

# BETTER SHEEP AND CATTLE NUTRITION BY PIPING ARTESIAN WATER

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## Abstract

Capping bores and controlling the flow of artesian water through pipes allows certain nutrient supplements to be given in drinking water, and the regulation of grazing to protect vulnerable pastures and to exclude unwanted animal species. The low rumen ammonia-N levels found in grazing animals during dry seasons strongly suggest that ruminally available N is the first-limiting nutrient in both mulga grassland and Mitchell grass associations. P deficiency occurs widely over the mulga lands and may also be a first-limiting nutrient in these areas. Initial studies of water-based nutrient supplementation have been promising, although there are concerns about the effects of non-uniform drinking water intake on urea consumption. Water medication could be extended to include anthelmintics, insecticides and growth promoters. Control of water reticulation potentially allows control of grazing by restricting availability of drinking water, and control of pest animals.

**Key Words: supplements, urea, phosphorus, minerals, water-based delivery, grazing management**

## Introduction

Capping bores and piping bore water should immediately benefit animal production. Water supplies will be more sustainable by reduced wastage and better control of the concentrations of dissolved salts. As well, capping and piping should facilitate other improvements in animal management. Producers may be able to manage grazing pressure on pastures by controlling the access of stock to water, fine-tune the nutritional environment by providing nutrients in piped water, and may be able to limit the adverse effects of feral and wild animals on pasture by denying them access to water. These outcomes are summarised in Fig. 1.

- (1) nutritionally effective – it provides the first-limiting nutrient (generally ruminally available N, but in mulga country P is also important);
- (2) reliable – it is accepted by the target animals (and in the context of piped bore water delivery, is unacceptable to non-target species), and intakes are uniform across the target flock or herd;
- (3) safe – there is little risk of toxicity if the delivery system breaks down or if animal management changes for some reason;
- (4) cost-effective – the cost of providing the supplement is less than the value of the response (almost certainly the case for breeders, but the situation is much less clear if used to promote growth or wool production).

## Strategic nutrient supplementation

We can fine-tune feeding management by nutrient supplementation. In a successful supplementation program the supplement has four important characteristics; it is:

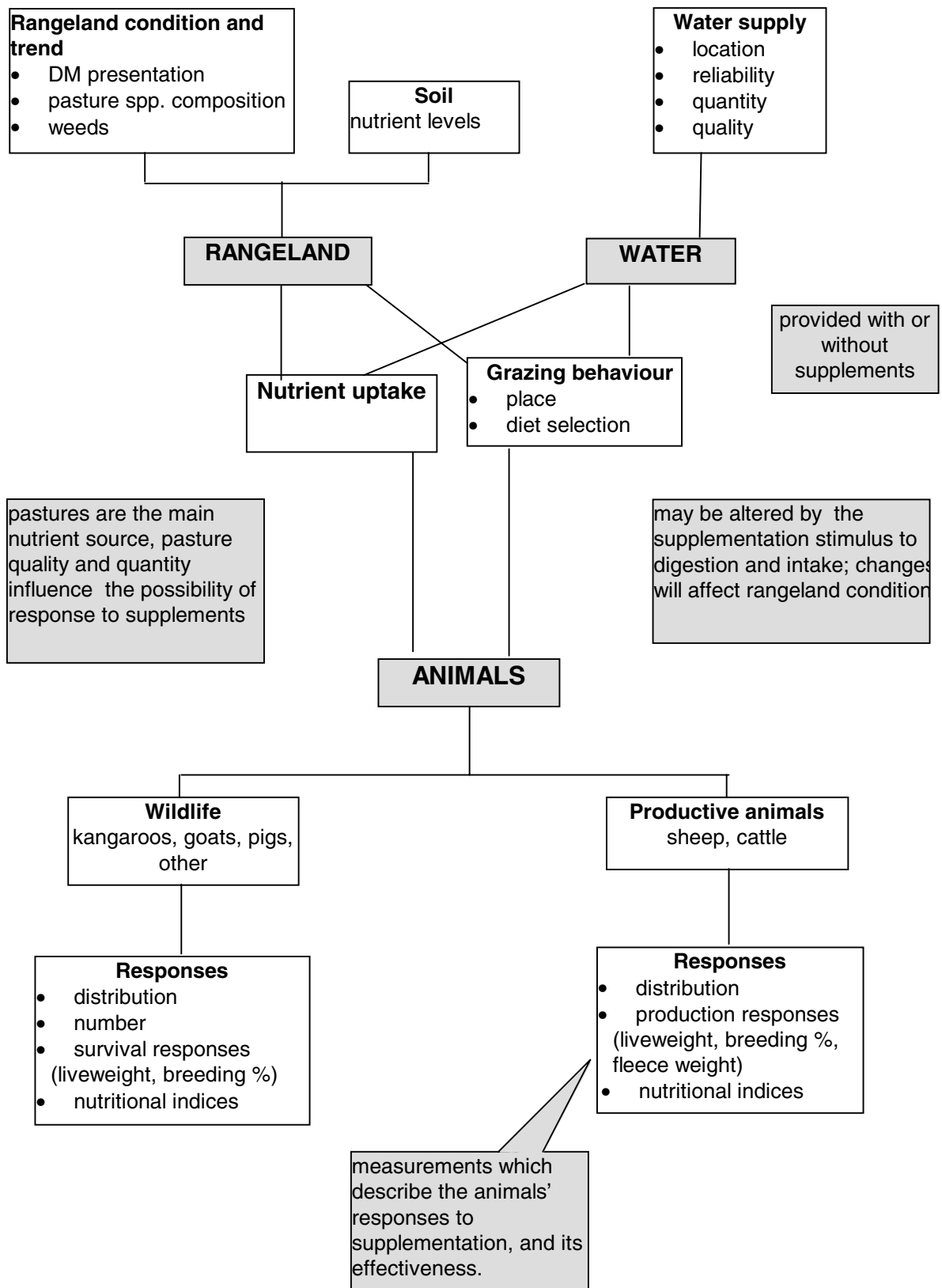


Figure 1. A conceptual model of the responses to capping bores and providing nutrient supplements via piped water.

Supplements of non-limiting nutrients will not improve animal performance, so it is critically important to identify those nutrients which are deficient. The first-limiting nutrient varies with soil and pasture types, season, and animal physiology. The annual and perennial grasses and forbs of the Mitchell grasslands can provide a nutritionally rich environment, especially in the summer. However, during periods of below average rainfall and/or during winter, N, S and P are marginal and may become deficient. To illustrate this, the data in Table 1 are from a study in which pasture utilisation was 30% of the available DM. Oesophageal fistulated sheep ate a diet in which curly Mitchell grass (<5 to 29 % of the diet DM), Queensland bluegrass (14 to 30%), yabila grass (<5 to 25%), and daisy burr (<5 to 45%) predominated. These data show that N, P, S and Cu may be deficient in dry periods. We must divide dietary N into that which comes from ruminally degradable protein or non-protein N, and bypass protein. McMeniman, *et al* (1986b) have shown that the rumen degradability of protein falls to less than 60%, and indicates a possible deficiency of ruminally available N, rather than bypass protein, in dry seasons.

The nutritional environment of the mulga associations consists of grasses, forbs and browse (which is principally mulga tree leaf). Seasonal conditions and stocking rates determine which of these constitutes the major part of the diet. The nutrient intake data in Table 1 is from diets which consisted of 49 to 69% grasses (principally mulga Mitchell and mulga oats), with up to 44% forbs. The November 1979 diet included 35% mulga.

Again, comparison with the SCARM (1990) ruminant animal feeding standards suggests that N and P may become deficient (or at least marginal) during dry times. McMeniman

(1985) has suggested that Na and S may also become deficient. When we feed sheep mulga leaf as their sole diet, their nutrient intake changes substantially from the situation that applies with the more usual mulga/grass diet. Mulga leaf is deficient in digestible protein, P and energy, and all of these are needed to obtain good animal production (McMeniman 1976; Niven and Entwistle 1983). Like Mitchell grass, the primary N deficiency is one of ruminally available N, so urea is a good supplementary N source. The responses to supplements of P and N depend on molasses, or another source of additional energy or minerals (especially S), being provided as well.

### **Comparisons of urea delivery systems**

Common supplement delivery methods include loose dry mixes, fortified molasses mixtures, nutrient blocks based on molasses or salt, and urea/molasses licks. Two of the major problems encountered with all of these is that individual animals may not use a supplement, and that individual intakes are very variable (Table 2). Reluctance to eat can occur even when "palatable" molasses-based supplements or vegetable protein meals are fed (Dove 1984; Smith 1986).

The efficacy and cost-effectiveness of a supplementation program depend greatly on all animals eating the supplement, in amounts which are effective. The amounts eaten should not be wastefully excessive or potentially poisonous. Fortified molasses systems illustrate the latter point. Smith (1986) reported that cows given M8U eat 2 to 3 or more kg/d. This is quite wasteful if the supplement is used as a N source – 2 kg of M8U/d provides nearly 3 times the effective dose of urea, and may be near the toxic level of urea consumption.

Table 1. Nutritive value of Mitchell grass and mulga/grassland associations (from McMeniman, *et al* 1986a,b).

Constituent	Sampling dates		
	November 1976	March 1977	August 1979
<b>Mitchell grassland</b>			
OM digestibility (%)	62.9	71.9	54.6
Nutrient content (g/kg DM)			
N	13.1	19.1	7.0
P	2.2	2.6	0.9
Ca	8.3	8.7	2.6
S	1.3	2.3	0.9
Nutrient content (mg/kg DM)			
Cu	10	9	3
Zn	48	37	21
<b>Mulga association</b>	November, 1978	February, 1979	November, 1979
Nutrient (g/kg DM)			
N	25.2	24.7	15.1
S	1.8	1.8	0.9
P	1.1	0.7	0.9
Ca	8.9	6.2	5.1
Nutrient (mg/kg DM)			
Cu	11.8	9.5	7.7
Zn	137	54	45

Table 2. Acceptance and consumption by cattle of urea from blocks (from Entwistle and Knights 1974; Nolan, *et al* 1974).

Experiment	Proportion consuming the supplement (%)	Urea intake (g/d.h <sup>-1</sup> )	
		Mean	Range
Entwistle and Knights (1974) <sup>1</sup>			
Low urea mix	84.9	11.7	
High urea mix	85.8	14.9	
Molasses only	78.5	–	
Nolan, <i>et al</i> (1974) <sup>2</sup>	83.3		0.9 to 84

<sup>1</sup> Merino ewes, dry Mitchell grass pasture, urea/molasses/water mixture

<sup>2</sup> 2-3 y.o. Hereford cows, New England winter native pasture, urea/molasses/water mixture

## Characteristics of water-based supplement delivery

The delivery of supplements in piped water has two important differences from conventional approaches:

- (1) all animals will consume the supplement, because (provided that there is no alternative water) all animals will drink from the supplied water source;
- (2) we can expect that there will be more uniform supplement intake between animals than occurs with conventional supplement delivery methods; and
- (3) we have to use nutrient sources which are water-soluble.

It is fortunate that the nutrients in the main grassland associations of the Great Artesian Basin (at least in Queensland) which are deficient, can be supplied easily from water-soluble sources, e.g. ruminally available N from urea or ammonium sulphate, phosphorus from sodium tripoly-phosphate, phosphoric acid (food grade), or sodium monophosphate, copper from copper sulphate, and sulphur from ammonium sulphate (or possibly Alimet or methionine hydroxy analogue).

Although water-based supplements are not new, e.g. P has been given in drinking water for many years (see Durand 1974 for a historical survey), we now know that there are risks in using some soluble nutrient sources. Soluble P sources which were used in the past (e.g. MAP and superphosphate) are contaminated with either F or Cd, and should not be used. The need for solubility refocusses our attention on urea and (for sheep) methionine sources, rather than on protein meals.

There have been few comparisons of water-based urea supplementation with more conventional methods. McLennan, *et al* (1991) showed that, during a dry June/October in 1986, weaner heifers responded to urea and ammonium sulphate in drinking water, although a better result was obtained from a fortified molasses mixture given in open troughs. The different responses may have been due to different urea intakes (fortified molasses provided up

to twice the daily amount of urea than the water-based supplement) or to the provision of extra energy and minerals from molasses.

A major advantage of water-based delivery, in comparison to conventional delivery systems, is that producers do not need special supplement feeders. As suggested by Stephenson and Hopkins (1985), and provided that animals can be supplemented *en bloc*, all the water used by the animals on a property can be dosed (with the supplement) at a single point, upstream of the paddock water troughs. We need to buy and maintain only one dosing apparatus, rather than a number of supplement feeders for each paddock. Additionally, water-based systems do not use expensive carriers such as molasses. Water-based supplementation is potentially much cheaper than most conventional systems.

Stephenson and Hopkins (1985) have reported that they successfully delivered an anthelmintic (Levamisole) and an insecticide (Vetrazin) in drinking water. They suggested that the technique would be suitable for growth promoters, rumen modifiers, and electrolytes. A commercial company has developed a glucose and electrolyte replenishment technique for transported cattle. Drinking water can also be used to provide polyethylene glycol (PEG) to animals which eat mulga leaf (although this is expensive). Condensed tannins (CT) in mulga leaf inhibit the digestion of protein. About 12 g/d of PEG will precipitate the mulga CT and give improved animal performance (Miller, *et al* 1997).

## Problems associated with water-based delivery of supplements

### Non-uniform or infrequent water consumption

The problems associated with water-based supplement delivery will have a greater effect on the efficiency of utilisation of urea, than of mineral supplements. Urea is used to increase the rumen ammonia-N content to a level which allows efficient microbial digestion of the (usually dry and mature) forage. Recommended minimum levels are about 45 to 200 mg ammonia-N/L rumen fluid

(Boniface, *et al* 1986; Perdock and Leng 1989).

For most efficient use, urea should be eaten frequently. Romero, *et al* (1976) have shown that roughage utilisation and N balance improve, and urinary N excretion decreases, as the frequency of urea ingestion increases. When animals eat “meals” of urea-based supplements, rumen ammonia-N peaks soon after intake, and then falls to control levels. Similar behaviour has been reported in animals given a urea supplement in the drinking water (Stephenson 1983). Rumen ammonia-N levels rose within 1 h after drinking to 162 to 291 mg/L, and then fell to control levels (68 to 133 mg/L) 23 h after urea supplementation was discontinued. Similar results were recorded by McLennan, *et al* (1991) with heifers.

Although we expect that all animals will consume some supplement, there is still some concern about the reliability of supplement intakes from drinking water. Supplement intakes will be inadequate if animals do not drink each day, or if some of their water requirements are obtained from the feed.

Sheep and cattle drink about 4 L of water for each kg of food DM they eat. This gives theoretical intakes of 5 to 6 L of water daily for dry, mature sheep, and 30 to 40 L daily for a 400 kg steer. It is difficult to predict the amount of between-animal variation in water consumption. Large coefficients of variation (55%) were recorded by McLennan, *et al* (1991) for between-animal water intake by weaner heifers, while small coefficients (9.5 to 17.7%, 5.8 to 11.4%) were obtained for sheep by Stephenson and Hopkins (1985), and Farid and Abdel-Aziz (1984). There can be quite large differences in the amounts of water drunk from day to day. Cattle in the experiment of McLennan, *et al* (1991) drank more water as the dry season progressed, and as day temperatures increased. These changes are expected, but we need to quantify them and take them into account when planning a supplementation system.

Irregular water intake could lead to urea poisoning. Toxicity has been reported on several occasions, e.g. Farid and Abdel-Aziz

(1984), when heat-stressed sheep were given a 0.5% urea solution once every 3 days. These sheep tolerated a 0.5% solution without problems when it was given daily, *ad lib*. In most Australian experiments, urea has been included in the drinking water at about 2 g/L (or 0.2 %), and this has generally given good results. However, 3 of 14 animals died from urea poisoning after a 24 h fast in hot weather in the study of McLennan, *et al* (1991).

### **Supplement stability and attractiveness**

Concerns about the stability of some supplements in bore water are based on reports of sedimentation, differences in the concentration of supplement in certain parts of the trough (e.g. when Co bullets were used in the UK to enrich trough water), algal growth, and evidence of the fouling of water pipes by some bore waters. There is only limited data on these questions, but Stephenson (1983) found reasonable consistency in urea concentration in different parts of the trough, and only small amounts of urea crystallisation in his dispenser.

Herbage growth due to winter rain makes more difficult the problem of choosing a “reliable” supplement, and in predicting animal responses to supplements. Growth of herbage in both mulga and Mitchell grass associations may negate any need for the conventional dry-season supplementary nutrients, i.e. N and S. Animals do not eat “free-choice” supplements if pasture is readily available and attractive. Thus we can waste money and time by giving supplements in winter, especially in areas of more reliable winter rainfall. Water-based delivery will help to overcome the problem of supplements becoming unattractive, but won't entirely eliminate it. Sheep in particular, do not need to drink water each day (e.g. Birrell 1992), and if pasture water contents are high and the animal's physiological demands for water are low, then even supplements delivered in water will not necessarily be consumed.

## Pasture management with water-based supplements

What will happen to pastures when we confine watering to selected points along a pipe, and couple this with possibly more effective supplement delivery? When animals are given urea supplements they generally eat more forage. We also know from studies of pasture growth and species composition that the grazing pressure near existing tanks and troughs is much higher than at some distance away from them (Cowley, *et al* 1996). If the expected greater effectiveness of water-based urea, S and P delivery is translated into higher grazing pressures, then carrying capacities and pasture sustainability will become important management issues. Losses of perennial grass species from heavily-used mulga pastures has been documented by Freudenberger, *et al* (1999), and restoration of the original pasture is likely to be slow (Cowley, *et al* 1999). Changes in grazing behaviour over time will affect pasture condition. Effects on pasture species composition, plant growth, plant nutritive value, diet selection, and the entry of weeds must be monitored after bores are capped and piped, irrespective of whether bore water is used to deliver nutrient supplements.

On the other hand, piping bore water will give producers additional control over water availability. This should give better control of pasture use, especially in dry periods when animals are forced to obtain most of their water by drinking. In theory, we can effectively close areas up simply by turning the water off. The distance beef cattle and sheep graze from water depends on ambient temperature and the water content of plants, as well as the animals' physiological state and individual differences between animals. In a Northern Territory study some cattle grazed up to 15 km from water and returned to drink every second day while others moved about 4 km and drank each day. Santa Gertrudis × Hereford cows in a similar environment to that of western Queensland (Rouda, *et al* 1990) walked about 8 km daily. This distance was not affected by supplementation.

Similarly, it might be possible to manage feral and native wild animals by denying or at least limiting access to water. However, not everyone wants to eliminate wildlife, especially Australian native animals and birds. An effect of restricting access to water is that pre-European patterns of wildlife distribution may be reinstated and the effects of this on the abundance, nutritional status and reproductive performance of native animals should also be monitored.

## Conclusion

In summary: water-based delivery of supplements should have these characteristics and outcomes:

- (1) the variability in supplement intake, both between animals and between days, should be reduced; but water-based delivery may not totally overcome seasonal variations in intake. Water-based delivery will probably be a good way of delivering urea and S supplements when they are needed (i.e. in dry winters), but we will have to test its effectiveness for P and other minerals where deficiencies are related to soil mineral status and are thus a year-round problem;
- (2) the technology for water-based delivery is now mature and reliable; and
- (3) we may be able to deliver drenches, growth promoters, etc. in a cost-effective way which eliminates the need for special mustering, and reduces the cost of these treatments and the stress on animals.

There are unanswered questions about the stability of supplements dissolved in bore water (precipitation, sedimentation and flocculation), and the effects of between-day and between-season variation in water intake on supplement intake and potential toxicity. These questions need to be resolved before we go too extensively into water-based supplementation. Opportunities for better pasture management by strategic use of watering points will be easier with piped reticulation. Ways of optimising this, and possible adverse effects on pasture structure and composition should also be examined.

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