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Prepared by: David Hirst
District Experimentalist

Swan's Lagoon Research Station, Millaroo 4807

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Water Medication

A review of the effectiveness of water medication to supplement grazing livestock

Queensland Government
Department of Primary Industries and Fisheries

CONTENTS PAGE

WATER MEDICATION REVIEW

1.0 SUMMARY.

The objective of this review was to report on the effectiveness of water medication as a method of supplementing stock, and on the performance of equipment used to dispense supplements into drinking water. In addition to a review of literature the experience of producers and others was documented and collated

During this review process sixteen properties using water medication were visited and numerous contacts were made with others with experience or knowledge of various aspects of water medication. All producers surveyed in this review considered water medication at least in principle to be an effective means of supplementing livestock, and better than alternatives. In most instances producers found that maintenance and operating requirements of the system were greater than originally anticipated. All producers said they observed positive effects of the supplement on their stock.

Supplementing cattle via the water trough using urea, phosphorus and other substances has been recognised as an alternate means of supplementing livestock for many years. This supplementation system has the distinct advantage of achieving compulsory intake, providing the animals are in a situation where their drinking water can be controlled, and the supplement can be effectively dispensed into water. On this basis water medication has been developed as a practical means of supplementing livestock.

Water medication is a complex issue and many things can and do go wrong. There have been many cases of stock losses through urea toxicity mainly caused by failure of medication equipment, but also through operator error and other reasons.

A review of literature on water medication revealed some detrimental effects on animal production can occur when supplements are fed in drinking water. Detrimental effects could include a reduction in water consumption leading to ill thrift and supplement losses from the water due to water quality problems.

Supplement loss can occur without the knowledge of the users. Loss of urea from both the concentrate tanks and water troughs can occur as ammonia and loss of phosphorus can occur by the formation of insoluble compounds which precipitate to the bottom of the concentrate tanks and or water troughs. These supplement losses are normally associated with alkaline water and/or water containing dissolved calcium and magnesium salts. The quantity of supplement lost is not known, but it is likely that it ranges from minor amounts to a large proportion of the urea or P added to the concentrate tanks. There are several possible practical solutions to avoid supplement loss, but further work is required to test the various possible solutions before water medication can be more widely advocated.

Both the Dosatron and the Norprim water medictors offer considerable improvements on the previous equipment. Both medicators do have some problems and the need still remains for improved dispensing equipment. As a small but increasing number of producers are successfully

using water medication, it is at least proven under certain field conditions. It is concluded from this that water medication technology is generally sound and considerable benefits can be gained by many more producers in the industry. As some aspects of water medication are not fully understood, caution should still be applied to its use. Further research and development on many aspects of water medication is required before this method can be more widely advocated as a practical and effective means of supplementing livestock.

Information available to producers using water medication about supplement formulations and concentrations which can be safely fed is usually inadequate and ad hoc and sometimes misleading.

2.0 INTRODUCTION.

This review of water medication was conducted at the request of MRC PDS proposal review group. This request was a result of a proposal by Peter Smith, DPI, Charters Towers to establish a PDS site in the Torrens Creek area which included the demonstration of the value of water medication as a supplement delivery system. The PDS proposal review group considered "the purpose of the demonstration cannot be achieved until a means of water medication is shown to be reliable". As water medication equipment developed during the last three decades had failed to provide a practical and reliable means of dispensing additives into stock water, it was logical to question the effectiveness of the more recently developed equipment.

There is a renewed interest amongst producers in water medication as a direct result of the availability new equipment (Norprim and Dosatron) to dispense additives into the drinking water of livestock. It was not known whether these new systems of water medication were actually better than the previous equipment and could provide a safe means of medicating stock waters. As a number of producers were already using the Dosatron and Norprim dispensers the opportunity existed to base the review on their practical experiences with this method of supplementation.

As this review process progressed many unexpected issues pertaining to water medication were revealed. As many of these issues could have a significant effect on the success or failure of water medication they have been included in this report. Although an attempt has been made to consider as many questions as possible on the practical aspects of water medication many issues and questions still remain unanswered.

It is understood this is the first time water medication has been investigated and more than just the obvious issues pertaining to the subject identified.

3.0 OBJECTIVES.

The objectives of this review were:-

(i) To collate and review information on water medication as a means of supplementing cattle.

(ii) To document producer experiences and review published and other information on the strengths and weaknesses of water medication equipment currently available.

(iii) To formulate recommendations based on information collected, for consideration by users and manufactures, on the use and reliability of water medication units to supplement cattle.

4.0 BACKGROUND.

Supplementing grazing animals via the drinking water has long been recognised as one means of administering supplements. The level of producer adoption has been low and there appears to be considerable opportunity for further adoption. The availability of new dispensing equipment has led to some adoption by innovative producers. Although water medication offers advantages over other methods of supplementation, it is not without constraints and problems. There remains a lack of knowledge about water medication and its efficiency to provide supplements for animal production.

Reports from trials and observations with water supplementation indicate wide variation in results, from successful outcomes to disastrous results. It cannot be assumed that water medication will always be effective as a supplement delivery system, and caution should be applied to using this form of supplementation. In situations where due care is taken and knowledge is applied correctly, supplements have been safely and effectively administered to grazing animals by this method.

This review process has identified some of the reasons water medication has not always been successful. There still remain several issues which will need to be resolved before this system can be more widely advocated as a practical mean of supplementing grazing animals.

5.0 METHOD.

This review was largely based on producer experiences in using water medication and the focus was on the practical aspects of the system. Direct contact was made with sixteen producers as property visits and by telephone. Information was also sought from beef and sheep extension and research staff in Qld and NT who had experiences with water medication. Manufacturers and marketing agents of various dispensing equipment were also contacted in person or by telephone (see appendix list of people who assisted in or provided information for this report). A review of relevant literature on the subject was also undertaken. Although an attempt was made to collect all relevant information on the subject some information may have been excluded or overlooked. Some information gathered could be considered anecdotal and difficult to draw

conclusions from. When this anecdotal evidence was recorded or repeated in a number of situations or was of particular note it is included in this report.
When initiated this review was thought to be a relatively straightforward task. As the review progressed, additional issues relevant to the subject and requiring investigation were identified and included.

6.0 SUMMARY OF INFORMATION FROM PRODUCER CONTACTS AND PROPERTY VISITS.

Producers contacted in this review were using either the Norprim or Dosatron dispensing systems or both, one other producer using Vogt dispensers was also contacted. Producers using the different methods were selected so that a valid comparison between the dispenser types could be made. It must be kept in mind that this group would have a bias in favour of water medication as they had already decided to use this supplement system.

Urea is the most common supplement fed using water medication. Ammonium sulphate is usually but not always fed in conjunction at rates ranging from 10 to 25% of the urea as a source of sulphur. Phosphorus is also fed where deficient using technical grade M.A.P. or in one case phosphoric acid. Most producers mix the supplement ingredients themselves. Although premixed supplements are available they are not widely used.

The main reasons producers initially used water medication were:

(i) Cattle would not eat other supplements such as dry licks and blocks.
(ii) Cost and need for supplement carriers such as molasses and salt.
(iii) Cost of lick blocks (Alice Springs district).
(iv) Efficiency of labour and time spent feeding.
(v) Compulsory intake by water medication overcomes problems of animals eating either too much or not enough supplement.

All producers surveyed who were still using water medication considered it to be an efficient means of supplementation and were planning to continue using the system. They felt that the supplements used were improving animal performance.

All producers were measuring water intakes of the animals to calculate dosing rates. Dispensing rates of urea were calculated so that the equivalent to 40-60 grams of urea was consumed by adult animals daily in most cases. The concentrations of urea in the drinking water did vary but most producers were feeding at the rate of between 1.0-2.0 grams of urea per litre of drinking water.

All producers feeding urea in the water initially started feeding at lower levels and increased the concentration to the full dose over a period of time. Various methods were used to achieve this, but in most instances on half of the required dose was fed for the first 2 weeks before increasing to the full dose rate.

Most producers surveyed found that water medication did not result in the savings of labour and time that they had anticipated. This was due to maintenance and operating requirements being greater than expected. Even though labour and time savings were less than expected most producers considered water medication an efficient means of supplementation and better than alternatives.

A number of cases of urea toxicity were reported by producers. Most of these cases of animal losses occurred as a result of the failure of the dispensing system resulting in excessive quantities of urea being added to the drinking water.

There have been only isolated cases of urea toxicity by other causes. In one case two animals from a unsupplemented paddock died after entering a paddock where urea was being fed in the water at a rate of 2.0 grams per litre. In this case the state of the animals hydration was not known when the medicated water was consumed, but it is likely that they were thirsty. In another case urea poisoning of one animal occurred when cattle from an unsupplemented paddock were being driven past a medicated trough containing > 2.4 grams urea per litre of water.

Some producers have been feeding urea to cattle in the drinking water where there were also other unsupplemented water sources in the same paddock. In these cases it is interesting to note that urea toxicity has apparently not occurred from naive cattle unaccustomed to urea drinking from the medicated trough.

One producer reported that cattle preferred to drink from non- medicated water sources during winter when the urea concentration was higher than normal. Another producer commented that when ammonium sulphate was fed with urea it seemed to put cattle off drinking.

7.0 ISSUES IDENTIFIED IN LITERATURE REVIEW AND OTHER ISSUES PERTAINING TO WATER MEDICATION.

7.1 Water medication versus alternate supplementation systems.

The actual and potential advantages, of this system are regularly advocated by people promoting this method of supplementation. Water medication is promoted on the basis of compulsory intakes, no need for additional supplement carrier etc without due consideration to alternate means of supplementing livestock. There is a lack of objective information to allow valid comparisons between the different supplement delivery methods. The feeding of supplements using alternative means such as dry licks, blocks etc should result in similar animal performance to water medication.

The capital cost of establishing a water supplement system is considerable and the operating cost when labour and maintenance is taken into account may also be greater than alternative methods. More skill is required to calibrate and maintain a supplement dispenser than to feed pre mixed dry supplement. A general cost benefit comparison is difficult to make between the various supplement delivery systems due to the variation between properties, land types and stock watering systems. In some cases the advantages gained by using water medication would justify the capital and operating cost and in other situations the reverse will apply.

In instances where a water reticulation system supplies several water points and a large number of animals from a single suitable water source it is likely water medication will be the best method of supplementation. For producers who are presently using dry licks successfully and are happy with there current cattle performance, it is unlikely that further benefits would be gained by changing to water medication. The added risk associated with water medication must also be considered as a few dead cattle from accidental urea poisoning can pay for a lot of dry lick.

Individual producers must decide which method of supplementation best suits their specific needs and situation. Demonstrating various methods of supplementing cattle and discussing the various aspects of each option through producer demonstration sites will assist producers in the decision making process. This alone may justify further demonstration of water medication through the PDS process. Even if water medication is not adopted by producers as a result of this demonstration process it is likely that producers will become more aware of the various options for feeding supplements to cattle. This is likely to result in more effective supplementary feeding programs being developed and adopted by producers.

7.2 Effect On Water Consumption When Supplements Are Added To The Drinking Water.

The addition of some supplements have the effect of reducing water consumption of cattle. This can lead to partial dehydration, illthrift and death. Playne (1974), reported reduced water intake when phosphoric acid was fed at a rate of 11 g P/hd/day. This method of supplementation actually increased weight loss of the cattle. Urea + sodium sulphate fed in a similar way did not reduce water intake, and decreased weight loss by 30 kg over a 6 month period. Holm and Payne (1980), reported increased growth rate of steers in a 3 year study of 31, 70 and 44 kg per year when a supplement of 6 ml 85% phosphoric acid, 9 g urea and 2 g ammonium sulphate was added per 10 litres of drinking water. Water intakes in this case were not significantly different from the control animals.

When a supplement of 16.7 g urea and 1.3 ml of 36% sulphuric acid per 10 litres of water was given to cattle via the drinking water in a separate study, Holm et al (1981), water intakes were 11.6 litres/hd/day compared to control animals which consumed 21.8 litres/hd/day. Foster (1977), reported reduced water intakes when urea and/or sulphuric acid was added to the drinking water of weaner steers. This report is somewhat ambiguous, but it does appear that the concentration of the urea in the water was higher than the normal concentration required to efficiently supplement cattle and this may explain the reduced water consumption. In a follow-up study where urea and salt or urea and sodium sulphate were used, water consumption of the supplemented group was not significantly different from the control animals.

In contrast to some of these reports, McLennan et al (1991), found that there were no significant differences in water consumption by weaner heifers when urea and ammonium sulphate were added to the drinking water at rates up to 3.0 and 0.6 grams per litre of water respectively.

In drawing conclusions from these and other reports it appears that acids, both sulphuric and phosphoric, may depress water intake of ruminant animals when it is added to the drinking water. The acid formulations used in the cases where depressed water intake was recorded are not exactly known and it may be that contaminates in the acids caused this effect rather than the acid itself. With phosphoric acid the old formulation of black acid (presumably used in these studies) is known to contain high levels of cadmium and other contaminates. More refined products such as food grade phosphoric acid may not cause this problem and need further investigation.

Urea and/or ammonium sulphate may also have a similar effect, but only when it is fed at a higher rate than would normally be required. It is still unclear what maximum levels of urea and ammonium sulphate can be used safely without reducing the animal's water intake. It is likely that this level is greater than 2.0 g urea and 0.4 g of ammonium sulphate per litre. Also, if this rate of urea feeding is exceeded the risk of urea toxicity is greater than the risk of dehydration through inadequate water consumption.

7.3 Losses of supplement from the truck to the rumen.

It is often assumed that when a supplement is placed in the reservoir of the supplement dispenser it will all eventually end up in the rumen of the animals at the correct amount providing the dispensing equipment is working correctly. Unfortunately, this is often not the case. Losses of supplement can occur from the reservoir and the water trough. The rate and amount of supplement loss is largely dependent on water quality.

When poor quality water is used the loss of both urea and phosphorus can be quite considerable. When mixed with alkaline water urea is often hydrolysed and escapes as ammonia gas both from the storage tank and the water trough. Measurements of total N in a concentrate storage tank at Katherine in Northern Territory, 24 weeks after 4.5% N was added and mixed as urea, was only 0.37% at the top and 0.73% at the bottom of the tank, Andison 1994. This represented a loss of approximately 85% of the urea added to the storage tank. Although concentrate solutions would not normally remain in the tank for this period of time, it does indicate that considerable losses of urea can occur before it is consumed by the animals.

There have also been reports of an ammonia smell being emitted from water troughs where urea has been added. If this ammonia odour can be readily detected at the water trough it can be assumed that a considerable amount of urea is being lost. At most sites visited in this review an ammonia smell could be detected in the concentrate tanks. This indicated that at least some urea was being hydrolysed and lost. As ammonia can be detected by smell at very low levels it is likely that the loss of urea from the concentrate solutions is only small.

At one site where ammonia could not be detected by smell phosphoric acid was also being fed and mixed with urea in the concentrate. As urea can split into ammonia and carbon dioxide in the presence of urease and or high pH water, it is likely that the acid was inhibiting the loss of urea as ammonia. Therefore it may be beneficial to include at least some phosphoric acid in the concentrate solutions not only as a phosphorus source but to reduce urea loss. Where a phosphorus supplement is not required other acids such as hydrochloric or sulphuric acid may be used to reduce the concentrate pH. The latter would also provide at least part of the sulphur requirements. This issue needs further investigation before this practice could be generally recommended since it is possible that the addition of acids may cause other problems.

The feeding of urea with low pH or acid water may also improve the utilisation of the urea and lower the risk of urea toxicity in the ruminant by slowing the rate at which the urea converts to ammonia and is absorbed in the rumen. The amount of acid needed to stabilise concentrate solutions is unlikely to have any significant effect in lowering rumen pH once it is further diluted by the dispenser into the drinking water.

Phosphorus can also be lost from the drinking water if the water quality is unsuitable. If the water contains dissolved calcium or magnesium salts the phosphorus can form calcium or magnesium ammonium phosphates. As these components are insoluble in water they will precipitate out of solution forming a sludge at the bottom of the water trough or concentrate tank making the phosphorus unavailable to the livestock.

At one property visited in this review a hard scale was being formed on the surface of a polythene water trough when MAP and urea was being fed in the water. Chemical analysis of this scale revealed it contained 17% phosphorus and 20% calcium. The bore water in this case contained 115mg/litre calcium and 99 mgr/litre magnesium. At another site it was confirmed that a sludge of magnesium ammonium phosphate was being formed in the bottom of the water trough when MAP and urea was being fed in the drinking water. In this case the water also contained high levels of calcium and magnesium. At several other sites visited similar sediments were present in the water troughs and concentrate tanks, but samples have not as yet been analysed.

There have also been cases of urea loss associated with high calcium waters where calcium carbonate crystals have formed in pipelines. It is suspected that this is a result of the carbon dioxide from the urea binding with calcium in the water. These crystals can also block the water flow when accumulated at bends and low points in the pipeline system. This is obviously a potentially more serious problem than the urea loss itself.

The addition of acids to the supplement concentrate may overcome these problems as both calcium carbonate and magnesium ammonium phosphate are soluble in, and will not form in, acid solutions. There are several other possible solutions to these water quality problems. Growforce currently recommend the use of Antiprex A, a polymeric hard water scale inhibitor which inhibits the formation of crystals in the water. This product greatly reduced the formation of calcium carbonate crystals at one site and is currently being tested on another property. The cost of this product is minimal and if it efficiently stops these problems, it will be a satisfactory solution. It may also be possible to use water softening or water conditioning systems to solve these problems.

7.4 Efficiency of supplement utilisation when fed via the drinking water.

It can be assumed that the ingestion of soluble sources of phosphorus contained in the drinking water will be utilised by the animals at least as effectively as other sources of P used in licks. It is possible that urea may be less efficiently utilised by the animal when ingested with the drinking water compared to other means. It is well established that for efficient microbial digestion of low quality pasture additional rumen ammonia is required and can be supplied at least in part as urea. The frequency of ingestion of urea can have a considerable effect how efficiently it is utilised. If urea could be ingested into the rumen continually throughout the day the efficiency of utilisation would be maximised. At present, it is not possible to achieve this under extensive grazing conditions. The reason urea is best fed in small amounts or continually throughout the day is that once it reaches the rumen it is quickly converted to ammonia, absorbed through the rumen wall, and thus is no longer available for rumen micro-organisms to convert to microbial protein. Recycling of urea within the animal in part alleviates this effect, with some urea being returned to the rumen via blood and saliva.

It is not known how many times during the day animals consume dry lick and if they eat lick every day. The same can also be said of animal's watering patterns. It is generally not known if all cattle come to water each day, or if they drink more than once. In one grazing study, Ernst (1973), it was found that weaner heifers consumed a molasses urea lick fed in roller drums an average of six occasions during the day but only consumed water on three occasions during the same period. This study was conducted in small 32 ha paddocks with only 12 animals in each paddock and may not reflect the watering and supplement consumption patterns of larger herds. It does indicate that lick supplements may be consumed at a slower rate or more frequently than supplements fed in the drinking water.

Elevated rumen ammonia concentrations have been reported for an extended period after urea was consumed in the drinking water of both sheep and cattle. In weaner heifers there was a large elevation in rumen ammonia concentration 2 h after drinking and on 2 of 3 samplings the levels were slightly elevated 18 h after drinking, albeit at subcritical concentrations, McLennan et al (1991). Stevenson (1983), reported that rumen ammonia levels in sheep were elevated 48 h after urea was consumed in the drinking water. These reports indicate that the frequency of urea ingestion via the drinking water may not be as critical for efficient utilisation as other reports suggest. McLennan and Hirst (1987), concluded that there is no reason to doubt that this method of supplementing urea will be equally effective as other traditional methods.

7.5 Urea toxicity.

Whenever urea is fed to ruminants there is always some risk of urea poisoning. These risks have been largely overcome by various methods to slow the rate of intake of urea. With water medication the ingestion of urea by the animals is compulsory, and subsequently more prone to animal deaths through urea toxicity. If the correct amount of urea can be consistently and reliably added to the drinking water this method should be as safe as other methods of urea feeding. Cases of deaths from urea fed in the drinking water are not uncommon. The majority of cases resulted from overdosing of water due to dispensing equipment failure.

A limited number of tests have been conducted and some anecdotal evidence documented on the toxicity of urea in the drinking water. Stevenson (1981), reported an experiment where sheep either with and without prior exposure to urea, and some which had been deprived of water for 36 h were drenched with various levels of urea dissolved in 200 ml of water. In this experiment

14 g of urea was needed to cause toxicity in the adapted sheep but only 9 grams of urea was required to cause toxic signs in unadapted sheep. With adapted, fasted sheep 10 grams of urea was enough to cause toxicity.

Cows 500-700 kg bodyweight and fasted for 18-24 hours were offered water containing urea at 4.5 grams/litre. The fasted cows consumed only 20 litres of water containing the urea without ill effects. Cows under these conditions would usually be expected to drink at least twice this amount of water. It is assumed the taste of the high urea concentration limited consumption and thus toxicity. From this work it was concluded, that urea concentrations of less than 2 g/litre in the drinking water are reasonably safe. McLennan et al (1991), reported the deaths of 3 of 14 weaner heifers from toxicity when urea was being fed at the rate of 3 g/litre and the animals had been without water for 36 hours. This chance finding highlights the danger of feeding urea in drinking water at higher concentrations.

It is the general consensus of people experienced in water medication contacted in this review that urea should not be fed to sheep or cattle at levels higher than 2.0 g/litre of water under any circumstance as a precaution against urea toxicity. The isolated cases of urea toxicity reported by producers (see summary producer survey) supports this opinion.

7.6 Mixing of concentrate solutions.

For water medication to be effective the supplement must be dissolved into a solution or form a stable suspension in the drinking water. There have been some concerns that urea and other supplements will settle out, forming a more concentrated solution at the bottom of the concentrate tank or water trough. Although urea is very soluble it is possible that some layering of urea in the solution could occur after mixing. Layering is more likely to be a result of the mixing procedure. Heat is absorbed when urea is dissolved in water and the solution becomes very cold. The density of the solution also increases when urea is dissolved. It is therefore possible that after mixing, a layer of dense cold urea water mixture may form at the bottom of the concentrate tank. This is likely to occur when vertical mixing of the entire concentrate solution is not adequate.

This review did not identify any instances where this had occurred and caused urea toxicity. Some producers did express concern that this may happen, and were ensuring adequate mixing of the concentrate solutions by using pumps to achieve vertical agitation of the entire contents of the concentrate tank.

Andison (1994), reported measurements of total N and P at the bottom of concentrate tanks to be approximately twice the amount measured at the top after the supplement had been mixed and then allowed to stand for a prolonged period (15-24 weeks). This result indicated that at least some urea and M.A.P. may settle in solution. As a precaution it is recommended that concentrate tanks be agitated each time the dispenser is serviced. Stevenson (unpublished data), reported some variation of urea concentration at different sites within the water trough itself when using a dry urea dispenser which added dry urea directly in the trough water. This variation in concentrations at different sites within the water trough would not have been enough to be considered a problem. With dispensers which add a concentrate solution to the water and the turbulence created by water entering the trough when stock are drinking it seems unlikely that problems will occur with the supplement settling in the trough.

7.7 Ammonia odour at medicated water troughs.

Although not observed during property visits for this review there have been occasional reports of an ammonia smell being emitted from water troughs and stock refusing to drink. This is obviously a serious problem when it happens. Dolinski (1995), reported that this problem occurred when urea supplemented water was not consumed by stock for a day or two after rain provided temporary surface waters. When the stock returned to the stagnant trough they refused to drink. The reason for this is not fully understood, but it is likely that it is a result of urease activity in the stagnant water releasing ammonia from the urea, thus creating an odour. A similar situation has occurred in a pipeline system where an ammonia smell was emitted from the float valve of a trough at the end of a 3 km pipeline. Also in this case cattle would not drink the water. The mechanism for the ammonia liberation in this case has not been positively identified but is currently being investigated.

7.8 Algae growth in medicated waters.

When supplements are added to water storages excessive algae growth caused by additional nutrients in the water may occur. Nitrogen and phosphorus nutrients and sunlight in combination will promote algae growth in water. This algae growth will remove at least some of the N and P supplement from the water. Some species of algae also produce toxins during decomposition which are poisonous to stock. Some producers surveyed commented that algae was a problem in both water troughs and tanks.

Algal growth is also a major problem when water is medicated in earth tanks and turkey nests. Supplement losses are likely to be high for other reasons if water is medicated in earth. Medicating water in turkey nests is therefore not an option. Supplement losses may also occur in other types of storage tanks open to sunlight.

Due to the risk of algae and other possible supplement loss from water held in reservoirs, the best site to medicate water is in the pipeline leading to the trough or in the water trough itself. One producer who had experienced algae problems said that small water troughs were better as the increased turnover of water in the trough minimised algae growth. Another producer had tried several methods to control algae including bluestone (copper sulphate), algae blocks (slow release copper sulphate), low chlor pool algicide (a chelated copper compound) and chlorine (swimming pool chlorine blocks). This producer reported that the chlorine blocks placed in the water trough provided the best solution while the chelated copper compound appeared to work in one storage tank.

Bluestone has been the most recognised and recommended method of controlling algae in stock waters. but it usually only has a temporary knock down affect on the algae and repeated application is necessary. The chelated copper compounds (coptrol and low chlor pool algicides) offer better alternatives as their effect should be longer lasting. Chlorine may also be another option but will only provide a knock down effect unless some form of slow release product is used. Chlorine may also have a detrimental effect on rumen digestion when consumed by the livestock in the water as it may affect the rumen micro-organisms.

There are several possible practical algae control measures currently available but further work is required to ascertain the most appropriate methods to use. The use of algicides will add to the cost of water medication and this additional cost should be considered when producers decide to use this supplement system.

8.0 DISPENSING SYSTEMS.

Over 20 different types of dispensing systems have been designed or adapted from equipment used in the intensive livestock industries and marketed by both individual inventors and established suppliers of livestock equipment. At the present time only two types are being marketed. Another 2-3 other types are being used by a few producers. The reasons many types of dispensers are no longer available is not entirely clear, but the following possibilities are most likely:-

- Lack of knowledge in using this supplement system led to operating problems such as urea poisoning,

- Lack of demand from producers for dispensing equipment led to unprofitable business,

- Backyard manufactures lacking marketing resources and background technical information, and who often give inadequate instructions on installation and operation,

- Failure of equipment,

- Aversion by producers to use water medication due to reports of dead stock from urea poisoning,

- Manufacturers risk of litigation resulting from stock losses through toxicity irrespective of the cause, and the inability to insure against the risk factor involved.

This review focused mainly on producer experiences with the Dosatron and Norprim dispensing systems. An assessment was also made of the Vogt dispenser as it is the only mechanical dispenser still available. All three dispensing methods are currently being used by producers to supplement livestock via the drinking water. It was concluded that no method as yet provides a complete solution to all of the problems associated with dispensing additives into drinking water. All three dispensers assessed have been associated with stock losses from urea poisoning.

Although the three systems are designed to perform the same task, their principles of operation are quite different. The Dosatron system uses a water-driven reciprocating piston to measure the water flow. This piston is connected directly to an adjustable concentrate injection piston pump. The Norprim system uses a flow sensor installed in the water pipe to measure water flow. A 12 volt electric pump is used to inject an adjustable amount of concentrate into the pipe or water trough. The Vogt dispenser uses a system of tipping buckets to measure water flow into the water trough. An adjustable auger is used to add dry supplement into the water flow as it enters the water trough.

8.1 Norprim

This dispenser was originally developed by Mr Jack Peart in 1990. Jack at that time was the District Animal Production Officer for the NT, DPI&F at Alice Springs and saw a need for water medication supplementation systems in that area. Prior to this some tipping bucket type dispensers had been used in this district, but had been found to be unsuitable because of their poor reliability. The Norprim dispenser was originally marketed by a private company, Dawson dispensers. Some of these original dispensers were not entirely reliable resulting in some cases of stock losses. Other losses occurred through operator error.

Ian Morton (Derwent Station, Alice Springs), Tony Manu (an electronics expert from Sydney who had originally supplied the electronic components for Dawson Dispensers) and Keith Hill (DPI&F) continued to modify and improve the original medication machine. Tony Manu is now manufacturing an improved dispenser in Sydney, which is currently marketed by Dalgety's in Alice Springs at a retail price of $1400. The Norprim dispenser is also manufactured and marketed in Queensland by Peart Rural Services at Mitchell for a retail price of $1950. Peart Rural Services also provides technical advice, installation and after sales service to customers.

It is difficult to report on the field performance of the improved version of the Norprim dispenser as it has only recently been released on the market. Ian Morton is currently using 5 dispensers which have been modified by Tony Manu incorporating the improvements made to the new dispensers. Ian is satisfied with their performance and is planning to increase the number of units he uses.

In principle the Norprim offers advantages over alternate methods of dispensing additives into the drinking water. The Norprim can be used in situations where the water pressure is very low, as energy from water pressure is not used to dispense the additives as is the case with most other systems. There is however some doubt about the ability of the Norprim to accurately dispense over a wide range of water flows. When only a small number of stock are watering the float value only partly opens and only slow flow of water occurs through the water supply line. In these instances the water flow is not recorded by the paddlewheel type flow sensor. This results in water entering the trough undetected and no supplement concentrate is dispensed, resulting in under dosing. The extent of this underdosing is currently being investigated along with methods to overcome the problem.

It appears that most of the problems with the early Norprim dispensers have been overcome, and the new type dispensers should provide a reliable and effective means of medicating stock water. However as these new units have not been widely used and their performance validated under field conditions, some caution should still be applied to their use.

8.2 Dosatron

Dosatron dispensers are manufactured in France and originally designed to add fertiliser to irrigation water for horticultural crops and for adding medicaments to the drinking water of intensively housed livestock. The Dosatron equipment has been imported to Australia since about 1990 and models are available at varying capacities and pressure requirements. The price of these dispensers range from $950 to $2150 depending on the model selected. Other types of dispensers which work on a similar principle were previously sold in Australia for medicating stock water, but were found to be unsuitable.

Of all the dispensers which have been used or tested for medicating stock waters the Dosatron is, at least in principle, the most accurate and reliable method. The Dosatron can by no means be considered the complete answer to the problems associated with dispensing additives into the drinking water as there are many situations where the Dosatron cannot be used without costly modifications to the water supply system.

Dosatron, unlike the Norprim, will not work at low pressure. Even the low pressure Dosatron dispensers require at least a 2 metre head of supply pressure. As many stock watering facilities consist of a water trough supplied from a turkey nest or tank constructed at or near ground level the water pressure is insufficient to power the Dosatron, and even when supply tanks are full the water pressure available is only marginally sufficient.

Several cases of stock losses through urea poisoning have occurred with Dosatron dispensers. These losses have in most cases been caused by incorrect installation resulting in the concentrate solution syphoning or being sucked directly into the pipeline and ending up in the water trough with disastrous consequences. When a negative pressure or vacuum occurs in the pipeline at the point where the dispenser is situated the concentrate solution can flow directly into the water system. This negative pressure can be caused by a number or combination of factors including; blocked filters, lack of supply pressure, empty supply tanks, and or the water troughs being installed lower than the dispenser.

Some Dosatron models have an anti-syphoning value to avoid overdosing caused by this negative pressure. These anti-syphons values should not be blocked off or modified. In at least one instance stock losses occurred as a result of a plumbing modification being connected to this safety mechanism. Providing users are aware of the possibility of concentrate being syphoned into the water supply, and due care is taken, overdosing should not occur.

Another problem with the Dosatron is that they are not entirely suitable for use with water containing sediments as it causes wear of the plastic cylinders. This wear can result in either failure of the equipment or at least underdosing when water leaks past the pistons. The marketing agents recognise this problem and recommend that only filtered water be used in the Dosatron. This review revealed that the use of filters often caused more problems than were solved. In some instances the filters quickly became blocked and stopped water flow. In some of these cases the producers decided to dispense with the filters and accept increased wear of the dispenser rather than risk stock perishing or to be continually cleaning the filters. One possible solution to the problem is the installation of stainless steel cylinder liners. This is being tested in New Zealand and one modified unit is being trialed in central Queensland. It is too early to report if these modifications have been successful.

The Dosatrons, being made of plastic, do not appear durable enough for Australian conditions. Some deterioration of the outside plastic casing and cracking of the injection pump cylinder has been noted on some units. Failure of the injection pump seals and the internal valve control mechanism have also occurred. The Dosatron dispensing units have not been in use for long enough to accurately estimate their service life, but the durability problems which have occurred after only short operating periods suggests that the expected life of the dispensers may be no more than 5 years.

Although the Dosatron dispensers are not without problems, provided they are installed correctly in suitable situations and due care is taken in operation they provide a practical means of supplementing stock via the drinking water.

8.3 Vogt

The Vogt dispensing system was included in the equipment evaluated in this review as it is the only one of many mechanical dispensers developed and marketed over the last 20 years which is still available. In this review the Vogt equipment also provided a benchmark to compare the more recently available equipment.

The Vogt medicators are manufactured by Vogt Engineering South Australia, and are marketed under the brand name Waterplus. Vogt Engineering had previously manufactured equipment for Water Medication Australia (WMA). WMA was also a South Australian company, and marketed these medicators and soluble supplement mixtures for a short time in the 1980's. WMA medicators were found to be unreliable and proved unsuitable as a practical means of supplementing stock via the drinking water. Few if any WMA medicators remain in operation today.

The current Waterplus medicator, although somewhat similar to the WMA equipment, has a different supplement metering system which should overcome some of the problems associated with the earlier equipment. The Waterplus equipment still has considerable limitations as a practical means of dispensing supplements. The low market demand for this product supports this opinion. Other equipment available is probably more suitable.

9.0 CALIBRATION AND DOSING RATES OF MEDICATION EQUIPMENT.

All operating instructions of water medication units and other information available from organisations such as the QDPI advocate dosing rates based on an amount of supplement per animal per day. These rates are largely based on feeding rates established by research using methods of administering the supplement to the animal other than via drinking water. There is only limited evidence to suggest that these feeding rates will give optimum animal responses when the supplement is fed in the drinking water. When attempting to feed animals using these supplement rates via the drinking water the water intake of the animals needs to be known so that the desired supplement concentration in the water can be calculated.

This system of calibration is not always simple and prone to miscalculation and inaccurate dosing due to day to day variation in water intakes. The water intake of a mob of cattle measured last week is not necessarily the same or even close to the amount they may drink next week. Variations in factors including; temperature, rainfall, humidity and pasture state have a large effect on animal water intakes. If water medication is to accurately achieve a desired level of supplement intake, the dosing rate will need continual adjustments. To accurately adjust the dosing rate, the climatic conditions for the next dosing period will have to be known and then calculated to estimate animal water intake. "I don't know of anyone with a glass ball that good".

None of the operating instructions for the dispensing equipment currently available nominate maximum limits for supplement concentrations. In fact if some instructions are followed correctly and the dosing rate is calculated during a period of relatively low water consumption the concentration of urea being fed could well be lethal when animal water intakes increased to higher levels.

As water medication is somewhat different than other methods of feeding supplements, the feeding rates need to be reviewed with the objective of formulating a simpler means of calibrating the dispensing equipment. It is possible that dosing rates can be formulated in such a way that it will not be necessary to measure animals water consumption for each situation. It may also be unnecessary to introduce animals slowly to urea supplement using this method. Some of the current recommendations of increasing the amount of urea fed via the water are far too cautious and require unnecessary adjustments to be made.

In the dry tropics, the animals need for additional NPN increases as the temperatures increase after winter and pasture quality declines. Water intakes increase with the warmer weather resulting in higher NPN intake. For practical purposes a single dosing rate can therefore be used during a feeding period from winter until summer rains. The body weight and lactation status of both sheep and cattle effect the amount of water consumed. This water requirement appears to match the animals requirement for additional NPN to some extent. It can therefore be argued that changing the dose rate for different classes of cattle and sheep and for different seasonal and environmental conditions may not be necessary.

If a single standard dosing rate could be formulated and fed safely to all classes of cattle and sheep it would greatly improve the appeal of this method of supplementation. Based on our current knowledge of water medication using urea an estimate of a single standard dosing rate can be calculated. The expected daily water intake of a 400 kg dry cow or steer grazing dry pasture in a tropical summer environment would be approximately 40 litres. For this animal to consume a recommended 60 grams of urea per day, the urea concentration in the water would be 1.5 grams per litre. The water intake of this animal will vary from day to day due to climatic changes and other factors but as this variation cannot be accurately predicted it is pointless even trying to adjust the dose rate to suit.

Although the example of 1.5 grams of urea is used here as an example of a safe optimum standard dose rate, this still has to be validated. Currently available information suggests that it is most likely to be in the range of 1.2 to 2 grams per litre of drinking water. This level of urea feeding is much lower than the rate that is likely to effect water intakes and the risk of urea toxicity at this level is minimal. Feeding at this rate and accepting that at times water consumption and therefore urea consumption may sometimes be lower than desired is preferable to increasing supplement concentrations during times of low water intake with the subsequent risk of urea toxicity as intakes increase.

Further work with water medication should be directed to formulating standard dose rates that can be safely and effectively used by most if not all producers in a particular environment.

10.0 CONCLUSIONS AND RECOMMENDATIONS.

Water medication can potentially provide a vastly improved supplementation system for grazing livestock and is likely to have widespread adoption providing operating and other problems identified in this report are appropriately addressed.

Four broad issues of water medication have been identified in this review which require further work. Although all these issues are important, they are discussed in the following order of priority

- **(i) Dispensing methods - further improvement/development of existing dispensing equipment and the development and evaluation of new methods.**
- **(ii) Water quality and its effect on supplement loss by crystallisation, precipitation, hydrolysis, urease activity and algae.**
- **(iii) Supplements - feeding rates, cost, taste, solubility, toxicity and their effects on animal production.**
- **(iv) Provision of information to producers - extension, technical support and demonstration of supplement systems.**

(i) Dispensing Methods

Presently the Dosatron and Norprim dispensers are being used successfully by several producers to medicate drinking water for livestock. Neither system is perfect and further development and refinement of both dispensers may be necessary for wider application. Modifications to the Dosatron to make it more durable and to cope with dirty water are presently being tested. A new Norprim dispenser has recently been released on the market incorporating several changes to the earlier models. As yet these changes or improvements have not been fully evaluated in the field, but it is likely that the problems associated with the original units have or will be overcome.

As there have been many different dispensers designed and marketed over the last 20 years it is likely that this process will continue with better equipment being available in the future. The development of new dispensing methods should be encouraged provided they offer real potential to improve upon current methods. If any innovative person or organisation provides ideas to further overcome dispensing problems there is a good argument to provide resources to develop these ideas so that better equipment is available to producers.

It has also been suggested that some process of soliciting ideas to develop better dispensing equipment be undertaken. As producers are by nature somewhat innovative it is possible that some have ideas to develop better equipment. The availability of equipment to accurately and consistently dispense supplements into the drinking water of livestock, has been the major contributing factor to the low level water medication use. The development of new methods to do this should be of a high priority.

(ii) Water quality and its effect on supplement loss by crystallisation, precipitation, hydrolysis, urease activity and algae.

Water quality in many instances determines the success or failure of water medication as a practical method of supplementation. Water quality problems caused by a number of factors are common. The effect of water quality problems ranges from the loss of small amounts of urea or phosphorus to total loss and complete refusal of animals to drink the water. If water medication is to be generally advocated as a practical means of supplementing livestock these problems need investigating so that practical solutions can be provided.

This review has identified some possible solutions to these problems but further investigation and testing of methods to overcome these problems is required. As the quality of stock water is so variable, solutions to problems may have to be sought for specific water sources. Work is currently underway to solve some of these water quality issues. One project at the Tropical Beef Centre (TBC) Rockhampton is investigating the precipitation of magnesium ammonium phosphate and the hydrolysis of urea in a pipeline system. Solutions to some other problems are being tested at other sites by producers. It cannot be assumed that the current work will provide solutions for the majority of the water quality problems.

(iii) Supplements - feeding rates, cost, taste, solubility toxicity and their effect on animal production.

At present the main supplements being fed in drinking water are urea as a source of NPN and technical grade MAP for phosphorous, with ammonium sulphate used to provide sulphur. These supplement sources cannot be considered the only options. Alternate sources of supplements do exist and need to be investigated. Acids such as phosphoric and sulphuric in particular offer potentially attractive alternate sources of P and S. Their use cannot be widely recommended at present due to possible effects on water intake.

There is a need to conduct further studies on various supplements to ascertain there suitability for use in water medication systems. There is a need to test the toxicity and palatability of water when various supplements are added at different concentrations. It may be possible to identify supplement sources that actually attract stock to drink medicated water so supplements can be fed when other water sources exist.

(iv) Provision of information to producers - Extension Technical Support and demonstration of supplement systems.

The suppliers of medication equipment do provide some information and technical support to producers who purchase equipment but this is largely restricted to operating instructions and promotional material. Information about supplements and feeding rates is somewhat inadequate. Other information about water medication available from QDPI and other sources is also inadequate and sometimes contradictory and misleading. There is a need to update much of this information in light of current knowledge.

The level of adoption of water medication is very low with only a fraction of producers who could potentially benefit from using the system presently doing so. To further increase the level of producer adoption further demonstration and promotion of the system is justified. A logical means of achieving this would be through the producer demonstration site (PDS) process where groups of producers can gather and discuss issues of water medication and other supplement methods relevant to their individual situations. If water medication is to be demonstrated at PDS the suppliers of equipment should be encouraged to participate in the process.

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13.0 APPENDIXES.

Appendix I List of properties visited in review.

Mirtna Station	Charters Towers	Ralph Rea
Fortuna Station	Aramac	Margaret House
Swanlea	Aramac	Bob Marshall
Politic Station	Aramac	Bill Ferguson
Duthie Park	Blackall	Peter Skewes
Grassdale	Dalby	Bruce Schraggs
Craiglea	Drillham	Duncan Sturrock
Currawong	Taroom	Dennis Conway
Killara	Proston	Colin Sieler
Namgoori	Banana	Bruce Ballentine
Lowville	Marlborough	Neil Donavon
Arizona	Julia Creek	Richard Makim
Derwent Station	Alice Springs	Ian Morten
Narwietooma Station	Alice Springs	Doug Simms
Victory Downs	Alice Springs	Bruce Morten
Indianna	Alice Springs	Tom Vickers

Appendix II List of others contacted during the review process or who provided information or reports.

Andison, Reg	NT, DPI&F	Katherine
Bawden, Desiree	QDPI	Longreach
Cheffins, Roger	QDPI	Bundaberg
Crawford, Greg	NT, DPI&F	Alice Springs

Dawson, Ken	Style Industries	Brisbane
DeHayr, Rob	DNR	Indooroopilly
Dockray, John	Growforce	Brisbane
Dolinski, Dawn	QDPI	Blackall
Engelke, Jim	Agriculture W.A.	Derby
Esdale, Col	QDPI	Biloela
Fry, Norm	Growforce	Dalby
Gill, Brian	NT, DPI&F	Alice Springs
Graham, Gavin	TBC	Rockhampton
Gulbransen, Bill	QDPI	Brian Pastures. R.S.
Hill, Keith	NT, DPI & F	Alice Springs
Kurtsehemko, Yuri	Style Industries	Brisbane
Malmborg, Steve	Country Industries	Brisbane
McGuigan, Keith	QDPI	Indooroopilly
Murphy, Gerry		Indooroopilly
Murphy, Ken	TBC	Rockhampton
Peart, Jack	NT, DPI&F	Darwin
Peart, Mike	Peart Rural Services	Mitchell
Phillips, Andrew	NT, DPI&F	Alice Springs
Slaney, Henry		Charters Towers
Smith, Peter	QDPI	Charters Towers
Tyler, Russ	QDPI	Gayndah
Vogt, Barry	Vogt Engineering	S.A.
Wilson, Ken	QDPI	Barcaldine
Wood, Tony	Pastoral & Feedlot Systems	Brisbane