figure 5: *Dried carcass of a wombat, April 2013 – this creature died on the surface, too exhausted to return to its burrow.*

In the meantime; and on a more positive note, some members of the Natural History Society are exploring methods of re-establishing the native grass, as it can no longer effectively do so on its own – due to, as mentioned above, the depleted “seed-bank” – to at least prevent the real possibility of these native grass species from going extinct on the reserve. Plants too, as well as animals, do after all have a right to exist! And a local extinction is the first step towards a complete one.

To this end, and after the Society held a conference in early 2012 to highlight the plight of the wombats, Society member Peter Collins successfully applied for a Natural Resources Management grant to fence off an area from kangaroos. While Peter saw the establishment of the enclosure fencing, sadly, he passed away in mid-2013, before seeing the final results of the project. The 2.7 hectare, kangaroo, wombat and rabbit proof enclosure that was erected with the grant money has appropriately been named after and dedicated to him.

The very fact that Peter “stood up” and started to do something provided me with the inspiration and motivation to get started on doing something myself; and I wasn’t going to wait for more grant money to be available (as that in itself can take some time), let alone wait for the enclosure to be erected. Because there are a number of problems to be solved in just getting the grass to germinate in the ground, let alone getting it to grow. Some of these problems are listed below:

1. Getting hold of the right species of seed (for the Moorunde area) in sufficient quantities; and being able to pay for a quantity of it.
2. Working out and deciding on the best and most practical method to plant it.
3. Finding or designing, making or adapting any machinery necessary to plant and establish a sufficiently large or significant area of grass.
4. Overcoming the “soil hard-pans” created by the wombats digging and re-digging up areas during the summer (when the soil is dry) in their efforts to obtain the introduced and toxic Thread Iris bulbs.
5. Choosing/deciding upon the best areas for the grass to grow in and/or run the trials in.
6. Overcoming the dormancy period of the Spear Grass seed, which can be up to three years or more.
7. Competition from introduced weeds.
8. When Spear Grass seeds are harvested and bagged they mat together (due to the hundreds of minute barbs on the seed head, see Figure 6) to the point where the accumulated seed, even lightly pressed into a bag, can end up like matted carpet felt underlay; and individual seeds then become extremely difficult to separate, see Figure 7. These minute barbs enable Spear Grass seeds to cling to virtually anything including the “shafts” of other spear grass seeds. This clinging effect is so extremely tenacious and is what causes the seeds to mat together. The seeds have a “sticking ability” that makes Velcro look like a lubricant!
9. The irregular and frequently inadequate yearly rainfall of the semi-arid environment that increases the risk of any trial failing due to circumstances beyond human control or influence.

Figure 6: *Close-up of a Spear Grass seed (*Austrostipa species*) showing hundreds of minute hairs or barbs. Photo: Charles Sturt University.*

[1] “Guide to the Kangaroos of Fowlers Gap”, Fowlers Gap Research Station, University of New South Wales.

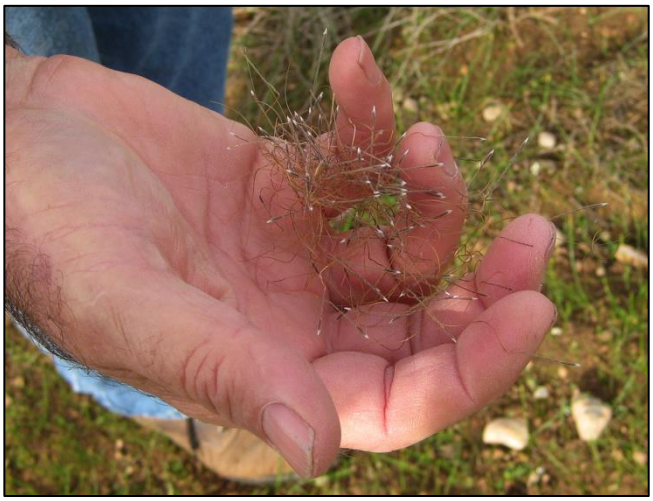

Figure 7: *Spear Grass seed (*Austrostipa species*) matted together like carpet underlay, making hand sowing difficult. Photo: Karen Collins.*

In relation to Problem 1 above, the availability of quantities of seed in any given year (and correspondingly the cost) varies according to the quantity of commercially harvested seed during the spring of the previous year. For example, Society members Peter and Karen Collins obtained two 50 gram "sample bags" of seed in 2012 (donated by Blackwood Seeds, Inman Valley) valued at $100 each ($2,000 per kilogram + GST). However, that was seed harvested in 2011. The 2012 growing harvest season was shorter than anticipated (due to a sudden drop in the spring rain accompanied by unseasonably hot weather) resulting in a scarcity of seed in 2013. The Society was only able to obtain 800 grams of seed (for planting in the 2014 season) at a price of $1,600 ($1,760 with GST). This extremely high cost was for "cleaned grade" seed rather than "re-vegetation grade" seed, which had already sold out, due to early seeding of the Spear Grass in spring and early summer 2012, catching everyone off guard. And a good reason for us to harvest our own seed!

With regards to Problems 2 and 3 above, it was (and still is) in my opinion impractical to attempt to establish an area by hand sowing. For a significant area to be established there is simply too much time and effort required, no matter how large a team of workers is assembled. And ultimately for any area to be of viable significance to wombats it would have to be in the order of hundreds of hectares. This means the use of machinery is the only practical option; and to me, any effort not involving the use of machinery would be a waste of time and effort. Hand sowing methods (if successful) would have to be relegated to small plots for the purpose of (for example) seed harvesting.

However, although machinery is made and available for establishing or re-establishing areas of native plants, I knew of none that could actually handle the sowing of Spear Grass seed, due to the matting issue mentioned in Problem 8 above. Further enquires on this matter also proved fruitless – although there are machines available to harvest the seed – for hire or manufactured on demand. There are also other "adaptive" methods of collection/harvesting.

With Problems 2, 3 and 8 in mind, I came up with the idea of cutting the "shaft" part of the seed from the "barbed spear-head" with a hand operated chaff cutter – which I happened to have. By passing the seeds through the cutter twice, the shafts were severed from the seed heads and cut into short enough lengths that the matting no longer occurred to any significant degree. As Spear Grass seed is extremely light and the required seeding delivery rates are correspondingly small (in units of grams per linear metre), it is desirable to "bulk up" the seed with a medium to make it possible to calibrate the flow rate of such small quantities of seed. It is impractical to separate the cut "shafts" from the "heads" prior to sowing, but by mixing the collection of seed "shafts" and "heads" with a delivery medium such as oat seeds or cat litter it was found possible to get it to "flow through" the delivery mechanism of a sowing machine. To "deliver" 50 grams (a volume of about ¾ of a coffee mug) into furrow say 200 metres long, is near on impossible without adding something to "bulk it up".

I came up with two possible machine options. One – an old barbeque gas bottle used as a cylindrical drum, rolling along (just above the ground) with a hole in the side that lets the seeds fall out; and two – a rabbit bait layer. The gas bottle idea would require a ripper with a cultivator shear attached – to be towed in front of the gas bottle, to make a furrow for the seed to fall into; but it had the advantage that it could handle the abrasive and coarse cat litter (which I believe is typically granulated limestone). The rabbit bait layer has to use oats rather than cat litter because the abrasive nature of the cat litter would quickly wear out the delivery mechanism. The rabbit bait layer already comes with its own small plough disc that cuts a furrow for the baited oat seeds to fall into (see Figure 8). Although in this case, the oats used as a sowing delivery medium wouldn't be poisoned. The bait layer has another advantage – a pre-calibrated delivery, meaning that the operator can easily determine how much Spear Grass seed to mix with a given quantity of oat seed to deliver over a known (or predetermined) furrow length. Should the oat seeds germinate (and some will) that is no problem in the semi-arid zone, as in an enclosure they die off and outside an enclosure they get eaten.

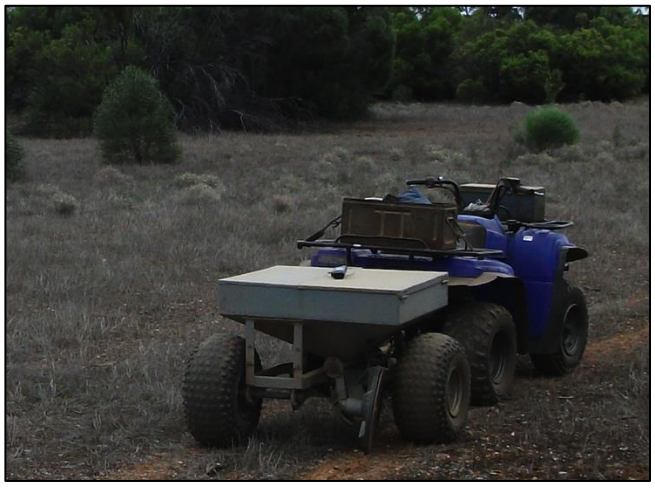

Figure 8: *Rabbit bait-layer being towed by quad-cycle. Small plough disc at rear cuts the shallow groove for the baited seed to fall in.*

Part Two

"Climate is what you expect; weather is what you get!"
– Richard Whitaker, Australian Meteorologist.

The idea of cutting Spear Grass "shaft" from its head and into shorter lengths, by putting it through a chaff cutter, was all very well but does the Spear Grass need its "shaft" to bury its barbed head for germinating? Under natural conditions the answer is almost invariably yes! Another problem to solve!

While Peter Collins worked on the NRM grant application and awaited a reply, I decided to run a test to find out if the furrow and/or ripper used in conjunction with the delivery machinery could still work. After filling two trays with soil (similar soil to that on Moorunde) I sprinkled some Spear Grass seed over the top of each. Because the seed is so expensive, I used some that I had harvested from my own property (near Cambrai). Seed that possibly wasn't suitable for Moorunde because it may not be the same species of Spear Grass; as Cambrai has a higher and more reliable rainfall – but seed that was suitable to at least test the affect that processing through the chaff-cutter had on germination. One of the trays had seed that had been "de-shafted" through the chaff cutter, plus the "shafts" cut into shorter length in the mix. This tray was also tipped at an angle to replicate the angled sides of a furrow (or trench) cut by either a cultivator shear/ripper or a plough disc. The other tray was left level and had the seed with their "heads" still attached to the "shafts", spread over the surface.

After daily watering, consisting of a few minutes under a sprinkler, for nearly two weeks, nothing had happened in either tray! Then one night we had a number of heavy showers of rain, and next morning the uncut Spear Grass seeds were standing up with their heads buried in the soil. They subsequently germinated. Large rain drops in a heavy shower fall at a speed of approximately 30 kilometres per hour – which is enough energy to lift soil particles (on bare ground) up to a metre or so above the ground. You can test this for yourself by hanging a length of white cloth over bare ground during heavy rain. One can presume, or possibly conclude that when a large drop of rain strikes a seed "shaft" (it being quite tensile), the seed springs into the air, and with the "shaft" acting like the feathers of a badminton shuttlecock, the seed falls back to earth "head first". With the barbs then doing the job of boring the seed into the soil, assisted by the vibrations from the "shaft" as it is struck again by more drops of rain.

But what about the seeds with their "shafts" cut off? With the tray tilted at an angle the rain, unlike the sprinkler, washed some soil (and seed) from the top two thirds of the tray, down to the bottom third. Most of the cut seeds were subsequently buried enough in this way that they too germinated. A furrow has two sides, with the "spoil" of soil formed from cutting the furrow left, at the top edges; so both sides would have soil and seeds washed into the bottom or centre. So I was now confident that the "cut seed" idea would work "in the field"; and furrowing or ripping was/is in any case a well-established and proven method of both pasture and native plant establishment. It has the added advantage of acting as a water catchment area and opening up an otherwise "hard top".

I already had a little ripper, as an attachment to a small grader that I had made to tow behind my quad cycle or mini tractor, to carry out repairs on the Moorunde access tracks (see Figure 9). The ripper part was originally made to cut water run-off drains, but its depth setting was adjustable so it was a serviceable implement for making Spear Grass sowing furrows. At least for small-scale sites that didn't have too many buried rocks.

To deliver the seed, I modified an old barbeque gas bottle (the smaller type that holds 4.5 kilograms of gas) with a circumference of 80 centimetres. This circumference was enlarged somewhat as it was necessary to wrap around and bolt on the tread from some old car tyres at each end of the bottle – to keep it just off the ground. After putting a shaft through the ends it could be attached to an A-frame towbar that attached to the little ripper/trencher/furrow maker. A hatch door for filling the bottle was cut into the side; then, as the bottle rolled along, seed and its delivery medium of cat litter dribbled out of a ¾" hole bored into the side of the "barrel". See Figure 10.

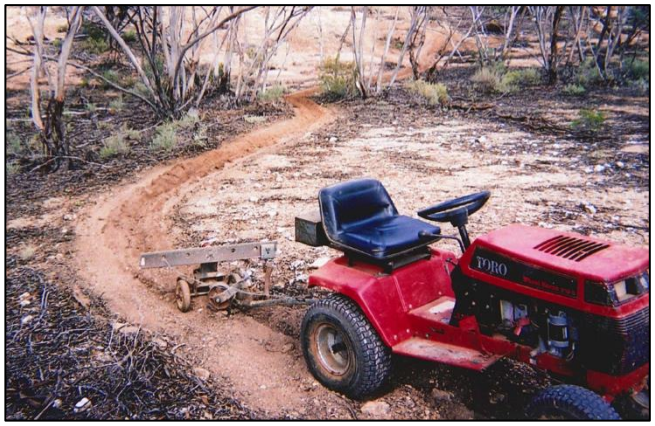

Figure 9: *Small grader towed by mini-tractor with little ripper attachment in use, cutting a water runoff drain.*

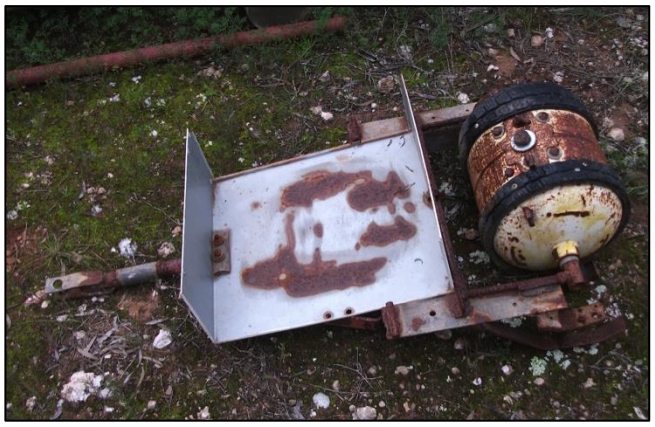

Figure 10: *Seed dispensing drum made from an old 4.5 kg barbecue cylinder fitted in an A-frame. Tow point is at the left. Strips of car tyre bolted to outside edge of drum to provide ground clearance for delivery hole. Sheet metal tray fitted for carrying various extra supplies.*

By November 2012 I had acquired (via a donation) some lengths of weld-mesh suitable to make a kangaroo, wombat and rabbit proof cage (15 x 2.5 metres) that could cover and protect five furrows, 15 metres long. I had also been given 50 grams of commercially cleaned Spear Grass seed from Karen Collins (one of the sample bags). After putting it through my chaff cutter twice to cut the shafts off the heads and then to cut these shafts into shorter lengths, the volume of the seed/cut-shaft

mixture was about ¾ of a coffee mug. After purchasing a bag of "kitty litter" from the local supermarket, I was ready to go.

The method of dropping a seed and cat litter mixture through the hole in the side of a rolling barrel (gas bottle) wasn't calibrated. This is a time consuming job that I couldn't be bothered going though. So instead of doing that I decided to fill the barrel to about two thirds and resolved to run back over the furrows again should any mixture still be left over after I had completed the lengths of furrowing I intended to do. The seed/cat-litter mixture also tended to drop out of the hole in "clumps" and to resolve that problem I dragged a short length of light chain behind the "seeder" to spread the seed further. This had the added advantage of partially burying some of the seed in the soil at the bottom of the furrows.

November was, I confidently believed, a good time to do the seeding because by that time the grass that grows naturally has "shattered" or shed it seeds onto the ground (as spring ends and summer begins). It also meant that the furrows would be ripped in dry soil, which is loose and therefore more likely to flow back into the furrows with rain, and bury the seed. Advice from a wombat expert, whom the Society had consulted, ran contrary to this. His recommendation was to sow after the first autumn rains, once the ground was wet. Although it may well be sound advice for sowing the types of species of Spear Grass that grow in wetter districts; Spear Grass (even in the semi-arid country around the Moorunde region) is still a perennial plant. To establish a root system in low rainfall (that generally falls over a relatively short growing period) it has to "get growing" on the first suitable rain, to be mature enough to get through a long dry summer. Also if the season "drops off" early and the parent plant cannot survive past spring, it needs to be able to produce viable seed by August or even by July.

In many years in these districts the first "decent rains" may not come until late May or even June; and still "drop off" by early September. These situations are not at all unusual. So any plant that germinates under these conditions will not make it, and to accommodate these vagaries in the climate and weather of the semi-arid districts the grass has adapted a number of strategies for its seeding and germination of seeds. Firstly, many of the seeds can lay dormant in the ground for several years; and in fact most of the seed will not germinate in the season following the year it falls from the stem. Secondly, heavy soaking rains in late summer or very early autumn, although uncommon but not unusual, are the favoured germinating conditions (personal observation). Plants that do germinate under these conditions can rapidly grow in the warm wet soil and warm sunny weather at this time of year; to a stage where they can then go into a state of arrested development that enables them to survive in something like a dormant state should no further rain fall until the "season proper opens" later in the year. Say late May or early June (personal observation).

The plant is then ready to "leap away" and "run up" viable seeding stems, even if the season then "drops off early", and total yearly rainfall is ultimately below average. This means in fact that Spear Grass has another adaptive advantage – it can act as an annual grass as well as a perennial (personal observation). As with all other annual grasses (including cereals such as wheat, barley and oats), after the seed has been fertilised (pollinated) the parent plant can (and usually does) die at the base first or at least its seeding stems do, as the soil dries out in spring.

The seeds "fill" from the bottom of the stem up. That is, the seeding stems die last and from their base (even if the parent plant is alive or not) – there is enough moisture, energy and nutrients in the still green stem for the seeds to "fill" and become viable without further rain. This is why and how farmers, in the days of sickles and scythes (tools that cannot effectively cut dry cereal stems), harvested their wheat, barley and oats when the crop was still green! They then bound a bundle of stems into a sheaf and stacked the sheaves into stooks for the grain to fill and ripen in the field. So the species of Spear Grasses in arid and semi-arid regions have adapted to not just manage the climate (in these regions) but also the weather!

By 14 November 2012 I had everything ready to start the trial on these premises and had chosen what I considered a good site – a clay-pan that regular attendees at our Visitor and Volunteer Weekends call "Casuarina Flat". It is situated just off and north of the main entrance track (Woodcutter Track) about halfway between the entrance gate and the campsite. There are a number of reasons for choosing this site. Firstly it is a clay-pan, and from many years of personal observation, personal communication with northeast pastoral district station people and from botanists such as Michael Hyde[2], I knew clay-pans to have been originally the favoured sites for Spear Grass to grow on. Secondly, the site being just off the entrance track was convenient to regularly inspect and easy to show to visitors. But perhaps most important of all, the area had been completely and repeatedly dug over by wombats seeking Thread Iris bulbs to eat! Consequently, by ripping a number of short (30 metre) furrows through this ground, it was hardly likely that any more damage could be done to the soil or its duricrust.

As my caged off area was to be only 15 metres long, there would be another 15 metres left exposed – to see what happened to that too. These exposed furrows ultimately did in fact get re-dug so extensively by the wombats that there was no trace of them left by May 2014, the time of writing. Although, before then, some Spear Grass had managed to germinate in them. A fourth reason for choosing this site is related to this constant digging by wombats. The clay-pans, although originally the best grass growing sites, were the areas that had been degraded the most from firstly overgrazing by sheep and then the constant summer digging. This caused the soil to form a "hard-pan" and in most instances removed any viable grass seed still dormant in the ground. So they are the sites most in need of recovery and restoration work – being the sites where natural regeneration is most unlikely to occur. It was reasonable to assume that any seeds that I planted, and which subsequently grew, would most likely be the only viable seeds present there, and therefore provide a good indicator as to the success of the method. Later (by May 2014 after seeding November 2012), this premise proved to be correct!

In addition to the caged and uncaged furrowed areas prepared for the seeding trial, I also erected a 2.5 x 2.5 metre cage as a "control site", adjacent to the furrowed area. This 6.25 square metre area was to have no seeding sown in it and would thus provide a comparison to the site prepared for sowing the seed in furrows.

[2] Michael Hyde (1957-2003), "Remnant native grasslands in the Mount Lofty Ranges, South Australia", 2001 and "An interim grass flora of South Australia", 2002.

Part Three

"A good farmer, John, has three important attributes – the ability to anticipate events, the capacity to be observant, and patience. By the time you have finished working for and being trained by me, you will leave with these abilities and my reference for your future employees will reflect that."
– Henry Young, Station Owner, Southeast District.

Just because some Spear Grass (and to a lesser extent Wallaby Grass) can still be seen to be germinating and growing naturally on favourable years in some places, there is no room for complacency or confidence that it will ultimately survive without intervention. Observations over many years on the Reserve (Moorunde and the Twelve Mile Plain) and confirmed in enclosures erected over a range of years indicate that the native grasses are in a state of serious decline. It is possible that they may well disappear completely in the foreseeable future without intervention; and in any case they are already so depleted that they no longer form even a minute fraction of the diet for wombats or kangaroos. The year 2013 was, and in all probability 2014 will be, a good year for the native grasses to germinate and grow (if the seed-bank was there) but germination still falls far short of what should be, and once was, the situation even as recently as 1974. When the grass, even on Portee Station (now the Twelve Mile Plain) was like a crop of wheat compared to about 0.001%, that grows now; or 0.01% if an enclosure is erected over a favourable site.

Those figures are only "guesstimates" of course. However, after two germination seasons in the 2.7 hectare enclosure (erected by April 2013), by May 2014 there was only an average of 0.5 Spear Grass plants in each of twenty randomly placed square metre quadrants (i.e. 10 plants in a total of 20 square metres counted) where there should have been about 100 plants per square metre (as was observed in the total-exclusion trial enclosure shown in Figure 1 of Part 1).

Intervention therefore, regardless of what can still germinate naturally will be an essential requirement; to ultimately prevent extinction of the grass on the reserve, and for maintaining and managing the reserve and other conservation areas within the district. Seeding trials and observation of their results will be an important factor for the future of Moorunde, its wombats and other wildlife. Regardless of what grasses can be seen to grow naturally in the enclosures that are constructed to conduct the trials. Natural regeneration inside any enclosure constructed for seeding trials gives a false indicator to what is actually happening outside in the wider reserve.

The site chosen for the 2.7 hectare enclosure funded by the NRM grant was selected after consulting an expert on wombats. He didn't select a clay-pan for the location of the enclosure. In personal conversation with me, he said that his site selection was "based primarily on the fact that most of the ground to be enclosed had not been hard-panned by the constant digging by wombats. It would therefore be more conducive to getting grass to grow successfully".

This meant that the vast majority of the land that was once the most suitable for Spear Grass was to be overlooked – areas that represent a considerable portion of the Reserve. See Figure 11, which shows a large area in the Reserve that is mostly clay-pan. The vegetation seen in the foreground is not Spear Grass but introduced Onion Weed that is highly unpalatable to all grazing animals. It also meant that as the soil in this location (the 2.7 hectare enclosure) was already in better condition and largely unchanged (except for weed infestation) then germination from natural seeding could confuse trial results. While the 15 x 2.5 metre (37.5 square metre) enclosure site on "Casuarina Flat" was unlikely to have any natural residual seed (seed-bank) to confuse issues – which later proved to be the case. The site of the 15 x 2.5 metre enclosure was also representative of most of the areas that need regeneration work, which is also what influenced my own site-selection decision. Figure 12 shows an area representative of such land in need of regeneration.

Figure 11: *Example of one of many large clay-pans on Moorunde – dug over by wombats and now infested with unpalatable Onion Weed.*

Figure 12: *This site is representative of large areas of the Twelve Mile Plain, that will not be able to recover without intervention and their condition will continue to decline. Compare this with Figures 1, 2 and 3!*

This must not be confused as my being critical of the site chosen for the 2.7 hectare enclosure erected with the NRM grant. My line of thought was to test multiple locations, which differed with the desire of others to enclose as large an area as possible with the available money. Which cannot be done if expensive fencing material is divided up to enclose multiple smaller sites instead of one. For example, 400 metres of wire netting will fence off one hectare (a square, 100 metres by 100 metres). However, should one wish to make two smaller enclosures with the same 400 metres of wire netting, each enclosure would be 50 metres by 50 metres, and a total of only 0.5 hectares is enclosed (i.e. only half the total area is enclosed

even though you have two enclosures). Also, twice as many corner strainer posts and gateposts are required.

Figure 13 is a photo of the five 30 metre long furrows cut and seeded (on 14 November 2012) on "Casuarina Flat". To the left is a sixth furrow as I did have some seed mixture left over and in fact I ran-out an extra 20 metres of seed, not in a furrow. This made up a total of 200 metres of seeded rows that "rounded off" the seeding "delivery rate" to 50 grams of seed per 200 linear metres or 0.25 grams of seed per linear metre. Inside the caged off section (see Figure 14) there were five 15 metre long furrows, a total of 75 linear metres. With a row spacing of 0.5 metres this represents an enclosed seeded area of 37.5 square metres. The "delivery rate" of 0.25 grams per linear metre over 75 linear metres was then equivalent to a "seeding rate" of 18.75 grams of seed over the enclosed 37.5 square metres or 0.5 grams of seed per square metre. And it is important (in the business of pasture establishment) to recognise the difference between "delivery rate" (per row or per unit of length) and "seeding rate" (per unit of area).

Figure 13: *Five 30 metre long furrows to be enclosed by the 15 x 2.5 metre cage, leaving 7.5 metres of furrow uncaged at each end, November 2012.*

Figure 14: *The 15 x 2.5 metre cage enclosing five 15 metre long furrows, a total of 75 linear metres, November 2012.*

By May 2014 the uncaged portions of the five furrows, extending beyond each end of the caged-off area, plus the extra furrow (the sixth furrow) and also the extra 20 metres seeded (but not in a furrow) had been completely obliterated by further digging by the wombats. Thus demonstrating my point that I wasn't, in ripping the furrows, doing any more damage – per se – than the wombats (see Figure 15). Initially, the 20 metres of seeding without a furrow could be traced because the white granules of cat litter could easily be seen – that eventually disappeared too.

On the day of seeding there was a south-easterly wind, and quite a bit of the Spear Grass seed was blown across the furrows before hitting the ground. This seed fell into a set of trenches that had inadvertently been formed by the soil spoil that had been thrown up between the furrows as the cultivator shear passed through. So that in effect, the wind-blown seed was also in "furrows". Later, this observation was an issue to keep in mind, when seeds did eventually germinate there.

Now it was just a case of patiently waiting to see what would happen! The opening rains for 2013 (remember that the seeding was done in November 2012) came as accumulated rainfall events on 22 and 29 April. Both rain events fell over a period of a few days, and the result was ideal conditions for Spear Grass germination – as illustrated by observations over the wider reserve and inside the large 2.7 hectare enclosure that had by then been erected. (This however was only in comparative terms from recent previous years). But! In my small trial plot, nothing happened – no grass germinated! Although I was a little disappointed, it came as no surprise as I had anticipated the dormancy factor inherent in Spear Grass germination.

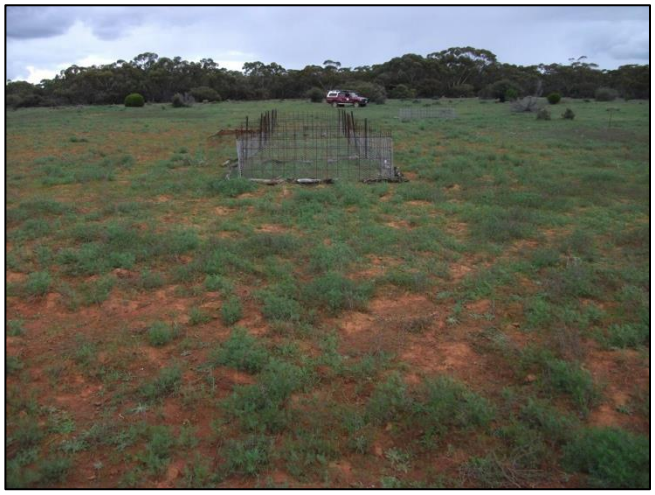

Figure 15: *May 2014 and the 7.5 metre lengths of furrow extending at each end of the 15 x 2.5 metre cage have disappeared due to the persistent digging-over by the wombats.*

However, at the time of writing (28 May 2014), that is, the second year after planting, I had counted 120 Spear Grass plants growing and well established within the 15 x 2.5 metre enclosure. This included a fairly large number growing in the "accidentally" created furrows between the spoil of soil of one furrow and the spoil of the next (the seed having been blown there by the wind at seeding time). Some plants could also be found in the area seeded outside the enclosure – all of them closely "cropped down" by either wombats or kangaroos grazing on them.

There may yet be more seeds to germinate in years to follow. However, 120 plants in the 37.5 square metre enclosure or a total of 75 linear metres of furrow, from a "delivery rate" of 0.25 grams of seed per linear metre, is not a bad result. The rows were 0.5 metres apart and therefore, as explained earlier,

equivalent to a "seeding rate" of 0.5 grams of seed per square metre. A fairly good germination rate of 1.6 plants per linear metre or alternatively 3.2 plants per square metre for a species of grass notoriously difficult to propagate in the field. These plants should and probably will grow on to produce several hundred seeds per plant.

Figure 16 shows four Spear Grass plants in the enclosure – one at centre bottom of the frame beside a clod of earth, a larger one above that and then above that, two smaller plants side by side in the furrow.

Figure 16: *Four Spear Grass plants growing in the 15 x 2.5 metre "Casuarina Flats" trial enclosure.*

Returning to the 2.7 hectare Peter Collins enclosure…

During the Visitor and Volunteer weekend of May 2013, I ran a trial in the 2.7 hectare Peter Collins enclosure that had then just recently been erected. For some obscure reason the 800 gram bag of Spear Grass seed the Society had purchased had been entrusted to me for "safe keeping". So I decided to help myself to 150 grams of it! Originally I had intended to use a rabbit bait-laying machine from the Cambrai depot of the Natural Resources Management (NRM) Board. However, the gateway into the enclosure was too narrow to get it in. The bait layers we use on Moorunde had all been modified to cut a much narrower furrow than the NRM machine – to reduce damage to the soil duricrust over the reserve, when laying the rabbit bait. In fact the Moorunde bait layers really only cut a shallow groove in the soil about 2-3 centimetres wide and 1-2 centimetres deep. These bait-layers could pass through the enclosure gateway, so I tested the ability of the Spear Grass to germinate in the narrow channels created with these machines by running out four 175 metre furrows (grooves rather than furrows). However even by 28 May 2014 I could find no grass in these shallow "grooves".

I also cut three 175 metre furrows with my little ripper/trench digger and seeded them at the same "delivery rate" as the four shallow "grooves" – 0.12 grams of seed per linear metre; or 12 grams per 100 linear metres. A total of 525 linear metres of furrow (three x 175 metres) using a total of 63 grams of seed. The rest of the seed (87 grams) was sown in the four shallow "grooves" cut by the bait-layer.

On this occasion, the furrows created by my little ripper were not completely ideal for sowing the seed, as the soil was already damp and root bound with weeds. So the furrows were not as deep as I would have considered optimal and the spoil soil was less likely to wash back into them.

However, by 28 May 2014 I had counted 252 Spear Grass plants in the "little ripper furrows", that had obviously germinated after the heavy February and nearly as heavy April rains (2014). This represented a germination (or "strike") rate of 0.48 plants per linear metre or 48 plants per 100 linear metres – compared to a germination rate of 1.6 plants per metre that I had obtained in the small "Casuarina Flat" enclosure. Seeding "dry" into the "Casuarina Flat" clay-pan soil at a delivery rate of 0.25 grams per linear metre compared to 0.12 grams per linear metre in the larger enclosure, even after taking into account the higher delivery rate of seed, the "Casuarina Flat" enclosure still provided a significantly better result.

Figure 17 shows a small Spear Grass plant that germinated in 2014 growing in one of the furrows in the 2.7 hectare enclosure and alongside is a much larger plant that had germinated the year before, after the 2013 April "opening rains". The two different generations can be (at this time) easily distinguished visually. The naturally germinated seed from 2013 has the dry/dead seeding stems from the previous spring/summer. While the plants in the furrows are much smaller and lack the dry/dead stems. It is also reasonable to assume that the vast majority of plants growing in the furrows (if not all) are from the artificial seeding too. As any naturally germinated seed (from 2014) was too wide spread to be of any real consequence. And any dormant seeds in the furrow would have been dug out as the furrow was cut. The plant count conducted elsewhere in the enclosure, in 20 random one-square metre quadrants, found 10 plants but only two of these had germinated in 2014, the rest were more mature plants from the 2013 germination – plants in their second season. Figure 18 illustrates a "second season" Spear Grass plant with its dry and dead seeding stems and leaves. Just one dead stem in a plant (no matter the size of the plant) is sufficient to indicate that it is in its second season.

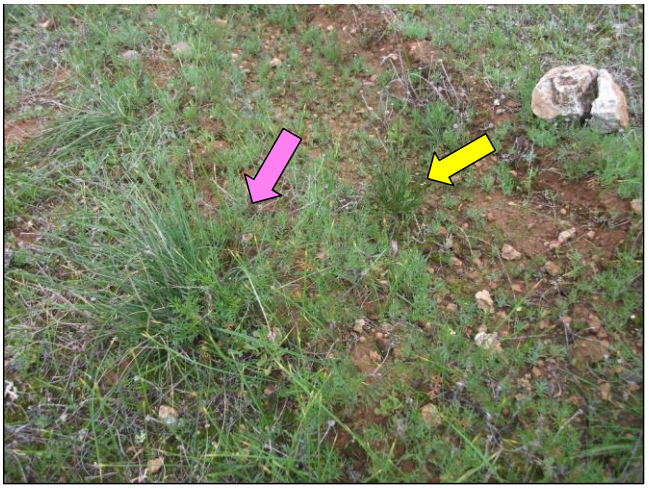

Figure 17: *A small 2014 germination Spear Grass plant (yellow arrow) growing in a furrow in the 2.7 hectare enclosure and a large "second season" (2013 germination) plant growing outside the furrow (pink arrow).*

Figure 18: *A "second season" (2013 germination) Spear Grass plant, easily distinguished by dry and dead seeding stems and leaves.*

Part Four

"Although some farmers do have degrees in agricultural science, being an Agricultural Scientist doesn't make you a farmer. Farming is the practical application of the Art, Science and Business Management of agriculture."
– Farm Management Lecturer,
Roseworthy Agricultural College, 1968.

Summary and Discussion

Casuarina Flat Enclosure
Seeding conducted on **14 November 2012**

- **50 grams of seed distributed along 200 metres** of seed trail as follows:
  - 20 metres without furrow,
  - 6 x 30 metre furrows (180 metres of furrow)
  - 5 x 15 metre lengths of these furrows enclosed in a grazing proof cage, i.e. *a total of 75 metres protected from any grazing.*
- **No germination** was observed on any of these portions of the seed trail in **2013**.
  This indicates that there was (1) no dormant natural "seed bank" in the ground at the time of seeding and (2) there was at least a one year dormancy period for the seed sown in 2012.
- A 6.25 square metre caged off area along side the seeded area was left un-seeded as a "**control site**". It showed no germination of grass in either 2013 or 2014, further indicating the absence of any natural "seed bank".
- **Delivery Rate** (quantity by weight of seed applied per unit length): **0.25 grams per metre**.
  Equivalent to 25 grams per 100 metres.
- **Seeding Rate** (quantity by weight of seed applied per unit area): **0.5 grams per square metre**.
  Equivalent to 5 kilograms per hectare.
  (Note: as the germination in the uncaged area was not measured, due to extensive digging/disturbance and heavy grazing, the calculations converting Delivery Rate to Seeding Rate for this area, are not presented here. It must also be noted that the Seeding Rate inside the enclosure was calculated using 0.5 metre row spacing.)
  Calculations converting Delivery Rate to Seeding Rate:
  0.25 grams per linear metre over 75 metres of furrow (caged area) = 18.75 grams of seed,
  5 x 15 metre lengths x 0.5 metre row spacing = 37.5 square metres of sown land,
  18.75 grams ÷ 37.5 square metres = 0.5 grams per square metre.
- **Strike Rate** (number of plants germinated per unit length): **1.6 plants per metre**
  Equivalent to 160 plants per 100 metres.
  (120 plants counted in the 75 metres of furrow in the caged area, 120 ÷ 75 = 1.6)
- **Germination Rate** (number of plants germinated per unit area): **3.2 plants per square metre**
  Equivalent to 32,000 plants per hectare at 0.5 metre row spacing.
  Equivalent to 16,000 plants per hectare if 1 metre row spacing was used – see **Discussion** below.
  (120 plants counted in the 37.5 square metre caged area, 120 ÷ 37.5 = 3.2)

2.7 ha Peter Collins Enclosure
Seeding conducted on **18-19 May 2013**

- It must be noted that in this enclosure some natural germination occurred in 2013 and 2014. An attempt to measure this natural germination was conducted in May 2014, supervised by Society President Peter Clements. A square metre quadrant was randomly placed at twenty locations over the un-seeded area within the enclosure (a total of 20 square metres) and plants were counted in each of the quadrants. This gave a total count of 10 plants per 20 square metres, germinating naturally, equivalent to an average of 0.5 plants per square metre. This square metre quadrant method was undertaken because it is "usual scientific practice", however I considered the method to be somewhat inappropriate in this situation – trying to compare a unit of area of natural germination with a linear planting germination method. With this in mind, I used, as a "control" comparison, the shallow grooves cut by the bait layer that were adjacent to the seeded furrows. I counted the natural germination along the four grooves closest to the three furrows – supervised by Society Member Geoff Weller[3] (a retired farmer and teacher). As mentioned previously (see Part 3), as of 28 May 2014, there was no germination of *seeded* grass inside these four 175 metre long shallow grooves. Allowing for the grooves being on average 10 cm wide, I counted all plants within 5 cm either side of the centre of the groove. There was a total *natural* grass germination of 32 plants, 14 from the 2013 season and 18 from 2014.

Summary of seeding trial in furrows cut by my little ripper within the Peter Collins Enclosure

- **63 grams of seed in 525 metres of furrow**
  (Note: row spacing was not considered here, as only the method of seeding was being tested)
- No germination took place inside the furrows in 2013 indicating there was no dormant natural seed present in

[3] Geoff Weller also supervised the count of Spear Grass in the furrowed areas of the enclosure on Casuarina Flat as well as the count conducted in the grooves of the Peter Collins Enclosure.

the furrows. A number of plants (uncounted) germinated in 2013 in the soil spoil (created by the cultivator shear) alongside the furrows indicating that dormant natural seed had been dug up and thrown out of the furrows while being cut. Thus leading to the reasonable assumption that most (if not all) of the germination in the furrows in 2014 would be from the artificial seeding.

- **Delivery Rate** (quantity by weight of seed applied per unit length): **0.12 grams per metre**.
  Equivalent to 12 grams per 100 metres.
- **Seeding Rate** (quantity by weight of seed applied per unit area)
  As noted above, row spacing was not considered. However, 100 rows, 100 metres long and one metre apart cover an area of one hectare, so an arbitrary seeding rate can be calculated.
  Calculations converting Delivery Rate to Seeding Rate:
  0.12 grams per metre x 100 rows x 100 metres = 1,200 grams or **1.2 kilograms per hectare**.
- **Strike** Rate (number of plants germinated per unit length): **0.48 plants per metre**
  Equivalent to 48 plants per 100 metres.
  (252 plants counted in the 525 metres of furrow, 252 ÷ 525 = 0.48)
- **Germination Rate** (number of plants germinated per unit area)
  Once again, assuming there are 100 furrows 100 metres long and one metre apart; one hectare would be seeded in 10,000 metres of furrow. With a strike rate of 0.48 plants per metre the calculated germination rate is 0.48 x 10,000 = **4,800 plants per hectare**.

Discussion

We can make some limited comparisons with an exercise conducted on Craigburn Farm (south of Adelaide) by the Department of Environment, Water and Natural Resources (DEWNR) where an area was revegetated with native Wallaby Grass[4]. Much of the trial is not relevant to the discussion here, however of note, they used a **Seeding Rate** of **8 kilograms per hectare**. Figure 19 illustrates their germination results.

Spear Grass seed is slightly heavier than Wallaby Grass seed so there would be a little less Spear Grass seed per kilogram; however 8 kilograms per hectare will be used as a guide/comparison here.

Once again, using our 100 metres x 100 rows (10,000 linear metres) to cover one hectare, we can convert the 8 kilograms per hectare Seeding Rate to a **Delivery Rate**:

8 kg or 8,000 grams ÷ 10,000 metres = **0.8 grams per metre**.

This is a Delivery Rate 3.2 times greater than what was used in the Casuarina Flat enclosure and 6.67 times greater than what was used in the Peter Collins Enclosure. With this Delivery Rate, and all other things equal, the Casuarina Flat **Germination Rate** of 16,000 plants per hectare (based on one metre row spacing, not the 0.5 metres as actually used) would increase to **51,200 plants per hectare!** The Peter Collins Enclosure **Germination Rate** of 4,800 plants per hectare would increase to **32,000 plants per hectare!**

Figure 19: *Craigburn Farm. Seeding grass tussocks two years after establishment, November 2013,* "Establishing Native Grass Cover in Grassy Woodland Restoration Projects", Chris Gibson, June 2014.

With these considerable differences in mind, it can be seen that the seeding trials on Moorunde were conducted with and extremely light Delivery or Seeding Rate – due to the expense of the seed, which we hope to remedy in the future by having our own seed harvesting area. It also renders any comparison between natural germination and that of seed artificially planted somewhat irrelevant. Simply because:

1) natural germination will depend on the site selected to conduct a trial – note that there was no natural germination on the Casuarina Flat trial; and
2) any comparison would still be dependent on the amount of seed applied per unit area within the trial site.

The trials discussed in this report were conducted to test the seeding technique and were not intended to be used as a comparison between that and what grows/germinates naturally, in any given area. So this technique worked!

Topics for future discussion are:

- the different treatments, depending on soil types, to prepare an adequate seed bed;
- the optimum economic seeding rate to re-establish large (very large) areas;
- the re-establishment of native grasses using grass grown in tube stock;
- establishing the priority locations to focus on;
- the feasibility in terms of resources available and problems still to resolve – in other words the Art, Science and Business Management of such a project.

"If you see native plants as your "pasture" and native animals as your "livestock", conservation reserves, just like farms, have to be managed, and the work required to do it is not all that different, as the principles are the same"

– (the late) Peter Aitkens, former Curator of Mammals, South Australian Museum.

[4] "Establishing Native Grass Cover in Grassy Woodland Restoration Projects", Chris Gibson, Department of Environment, Water and Natural Resources, June 2014, DEWNR Technical Note.