

**EFFECTIVENESS OF WATER MEDICATION
TO SUPPLEMENT BREEDER CATTLE
IN SPINIFEX COUNTRY**



**PRODUCER DEMONSTRATION SITE
ALICE SPRINGS DISTRICT**

**Effectiveness of Water Medication
to Supplement Breeder Cattle in Spinifex Country**

NT Department of Business, Industry and Resource Development

and

Meat and Livestock Australia

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1. EXECUTIVE SUMMARY

1.1 What Was Done

This was a two-part producer demonstration site (PDS) with the PDS Part 1 (1998 to 1999) using 314 mixed-age breeder cows and the PDS Part 2 (1999 to 2001) using 286 first calf heifers. In both parts of the PDS the cows or heifers were drafted into two even groups and put in separate paddocks. One group received nutrient supplement by water medication (Treatment group) and the other group received no supplement (Control group).

1.2 Why Use Water Medication

Water medication has long been recognised as an alternative means of supplementing cattle. Technological improvements to the systems that deliver nutrient supplement through the water have greatly improved their safety and cost-effectiveness in recent years. Producer interest has been renewed in this method of supplementation after a long period of scepticism due to early safety problems. Central Australia is well suited to water medication due to the vast majority of stock watering points being troughs rather than uncontrolled surface water. This PDS was set up to demonstrate to pastoralists, the safety aspects and cost-effectiveness of water medication in marginal country in the Alice Springs district of the Northern Territory.

1.3 Summary of Findings

In both parts of the PDS there was considerable productivity improvement in cattle receiving nutrient supplement through water medication systems, compared to unsupplemented cattle.

Breeder weights, pregnancy rates, weaner weights and weaner numbers, plus the approximated number of breeder cow deaths, were considered when analysing the results. In a cost:benefit analysis on findings recorded over a dry year in the PDS Part 1, there was a net benefit to cost ratio of greater than 9:1 for the Treatment group.

The two years of the PDS Part 2 had exceptional rainfall. Cattle were on water medication for approximately 50% of the time due to the availability of surface water. However the results clearly demonstrated more production from the Treatment group compared to the Control group through increased numbers of pregnant heifers plus more and heavier weaners.

The reliability of the water medication units was demonstrated over the 3-year period. Very few faults occurred with the units during the PDS and those that did were minor. More importantly there were no cattle deaths recorded as being due to urea poisoning.

This PDS demonstrated considerable benefits to breeder cattle production on spinifex grazing country from using water medication.

2. INTRODUCTION

2.1 Alice Springs District Information

The Alice Springs district is an arid region that normally has a dry climate with low and erratic rainfall. Temperatures are normally high during summer, but there is a high day/night range with frosts in winter. The evaporation rate is high throughout the year with an average evaporation rate at Alice Springs of 3,000 mm or ten times the average rainfall (Roeger and White 1996).

The co-operating MacDonnell Range producers in the water medication Producer Demonstration Site (PDS) have large properties that average around 2,000 km². This producer group covers an area of 15,561 km². The area has annual rainfall similar to Alice Springs, which has recorded rainfall ranging from a low of 60 mm (1928) to a high of 782 mm (1974) (Roeger and White 1996).

The MacDonnell Range producers specialise in extensive beef cattle production. There are a number of different cattle breeds used including Brahmans, Santa Gertrudis, Shorthorns and crossbreeds. These producers have classed their properties as one-third good country, one-third marginal country and one-third less productive country (NT DPIF 1995). The less productive country has the least potential for profitable cattle production.

Spinifex country is the least productive land type in the Alice Springs district and covers up to 70% of individual stations in the MacDonnell Range producer group. Because of the large areas of spinifex country, even slight productivity improvements have potential financial benefits. The other major land type in the PDS area is limestone country. Producers consider limestone country to be very sweet annual grass country with a light carrying capacity (NT DPIF 1995).

The MacDonnell Range producer group identified and recommended that water medication be investigated as a means of improving the productivity of spinifex country. This Water Medication PDS was a direct result of that recommendation.

This PDS was located at Narwietooma Station (2,725 km²)—one of the larger properties in the MacDonnell Range producer group. The Narwietooma homestead is situated 160 km north-west of Alice Springs by road (co-ordinates: 23°15' S, 132°38' E).

2.2 Background to Supplementation in the Alice Springs District

It has been well documented that native pastures in the Northern Territory have low digestibility, are deficient in nitrogen (N), phosphorus (P), and sodium (Na) for most of the year, plus are deficient in sulphur (S) in the dry season (Andison 1994). This is especially true in the Alice Springs district where on average there is one dry year in four and always the possibility of several consecutive dry years (Bertram *et al.* 1996).

Nutrient supplement has been widely used throughout the Northern Territory for many years as a means of overcoming these pasture deficiencies. Methods of supplementation have included the use of lick blocks, loose (dry) mixes and to a lesser degree over the past twenty plus years, water medication.

Water medication has long been recognised as an alternative means of supplementing cattle. Mechanical-type systems were used in the early stages of water medication in the Alice Springs district. Unfortunately these systems often failed, causing cattle deaths through urea poisoning. The reason for failure was often the corrosion of moving mechanical parts, operator error, or damage to equipment by cattle and other animals. After a number of cattle deaths through urea poisoning, the few producers who were supplementing through the water stopped using these systems and went back to supplementing with lick blocks and dry mixes.

In 1989 an electronic water medication unit (prototype of the NORPRIM® unit) was designed by Jack Peart of the then NT Department of Primary Industry and Fisheries (DPIF) in Alice Springs. Jack was the District Animal Production Officer for the department at the time. As with most new innovations there were teething problems and cattle losses occurred through unit unreliability and operator error.

Despite these losses, local producers and DPIF staff continued to see the enormous potential benefits of water medication. With the assistance of an electronics expert, the original unit was modified and improved to a high standard of reliability and safety. The current manufacturer who took over the marketing of the unit has further improved the design and safety features of the NORPRIM® unit to the highly professional and safe standard it is at today.

There are at present two electronic water medication units that are marketed from Queensland and are being used successfully in the Northern Territory:

- the NORPRIM® unit which was developed in the Northern Territory;
- the NUTRIDOSE® unit which was developed in Queensland.

These electronic units are ideal because they can be used for most flow situations, such as from a turkey nest, tank or straight off the direct flow from a bore. They work well in situations where there are low-pressure heads and can service single or multiple troughs.

The NORPRIM® unit was used in the Narwietooma water medication PDS.

2.3 Water Medication versus Lick Blocks

There are obvious advantages and disadvantages to using water medication as opposed to lick blocks for cattle supplementation in Central Australia.

Some Advantages of Water Medication:

- The cost of providing equivalent nutrients is approximately half that of proprietary lick blocks.
- All cattle receive their nutrient requirements, as water intake is proportional to body size—problems with gluttons and shy feeders are eliminated.
- Cattle receive appropriate nutrients (e.g. phosphorus) even when there is abundant feed available (Dolinski and McLennan 2002).
- Cattle spend less time congregating around water points, as there are no attractants such as lick blocks to keep them there (*pers. ob.*; Dolinski and McLennan 2002).

Some Disadvantages of Water Medication:

- There is an up front capital cost to install the units.
- Knowledge and skill is required to operate the units.
- When surface water is available (e.g. after rainfall), cattle will rarely drink on controlled waters.

There is a perception in the district that water medicators have low reliability. This perception is based on producers' previous experiences and the disadvantages listed above.

2.4 Objectives of the Producer Demonstration Site

This PDS had three objectives:

Objective 1

To demonstrate and record productivity improvement in breeders receiving nutrients by water medication systems, compared to unsupplemented breeders on similar country.

Objective 2

To demonstrate a reliable and cost-effective means of providing essential nutrients to cattle.

Objective 3

To demonstrate that marginal country can be utilised and productive all year round.

3. MATERIALS and METHOD

3.1 Two-Part PDS

This was a two-part PDS with the PDS Part 1 using mixed-age breeder cows (1998 to 1999) and the PDS Part 2 using first calf heifers (1999 to 2001). Towards the end of the first year of the PDS, the participating producer suggested that first calf heifers be used for a second phase of the PDS. The rationale for this was that there is very little data available in the Alice Springs district on the benefits of supplementing first calf heifers and there have been problems getting them 'in-calf' again following their first calf. By changing the PDS Part 2 group to first calf heifers, valuable information would be obtained on the benefits of nutrient supplement to this high-risk group of cattle.

3.2 The Paddocks

The participating producer made a 118.3 km² paddock available for the PDS. The property had previously been extensively surveyed by the NT Department of Lands, Planning and Environment, so information was readily available on specific land types and the areas they covered.

The original paddock was split in two using a two-wire electric fence. The fence was positioned to ensure that the proportions of land types were as similar as possible in both paddocks. The paddocks were slightly different in size with the western side of the paddock being 64.5 km² in total, consisting of 26.5 km² of limestone country and 38.5 km² of spinifex country. The eastern side of the paddock was 53.8 km² in total, consisting of 31.5 km² of limestone country and 22.3 km² of spinifex country.

Paddocks and waters were checked on a regular basis and maintained as required by both station and the NT Department of Business, Industry and Resource Development (DBIRD) staff throughout the PDS.

3.3 Waters and Equipment

There were two operational bores in each paddock—Lynch and Lignin bores in the eastern paddock ('Hill' paddock); Wilke and Browse bores in the western paddock ('Camel' paddock). All bores pumped water into turkey nests that then supplied water to troughs in trap yards at each bore.

'Hill' paddock had the complication of a dam containing water for most of the PDS period. This dam was fenced off and the fence was maintained in the PDS Part 1 when the water medication units were in this paddock.

NORPRIM® water medication units were used for both parts of the PDS. For the PDS Part 1 (1998 to 1999), units were installed at Lynch and Lignin bores in 'Hill' paddock. The unit at Lynch bore had a turbine flow meter and the unit at Lignin had an in-line paddle-wheel flow meter to record water flow.

Both the turbine and in-line paddle-wheel flow meters sent a signal to an electronic controller that ran an injection pump for a set time. This pump then injected nutrient concentrate from the nutrient tank and dispensed an accurate dose into the trough (Appendix 1. Calculation of Nutrient Dosage for PDS Water Medication).

During PDS Part 1 paddock inspections it was observed that cattle mainly watered at Lynch bore in preference to Lignin bore. This was fortunate because observations established that the turbine flow meter at Lynch bore was more accurate in water measurement than the paddle-wheel flow meter at Lignin bore. As a result the majority of Treatment group cattle would have received nutrients at the required rate during PDS Part 1. The higher accuracy of the turbine flow meter was more apparent when only a few head of cattle were drinking and water inflow past the meter was low. The option of paddle-wheel flow meters should not be dismissed, as recent improvements in design and safety may have overcome the problem identified in this PDS.

Water measurement is critical because it determines the amount of nutrient that is dispensed into the water.

In PDS Part 2 a couple of changes were made. As a result of observations on the flow meters, turbine meters were fitted to both water medication units. The units were then swapped from the 'Hill' paddock bores to the 'Camel' paddock bores. The latter was done to help detect paddock differences that could have influenced the PDS results.

**Figure 1. Water medication unit
- on property installation**



3.4 Paddock Groups - Mixed Breeders: PDS Part 1

A group of 314 mixed-age, continuously-mated breeder cows was split into two even groups as determined by weight and pregnancy status.

The profiles of the two groups at the beginning of the PDS Part 1 were similar. In the Treatment group there were 1.3% fewer lactating cows and 4.2% more mid- to late-term pregnancies that could have been related to weaner production at the end of the PDS. In the Treatment group there was only 1% fewer cows over 8 years of age.

Calves were mothered-up into their respective groups. One group of 159 breeder cows (Treatment group) went into 'Hill' paddock and was supplemented through the water troughs from December 1998 until October 1999. The other group of 155 cows (Control group) went into 'Camel' paddock and did not receive any nutrient supplement.

Data was collected from the breeder cows in December 1998 and again in April, August and October 1999. The data collected from the cows were weight, pregnancy status, body condition score, wet/dry status, weaner numbers and weaner weights. For data collection in both parts of the PDS, calves were selected for weaning by station management in line with their normal station practices.

Blood samples were collected from up to 20% of the breeder cows in both the Treatment and Control groups, in order to determine blood levels of urea, protein and phosphorus. Blood reference values are given in Table 1. The sub-samples of breeders blood sampled are given in Table 2.

3.5 Paddock Groups - Heifer Breeders: PDS Part 2

A group of 286 first calf heifers that had been continuously mated from April 1999 was split into two even groups and replaced the PDS Part 1 breeder cows in October 1999. The profile of the two groups at the beginning of the PDS Part 2 was similar. In the Treatment group there were only 1.3% more mid- to late-term pregnancies. The first calf heifer groups were allocated to the paddocks at the same time as the swap of the water medication units from the 'Hill' paddock bores to the 'Camel' paddock bores.

One group of 144 heifers (Treatment group) went into 'Camel' paddock and was supplemented through the water troughs from October 1999 until November 2001. The other group of 142 heifers (Control group) went into 'Hill' paddock and did not receive any nutrient supplement throughout the PDS Part 2.

The exceptional rainfall in 2000 and 2001 resulted in widespread surface water, which caused difficulties in effectively mustering the cattle. Consequently there were only two data collections in each year instead of the three collections that were originally proposed.

Data was collected in 1999 (October), 2000 (May, November) and 2001 (May, November). The data collected from the breeder heifers were weight, pregnancy status, body condition score, wet/dry status, weaner numbers and weaner weights. Blood samples were collected from up to 15% of the heifers in both the Treatment and Control groups at each data collection, in order to determine blood levels of urea, protein and phosphorus (Table 1 and Table 2).

Table 1. Reference laboratory blood values

Blood Urea (mmol/L)	Low < 2.1	Low normal 2.1 – 3	Normal 3 – 9.6	High > 9.6
Blood Protein (albumin) (g/L)		Low < 21	Average 21 – 36	Above average > 36
Blood Phosphorus (mmol/L)	Deficient < 1	Low 1 – 1.29	Normal 1.29 – 2.26	High > 2.26

Table 2. Breeders blood sampled

Mixed breeders: PDS Part 1	Treatment group - wet & empty/ early pregnant (25 head) Control group - wet & empty/ early pregnant (25 head)
Heifer breeders: PDS Part 2	Treatment group - wet & empty (20 head) Control group - wet & empty (20 head)

4. RESULTS

4.1 Mixed Breeders: PDS Part 1

Results from the start date in December 1998 to the final data collection in October 1999 showed positive responses in the Treatment group—in weight gain, body condition score and pregnancy (including wet & pregnant rates), plus fewer missing (presumed dead) breeder cows. In calculating the numbers of dead cows in each group it was assumed that the disease risk (e.g. plant poisonings, reproductive disease) for each group was similar, given that the PDS paddocks were adjacent and the breeding stock in each group were derived from the same source.

In May 2000 a total of 46 cows in the Control group and 14 cows in the Treatment group were still missing (presumed dead). The PDS area was mustered an extra three times after May 2000 and assuming an 80% muster and an equal chance of mustering any one cow, there would be a less than 1 in 650 chance that one of those missing cows was alive in the paddock. Management noted a number of dead cattle during PDS Part 1—more than 10 head in the Control paddock and more than 2 head in the Treatment paddock.

Results of breeder cow weights, pregnancy rates and body condition scores at October 1999 are shown in Table 3. Further results appear in Figure 8, Figure 9 and Figure 10 in Appendix 2. Mixed Breeders: PDS Part 1 Results.

Positive responses in the Treatment group also included more weaners. The difference in the number of weaners between groups may have been a result of more deaths of cows and calves plus fewer calves being heavy enough to wean in the Control group.

At the end of PDS Part 1, there were 66 (32%) calves from the Treatment group that were unweaned compared to 50 (34%) calves from the Control group. Results for weaner production are shown in Table 4.

**Table 3. Breeder advantages
(Treatment vs Control group) October 1999**

Group	Average weight (kg ± s.e.)	Pregnant (%)	Wet & pregnant (%)	Above body condition score 2 * (%)
Treatment	446 ± 6	53	19	92
Control	409 ± 7	42	7	61
Difference	+ 37 **	+ 11	+ 12	+ 31

* Body condition score was measured on a scale of 1 to 6; score 2 is equivalent to 'store condition'.

** The positive weight difference is based on final weights for all breeder cows, which were initially at a range of lactation and pregnancy statuses. For cows that were initially wet and empty, the weight gain over the PDS was significantly higher (+ 35 kg) in the Treatment group (Microsoft EXCEL: T-Test, $p < 0.01$).

**Table 4. Weaner advantages
(Treatment vs Control group) December 1998 - October 1999**

Group	Weaner numbers	Average weaner weight (kg \pm s.e.)	Total weaner weight (kg)
Treatment	138	201 \pm 4	27,788
Control	97 *	202 \pm 5	19,587
Difference	+ 41	- 1	+ 8,201

* Weaner numbers have been adjusted to reflect group differences in breeder cow numbers at the start of PDS Part 1.

Results of the blood collection at August 1999 are shown in Figure 2, Figure 3 and Figure 4. These results highlighted the difference water medication made to the blood phosphorus, urea and protein levels of the Treatment group compared to Control group in the middle of a dry year.

Figure 2. Blood phosphorus results

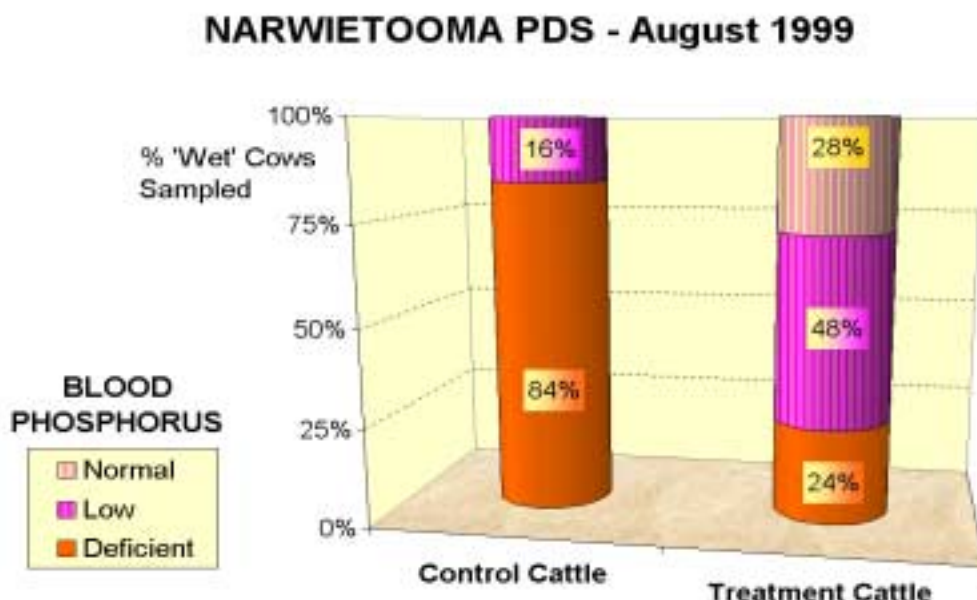


Figure 3. Blood urea results

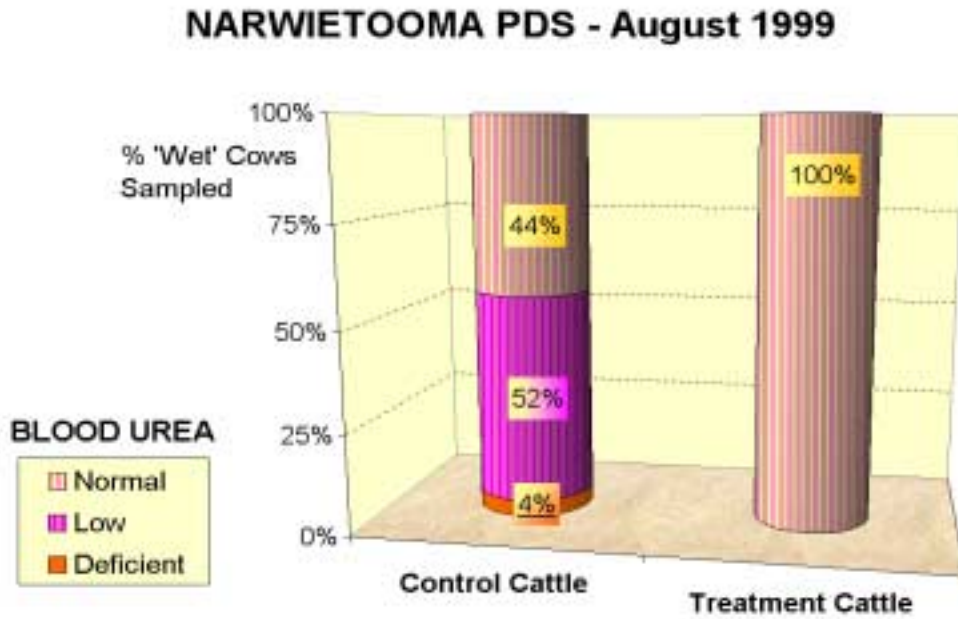
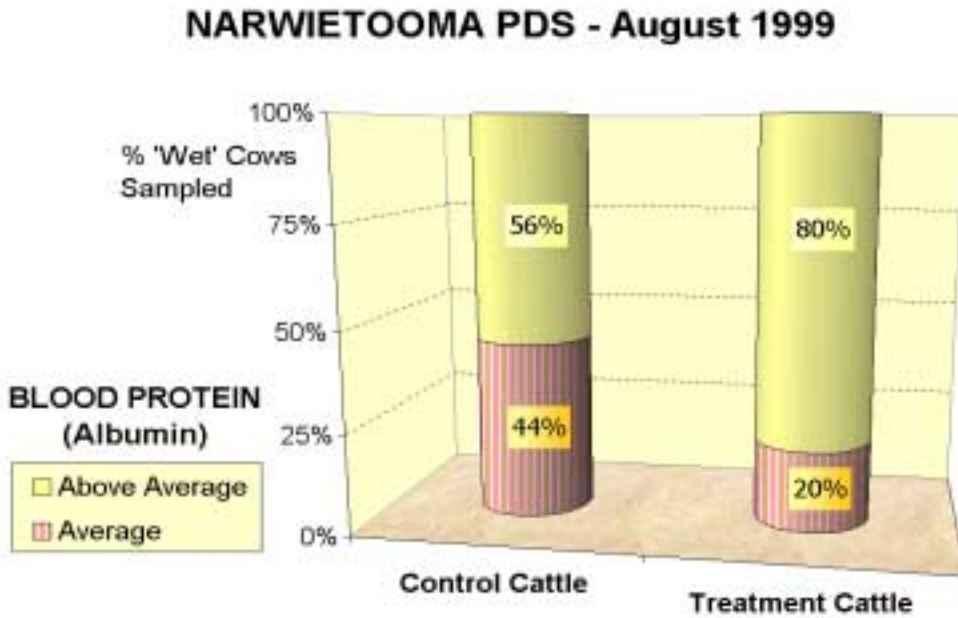


Figure 4. Blood protein results



4.2 Heifer Breeders: PDS Part 2

The Control group had a weight advantage over the Treatment group at the end of the PDS Part 2, based on all breeder heifers with a range of lactation and pregnancy statuses.

However for heifers that were wet and empty at November 2000, the final 12-month weight gain was higher (+ 31 kg) in the Treatment group.

The Treatment group had considerably higher pregnancy rates and 18% more wet breeder heifers compared to the Control group at the final data collection (November 2001).

Results of heifer weights, pregnancy rates and body condition scores at November 2001 are shown in Table 5. Further results appear in Figure 11, Figure 12 and Figure 13 in Appendix 3. Heifer Breeders: PDS Part 2 Results.

Positive responses in the Treatment group also included more and heavier weaners. The difference in the number and weight of weaners between groups may have been caused by more deaths of calves, plus fewer calves being heavy enough to wean and weaners being less well grown in the Control group.

At the end of PDS Part 2, there were 19 (9%) calves from the Treatment group that were unweaned compared to 15 (8%) calves from the Control group. Results for weaner production are shown in Table 6.

Difficulty in determining deaths of breeder heifers was mainly due to the low mustering efficiency (average 80%) during the good seasons in PDS Part 2, plus a lack of follow-up recording after the end of the PDS. However 19 Treatment group heifers and 15 Control group heifers placed in the PDS Part 2 in October 1999, were neither yarded nor noted during all four subsequent musters. Dystocia may have been a cause of death in some of these heifers. There would be a less than 1 in 650 chance that one of these missing heifers was alive in the paddock.

**Table 5. Breeder advantages
(Treatment vs Control group) November 2001**

Group	Average weight (kg ± s.e.)	Pregnant (%)	Wet & pregnant (%)	Above body condition score 2 * (%)
Treatment	442 ± 6	74	54	93
Control	462 ± 8	53	24	89
Difference	- 20 **	+ 21	+ 30	+ 4

* Body condition score was measured on a scale of 1 to 6; score 2 is equivalent to 'store condition'.

**Table 6. Weaner advantages
(Treatment vs Control group) October 1999 - November 2001**

Group	Weaner numbers	Average weaner weight (kg \pm s.e.)	Total weaner weight (kg)
Treatment	198	236 \pm 4	46,728
Control	188 *	224 \pm 4	42,112
Difference	+ 10	+ 12	+ 4,616

* Weaner numbers have been adjusted to reflect group differences in breeder heifer numbers at the start of PDS Part 2.

5. DISCUSSION

5.1 Mixed Breeders: PDS Part 1

There was an estimated net financial benefit to the Treatment group over the Control group of \$213 per breeder cow year using the PDS Part 1 data—numbers weaned from both groups plus assumptions in 2000 about cows remaining at the final data collection (Table 7). The approximated financial advantages are realistic and Table 8 projects the net financial benefit over a range of assumed water medication benefit. Numerous factors other than water medication may have influenced productivity of cattle in this PDS (e.g. paddock differences, disease, previous pregnancy patterns).

**Table 7. Net financial benefit to Treatment group over Control group
December 1998 - October 1999**

+ 11% pregnancy in Treatment group (147 head x 11% x \$50 per pregnancy)	= \$ 809
+ 37 kg advantage in Treatment group (147 head x 37 kg x \$1.00 per kg)	= \$ 5,439
+ 8,201 kg advantage in Treatment weaners (8,201 kg x \$1.30 per kg)	= \$ 10,661
32 more cows missing ('presumed dead') in Control group (32 head x 409 kg (av. wt at final weigh) x \$1.00 per kg)	= \$ 13,088
Gross financial benefit to Treatment over Control group	= \$ 29,997
Less depreciation of the cost of two water medication units with installation at 10% per year (\$300 per tank; \$1,800 per unit; \$400 labour per unit) x 10% per year for 317 days	= \$ 434
Less cost of supplement (assuming cows drank 40 litres per day) (147 head x 317 days x 5.05c per day)	= \$ 2,353
Net financial benefit to Treatment over Control group	= \$ 27,209
The net benefit to cost ratio was greater than 9:1.	
This is equivalent to a benefit of \$ 213 per breeder cow year	

Table 8. Variable water medication benefit per breeder cow

Assuming water medication benefit at	60%	80%	100%
Benefit per breeder cow year	\$ 128	\$ 170	\$ 213

5.2 Heifer Breeders: PDS Part 2

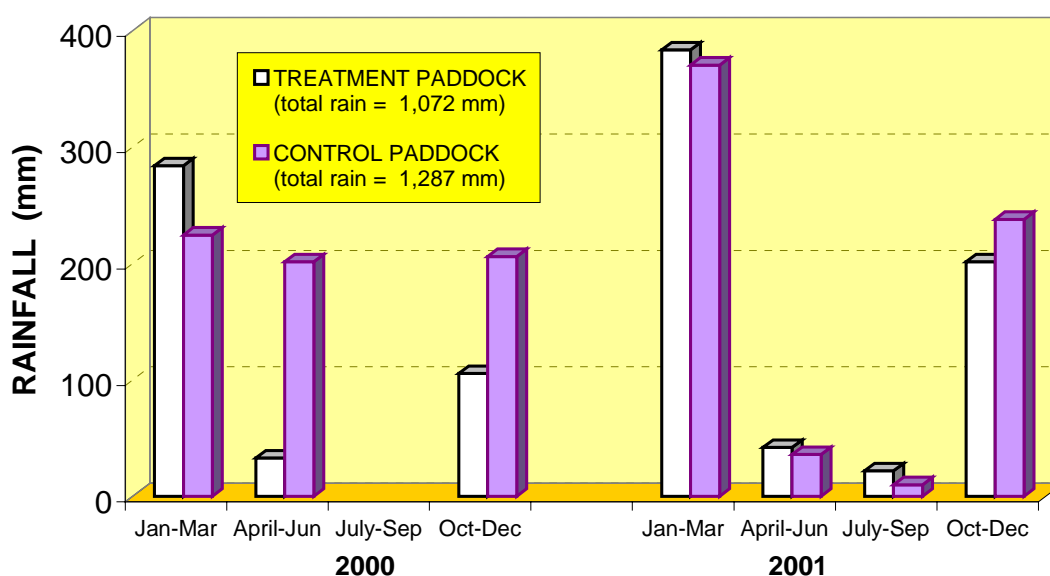
There was exceptional rainfall during two years of the PDS Part 2 as detailed in Figure 5. Rainfall recordings were taken at Lignin bore in the Control group paddock and Browse bore in the Treatment group paddock. These bores were 15 km apart.

There were two noteworthy outcomes from this exceptional rainfall:

- In 2000 the Control group paddock recorded 210 mm more rain than the Treatment group paddock. Paddock observations supported the management belief that the Control group paddock grew better feed than the Treatment group paddock.
- In 2000 and 2001 surface water was available to cattle for over half the year and whilst drinking this water, the Treatment group received no nutrient supplement.

Figure 5. Rainfall in PDS Part 2

NARWIETOOMA PDS - 2000 and 2001



The annual rainfall recorded in both PDS paddocks for the final two years (range: 423 mm to 655 mm) was greater than the long-term mean annual rainfall for Alice Springs (285 mm).

Despite the fact that the Treatment group had 215 mm less rainfall in their paddock, the Treatment group demonstrated better pregnancy rates plus they had more and heavier weaners. Also the Treatment group were only 20 kg lighter than the Control group, even though they had more drain on their systems while raising these weaners.

The advantages seen in the Treatment group can be explained by the positive effect of even minimal phosphorus supplementation for breeder heifers in paddocks proven to be phosphorus deficient. Soil sample analysis by DBIRD staff showed that over 50% of the PDS area had available soil phosphorus levels of less than 6 ppm, a level considered deficient (McCosker and Winks 1994).

The importance of phosphorus in the diet has been well documented over many years and it is known that phosphorus can have a huge impact on reproduction rates.

McCosker and Winks (1994) reported that 68% of northern Australia would provide a diet for cattle which was deficient or acutely deficient in phosphorus, 12% would have marginal or mixed phosphorus deficiency and only 20% would provide a diet adequate in phosphorus.

During the two good seasons of the PDS Part 2, the Treatment group received enough additional phosphorus through the water medication to provide an advantage relative to the Control group. Blood phosphorus levels of each group in 2000 and 2001 are illustrated in Figure 6 and Figure 7.

Figure 6. Blood phosphorus results

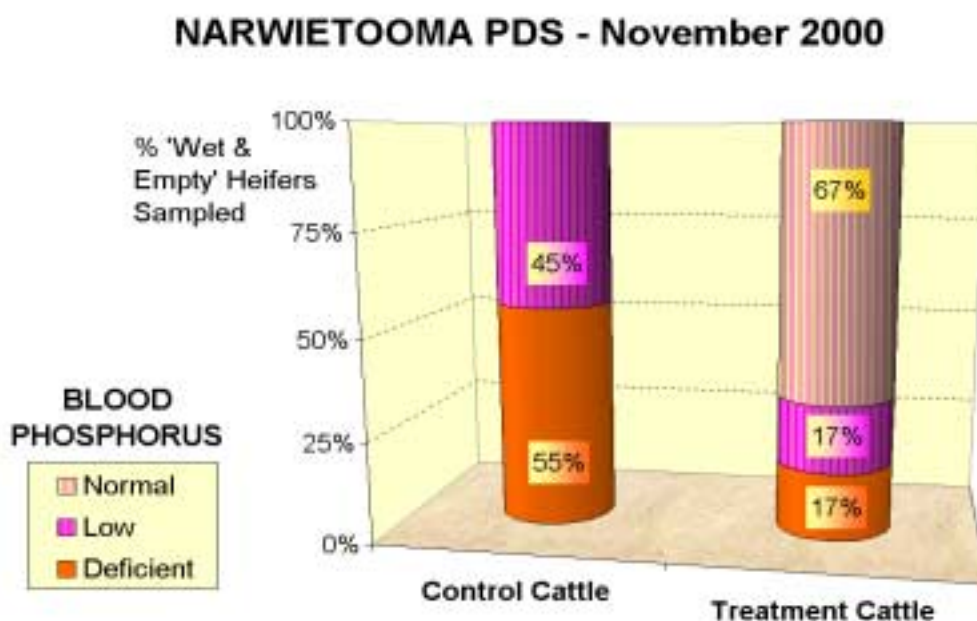
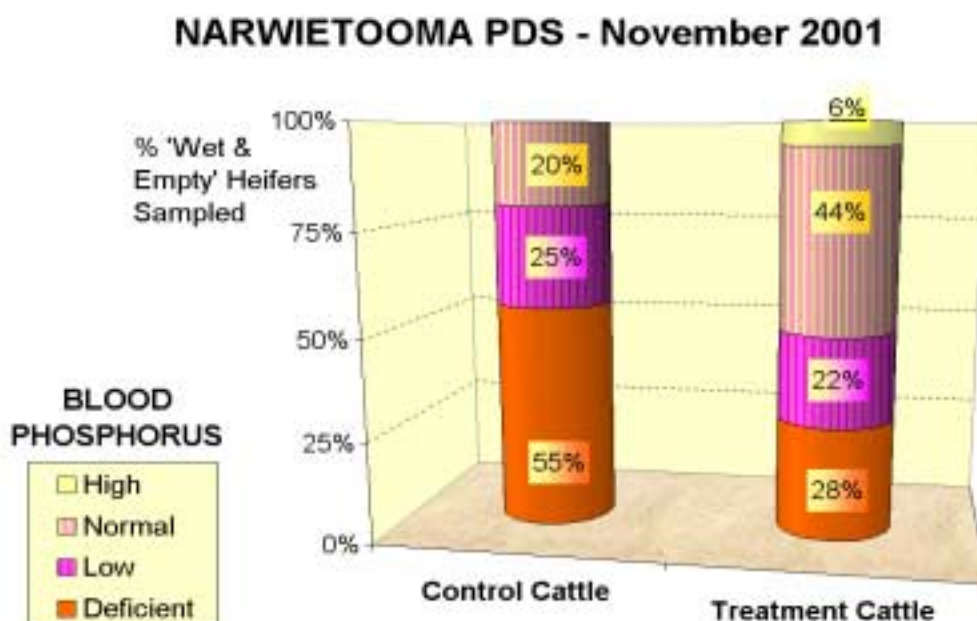


Figure 7. Blood phosphorus results



5.3 Water Medication Unit Reliability

As stated earlier, the water medication units were normally checked on a regular basis to ensure they were maintained and operating properly.

There were several maintenance problems that occurred with the units over the three years of the PDS but they were generally simple faults that were easily rectified:

- One unit part (turbine flow meter) developed a fault after dingoes ate the wiring into the meter. The wires were replaced but the turbine flow meter failed to operate properly and needed replacement.
- Corrosion of wires and terminals occurred on several occasions but this was easily rectified with a cleanup and a spray of CRC. The new lanolin-based products on the market may be a longer-term solution to corrosion.
- Weeds from the turkey nest blocked the turbine flow meter several times early in PDS Part 1. This was fixed by putting wire mesh over the outlet from the turkey nest.

Although these problems occurred, a constant supply of water to the medicated troughs was maintained throughout the PDS. Detailed operational issues are referred to in Appendix 4. Handy Hints and Information.

5.4 Nutrient Supplement Mix

The nutrient ingredients used in the Narwietooma water medication PDS were:

- Urea containing a minimal level of biuret (only 0.4%). Biuret is a non-soluble condensation product of urea, so although being more expensive, this urea minimised biuret in the nutrient concentrate and thus reduced the chance of residue in the nutrient tank or delivery system.
- Technical grade MAP (mono-ammonium phosphate) as a source of phosphorus. Technical grade MAP was used because it is purified and has cadmium levels below detection. Agricultural MAP is cheaper but should never be used because the cadmium levels in this product are unrestricted.
- Sulphate of ammonia. Care needs to be taken with the type of sulphate of ammonia used. For example, one company (Incitec Ltd) do not recommend their base product for stockfeed use due to organic impurities. However their refined product (Gran-am®) is suitable for stock use but can cause formation of scum on the water.

The nutrient tanks used in the PDS had 900 litres capacity. The weight of nutrient ingredients used in both PDS Part 1 and PDS Part 2 were 120 kg of urea, 50 kg of MAP and 50 kg of sulphate of ammonia plus water to make 900 litres of nutrient concentrate. To mix, the 220 kg of ingredients were put in the nutrient tank first and mixed with water from a high-pressure pump. There was never a problem mixing in this manner and by the time the tank was half full, the nutrient ingredients were totally dissolved (Appendix 4. Handy Hints and Information).

The assumption was made that a 400-kg cow was drinking 40 litres of water per day. This assumption was used throughout the PDS although cattle would have drunk more in the summer and less in the winter.

It was not possible to determine the amounts of water drunk by the cattle because there was a large number of feral camels also watering in the PDS paddocks. This is the only concern created by the camels' presence. Based on the results of co-grazing cattle and camels research (Phillips *et al.* 2001), it is assumed that the camels in the PDS paddocks would have had minimal effect on breeder cattle productivity.

At the assumed water consumption rate, cattle were receiving per day:

- 32 g of urea;
- 13 g of MAP;
- 13 g of sulphate of ammonia.

(Appendix 1. Calculation of Nutrient Dosage for PDS Water Medication)

This equated to 19.4 g of nitrogen, which is equivalent to 120 g of crude protein and a cost of 5.05 cents per head per day.

The ingredients in the mix remained unchanged during both parts of the PDS and no cattle deaths were identified as being due to urea poisoning during the overall 3-year period.

Future research work in the area of water medication should focus on the ingredients provided through the water medication units and the most appropriate time to provide them.

6. CONCLUSIONS

The three objectives of the Narwietooma water medication PDS were met:

Objective 1

To demonstrate and record productivity improvement in breeders receiving nutrients by water medication systems, compared to unsupplemented breeders on similar country.

As proven by the results from both parts of the PDS it was clear that this objective was met. There was substantial productivity improvement in cattle receiving nutrient supplement through water medication systems, compared to unsupplemented cattle.

Objective 2

To demonstrate a reliable and cost-effective means of providing essential nutrients to cattle.

The reliability of the water medication units was demonstrated over a 3-year period as discussed in subsection '5.3 Water Medication Unit Reliability'. Very few faults occurred with the units during the PDS and those that did were minor. More importantly there were no cattle deaths recorded as being due to urea poisoning.

As outlined in the discussion under subsection '5.1 Mixed Breeders: PDS Part 1', there was a net benefit to cost ratio of **9:1** in the PDS Part 1 with considerable differences favouring the Treatment group. In this analysis, breeder cow weights, weaner weights, weaner numbers, pregnancy rates, and the total number of cow deaths were taken into consideration. This clearly demonstrated that the installation and use of water medication was cost-effective within 12 months.

Objective 3

To demonstrate that marginal country can be utilised and productive all year round.

In dry years, the paddocks at Narwietooma that were used in the PDS have been unproductive to the point of breeders dying in them. In the PDS Part 1 there was a dry year and 32 more breeder cows were missing (presumed dead) in the Control paddock compared to the Treatment paddock.

The results also clearly demonstrated more production from the Treatment groups compared to the Control groups in both parts of the PDS.

As a direct result of this PDS, beef producers in the district are beginning to accept water medication as a safe and reliable method of supplementing cattle. The relevance and implications of these results to commercial producers will mean production increases in a district that has not used nutrient supplement extensively.

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8. APPENDICES

Appendix 1. Calculation of Nutrient Dosage for PDS Water Medication

Nutrient tank concentration of ingredients

Nutrient ingredients	% N	% S	% P	Nutrient tank volume (L)	Bag weight (kg)	Bags added (nos)	Weight added (kg)	Proportion of each ingredient (%)	Nutrient concentration in tank (g/L)
Urea	47%	0%	0%	900	40	3	120	55%	133
Tech grade MAP	12%	0%	27%	900	25	2	50	23%	56
Sulphate of Ammonia	21%	24%	0%	900	50	1	50	23%	56

Trough concentration of nutrients and cow consumption

Nutrient ingredients	Dilution rate (1 L nutrient concentrate:167 L trough water)	Nutrient concentration in trough (g/L)	Nutrient per 400 kg cow drinking 10% body weight (g/day)	g N	g S	g P
Urea	167	0.8	32	15.0	0.0	0.0
Tech grade MAP	167	0.3	13	1.6	0.0	3.6
Sulphate of Ammonia	167	0.3	13	2.8	3.2	0.0

Total	19.4	3.2	3.6
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N:S ratio = 6.08

The concentration of nutrient ingredients in the nutrient tank remained the same throughout both PDS Part 1 and PDS Part 2. Cattle would have received more nutrient supplement in summer than winter, as water consumption is higher in summer.

Appendix 2. Mixed Breeders: PDS Part 1 Results

Figure 8. Average weights
(Treatment vs Control group) December 1998 - October 1999

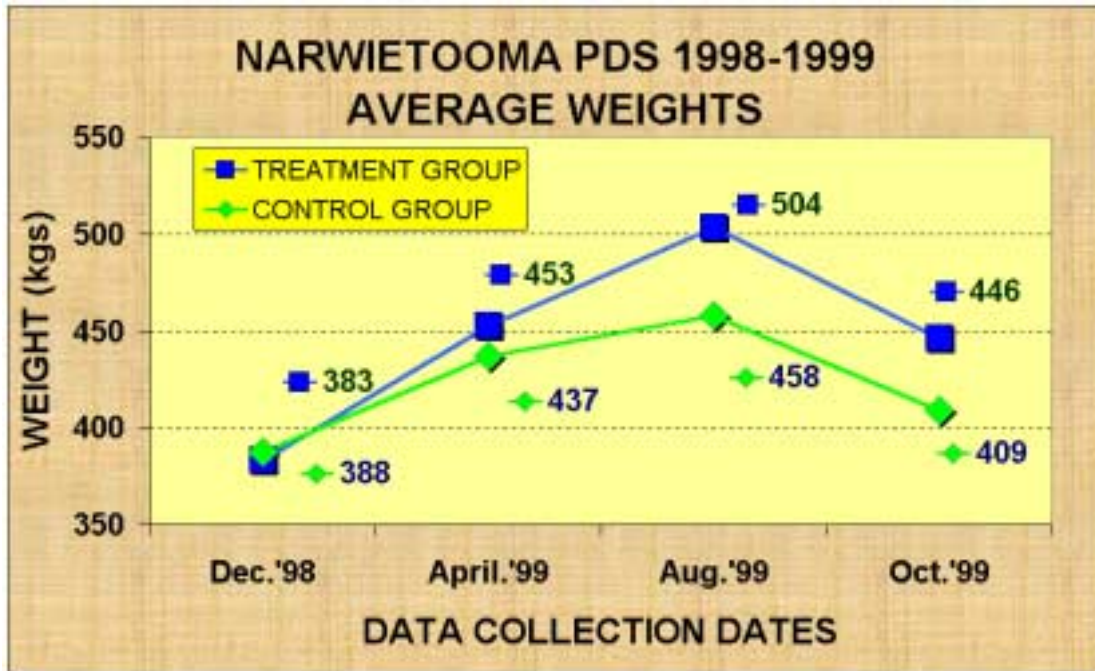


Figure 9. Percentage pregnant
(Treatment vs Control group) December 1998 - October 1999

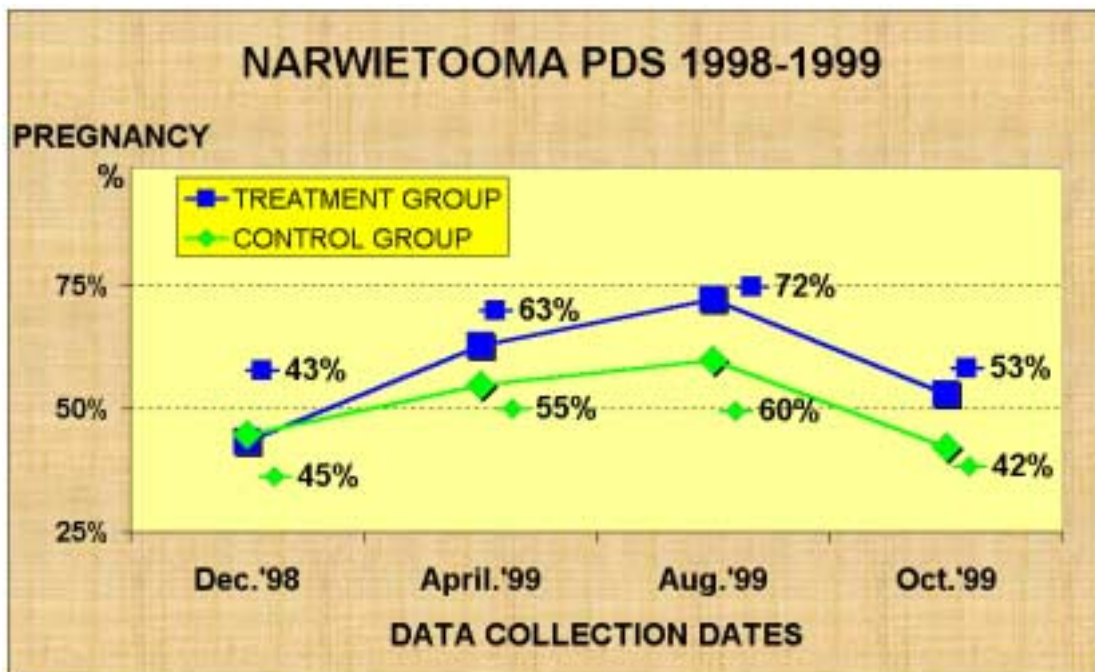
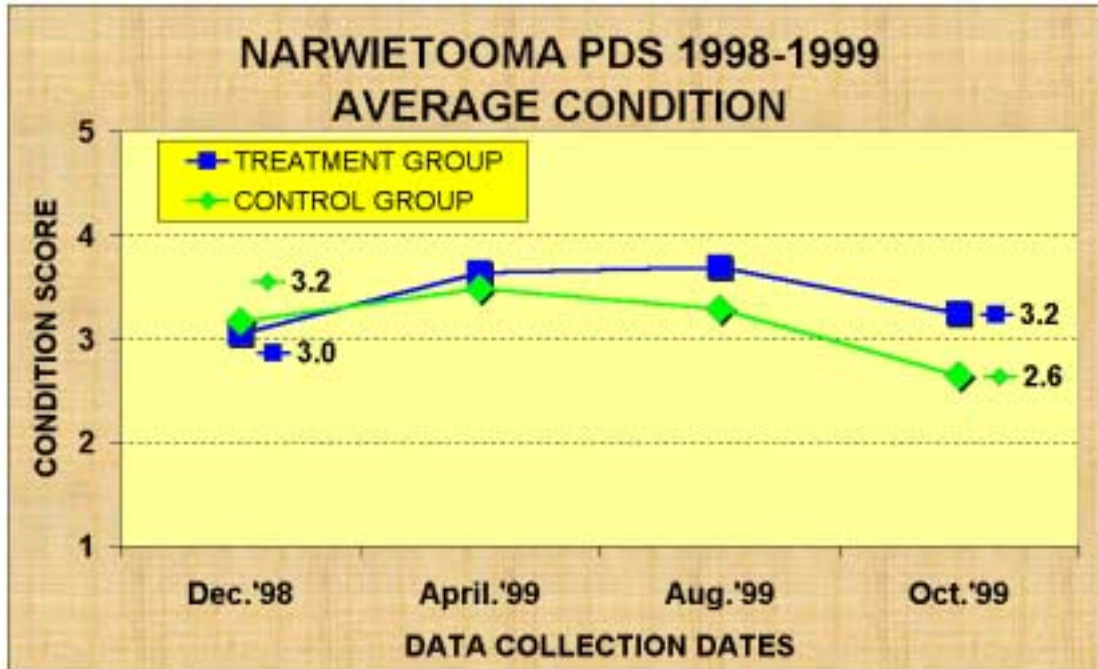


Figure 10. Average body condition score
(Treatment vs Control group) December 1998 - October 1999



Appendix 3. Heifer Breeders: PDS Part 2 Results

Figure 11. Average weights
(Treatment vs Control group) October 1999 - November 2001

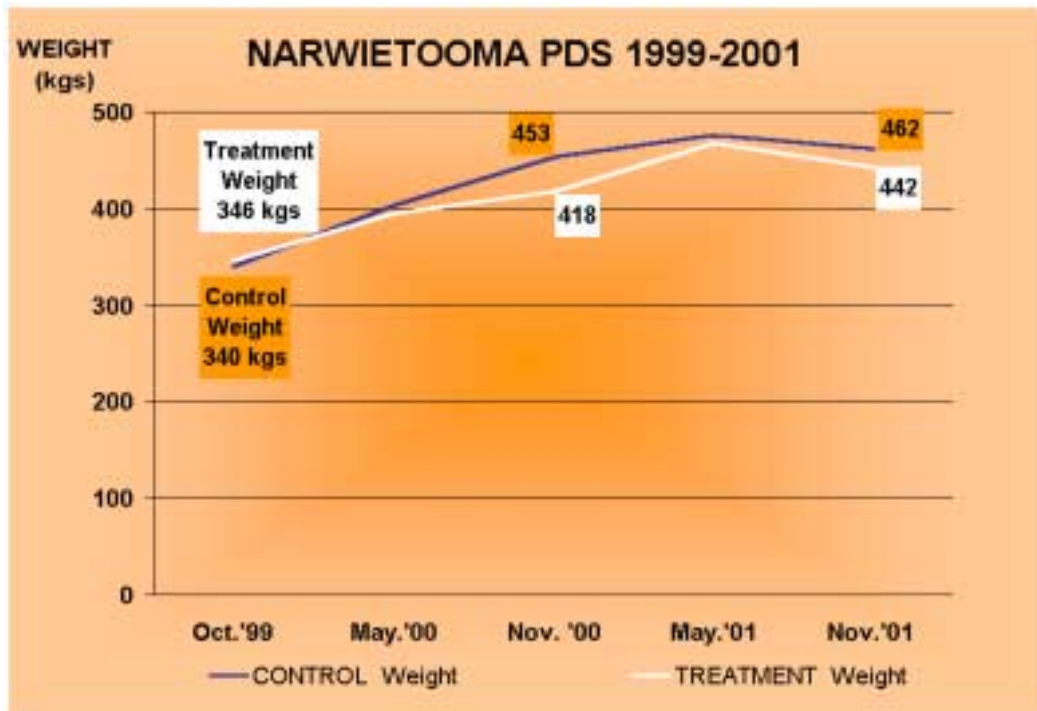


Figure 12. Percentage pregnant
(Treatment vs Control group) October 1999 - November 2001

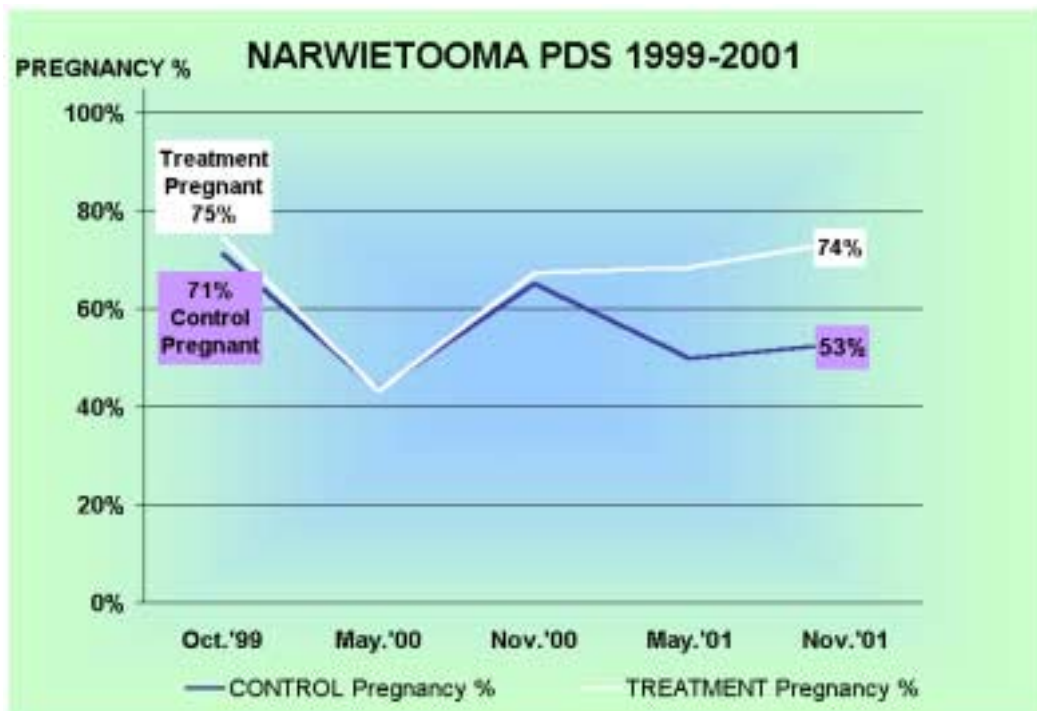
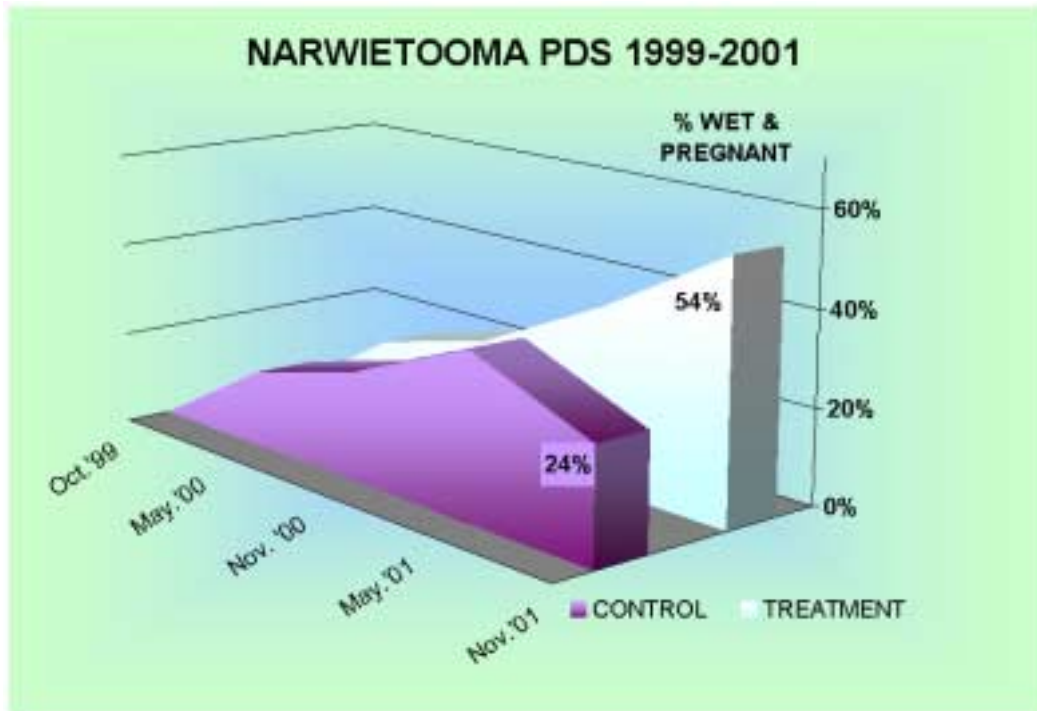


Figure 13. Percentage wet & pregnant
(Treatment vs Control group) October 1999 - November 2001



Appendix 4. Handy Hints and Information

The following hints and information are based on experience of water medication by:

- the author with over 13 years experience in Central Australia;
- people with experience from other parts of Australia.

Background

- What is urea? Urea is the cheapest form of soluble nitrogen and is used for production of dietary protein that is otherwise limiting during dry feed conditions. Urea is ideal to use when there is plenty of dry standing feed available; it will enable cattle to eat more dry feed and digest it better.
- What is phosphorus? A large part of Central Australia is phosphorus deficient. The role of phosphorus spans from bone formation, nerve structure and energy production to nutrient absorption, activation of B-vitamins and the formation of genetic material (National Research Council - Subcommittee on Beef Cattle Nutrition 1984; McCosker and Winks 1994; Dryden 1995). Low conception rates, decreased growth rates and inefficient feed utilisation are some of the effects of phosphorus deficiency.
- What is sulphur? Sulphur is found in virtually every tissue and organ of the body. Sulphur is involved in the metabolism of protein, fat and carbohydrate as well as blood clotting and endocrine function (National Research Council - Subcommittee on Beef Cattle Nutrition 1984). A sulphur deficiency can result in weight loss and weakness plus, in extreme cases, death.
- As a general rule, feed more urea when pastures are dry and more phosphorus when there is green feed available.

Water medication unit and nutrient mix

- Ensure your nutrient tank is big enough for your needs. You are only limited by your imagination. The idea of supplementing through the water is to save money and labour costs. The bigger the tank, the less often you have to fill it. A mix as outlined in subsection '5.4 Nutrient Supplement Mix', using a 900 litre tank with a 100 head of cattle drinking 40 litres of water per day, would last approximately 40 days.
- Cover any exposed electrical wires with garden hose, as birds, dingoes and other wildlife in the area will chew them.
- Enclose the water medication unit in a secure area to prevent accidental damage by larger animals.

- Always mix nutrient ingredients until they are totally dissolved. We found a good way to do this is to put all ingredients in the nutrient tank and then mix using a high-pressure pump like the ones on fire units. By the time that the tank is half full, the ingredients are totally dissolved.
- Wherever possible put your water medication unit on multiple trough systems. This is a much cheaper option than having a unit on each trough. Another option is to install portable set-ups that can be moved around the property.

Operational issues

- Setting up a water medication unit can involve a number of calculations. When first starting off, get some expert advice from your distributor or someone who has experience with water medication units.
- For safety reasons, older water medication units require upgrading to include all the new risk-reduction features of the current models.
- Regular maintenance of water medication units is important to ensure they are operating correctly. Spend a few minutes on a bore-run checking out the operation of the units and cleaning the filters. It's a lot less time consuming and easier to do these basic checks than to put out lick blocks.
- One way to check that the water medication unit is measuring water flow correctly is to empty your trough and refill it. Then see if the litres recorded on the unit correspond with the volume (litres) of water that your trough holds.
- An easy way to measure the volume of a curved trough is to measure the diameter at the water level (in metre units), square it, multiply by the length of the trough (in metre units), then multiply by 0.7854 and divide by 2. A calculator is handy for this equation. This will give a volume calculated in kilolitres.
e.g. If a trough is 0.8 of a metre wide at the water level and 6 metres long:
... first multiply 0.8 by 0.8 ⇒ 0.64;
... next multiply 0.64 by 6 ⇒ 3.84;
... next multiply 3.84 by 0.7854 ⇒ 3.015;
... next divide 3.015 by 2 ⇒ 1.507.
Therefore the trough volume is 1.507 kilolitres or 1,507 litres.
- Dolinski and McClennan (2002) reported that some waters of very high pH react with the urea and give off ammonia gas when the water in the trough is unused for a period of time. Cattle are reluctant to drink the water when it emits this strong smelling gas (odour). When you have high pH waters, all urea-treated waters must be turned over on a regular basis. Smaller troughs may be the solution to this problem if you have low cattle numbers watering.

- Hirst (1996) reported some concern that urea and other nutrient ingredients would settle out or layer in the nutrient tank. Andison (1994) reported measurements of N and P at the bottom of nutrient tanks to be approximately twice the amount measured at the top after the nutrient concentrate had been mixed and stood for 15 to 24 weeks. There are two simple solutions for this problem while using the nutrient concentrate; don't leave it standing for long periods or give it a stir occasionally if it is taking longer than expected to use.
- Although not always the case, more algae growth may occur in the trough due to the nutrients you have added to the water. Some producers have used copper sulphate and pool chlorine to control this algae growth. Others simply clean their troughs out more regularly than in the past.
- Don't make the mistake of thinking that by adding a variety of minerals and vitamins, you will get big improvements in animal production. The cost may well outweigh the benefits. Most benefit is gained by supplying the nutrients that are most limiting in the diet.
- In Central Australia the most limiting nutrient in a dry time is protein. Urea and sulphate of ammonia can address most of this protein deficiency. At certain times of the year, most of Central Australian pasture is phosphorus deficient and major production benefits can be gained by feeding phosphorus to lactating breeders.

Supply to livestock

- Never allow cattle access to any other urea-based supplements when supplying urea through the drinking water. Cattle will die if they consume too much urea.
- Monitor how much water cattle are drinking and vary the amount of nutrient concentrate accordingly. Cattle will drink considerably more in summer than winter.
- Introduce cattle gradually to water medicated with nutrient supplement especially if intending to supplement with a high concentration of urea. Although we water medicated with a relatively low concentration of urea, we started with a half mix for the first two weeks of supplementation.
- Experience has shown that horses show no ill effects when running with cattle on water medicated with nutrient supplement. Research has shown that it took 450 g of urea administered by stomach tube to kill horses (Clarke and Clarke 1975). So considering they would get less than 40 g per day in a normal situation, there should be no risk to horses. The same applies to dogs and people.

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