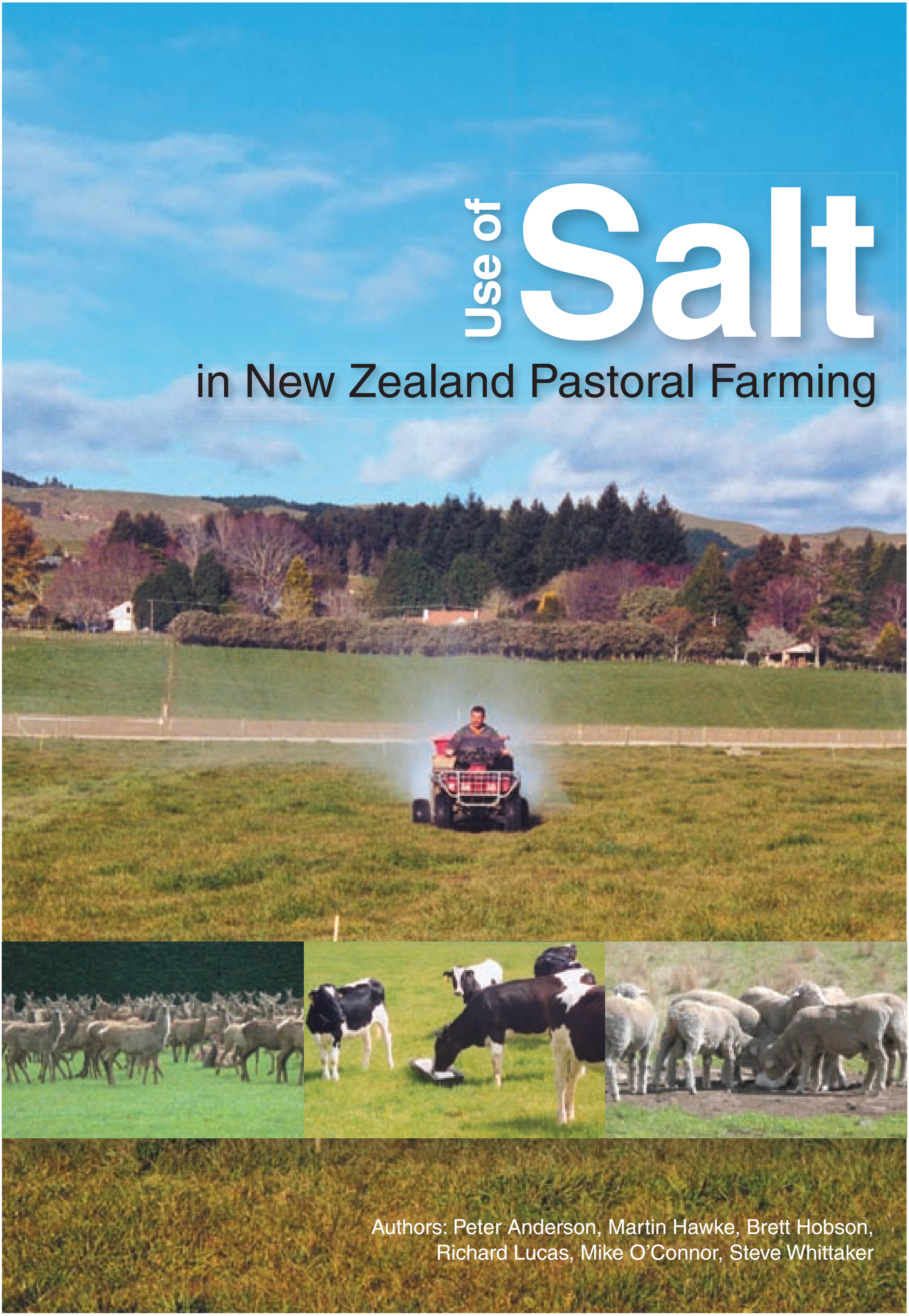
Use of Salt in New Zealand Pastoral Farming



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Foreword

Common salt is sodium chloride, NaCl. Sodium (Na) is essential for animal health and production but is not required for pasture growth. The need to supplement pastures or supply salt to livestock is dictated by the Na requirements of the animal. For grazing animals the Na content of the pastures and their herbage intake is therefore all important. Salt also has other uses outside pastoral farming.

In 2004 Dominion Salt funded salt trials at Mt Grand, Hawea Flat. The trials were looking at the use of salt as a tool to manage grazing. The results of that work appear in this booklet. A well attended field day led to plenty of discussion of the work. From the discussion it became apparent that knowledge about Na and the use of salt was variable - some farmers were using salt in multiple applications and their neighbours didn't consider Na/salt an issue. Knowledge among academics and advisors was also patchy. Recommended study texts and publications for the agricultural industry are often very scant on references to Na. This text will hopefully serve as a reminder that sodium is essential in animal production systems.

"There seems to be very little published scientific material promoting the use of salt. Farmers need facts, please." - Lawrence Cheetham, Masterton.

Lack of sodium can be a production limiting issue. It is easily fixed with salt.

The value of salt in the diet of animals and humans was recognized hundreds of years before the nature and extent of its need were established. The value of supplementary salt for cattle was first demonstrated experimentally in 1847 but the effect of salt deprivation on lactating cows was not reported until 1905. A further half-century passed before sodium rather than chlorine was identified as the element in salt which was primarily concerned in commercial animal production (1).

Naturally occurring dietary deficiency of chlorine is rare but chlorine deficiency has been demonstrated experimentally in poultry and calves. Chlorine is found within cells and in body fluids including gastric secretions where it occurs as hydrochloric acid (HCl) and in the form of salts. Chloride ions (Cl^-) are also vital for respiration functions. Most pastures contain more than three times as much chlorine as sodium with little difference between species. Pastures, therefore, invariably provide sufficient chlorine for grazing animals.

This booklet summarises the role sodium plays in New Zealand pastoral farming systems and the production benefits salt can provide. Information is drawn predominantly from New Zealand experience. References are numbered, the numbers appearing throughout the text with a full listing at the end of the book. It is hoped that this single publication will provide practical guidance to a wide range of farmers, agricultural consultants, academics and students.

Acknowledgements

Dominion Salt acknowledges the work carried out by the authors and the expertise they brought to the project. The authors included: Peter Anderson, Veterinarian, Blenheim; Martin Hawke, Agricultural Scientist, ex AgResearch, Rotorua; Brett Hobson, Dominion Salt Limited, Christchurch; Richard Lucas, Plant Scientist, retired Lincoln University, Christchurch; Mike O'Connor, Soil Scientist, ex AgResearch, Hamilton; Steve Whittaker, Veterinarian, Tokoroa.

The contribution of the farmers who described their experiences and freely gave their advice is also gratefully acknowledged.

Introduction 1.0

- Salt has been traded for thousands of years
- Salt's colorful history is covered in "Salt - A World History", Mark Kurlansky (2)
- Salt is essential to life
- Salt is used in significant quantities in a range of industries including agriculture

Brief history of salt 1.1

Harvested from the sea or wrested from the earth, salt would appear to be one of the humblest commodities. Yet the sodium and chlorine it contains are life-sustaining elements.

Common salt is sodium chloride, NaCl. Sea water is the most abundant source on earth and contains 2.5% salt. 2000 years ago the Romans worked out a process for evaporating sea water and produced solar salt. Salt is also found in large underground deposits formed 150 million years ago. Extraction of underground deposits is either by mining or by dissolving in water and artificially evaporating the brine into salt.

Historically salt was highly valued. Roman legionnaires who guarded the Via Solaria, one of the most famous military roads in history, received part of their pay in salt, the "salarium". From this came the modern word "salary". To this day a good man is "worth his salt" and we take others' dramatic pronouncements "with a pinch of salt". In medieval times people partaking of food around the board in the lord's castle were seated above or below "the salt" according to their station in life.

We have known for thousands of years that animals need salt. Stories have been told of humans following animal trails to salt sources, and then the humans using salt to draw animals to them.

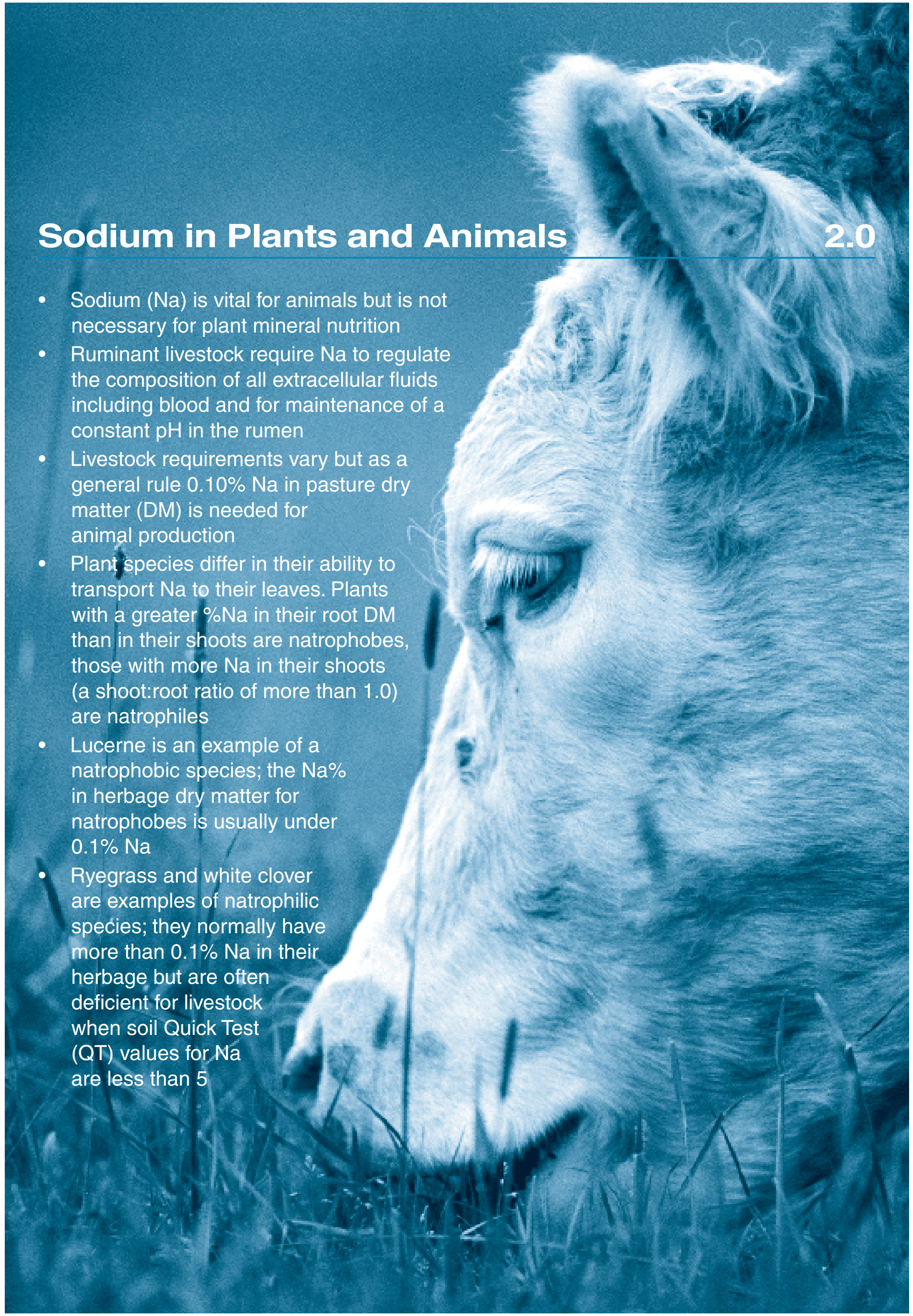
Salt has influenced the location of nations and cities, been the cause of wars, given rise to superstitions and religious beliefs and is as essential to life as the air we breathe and the water we drink.

Current uses 1.2

Worldwide salt production is estimated at 240M tonnes annually (2006). China is the world's largest producer at 48 million tonnes annually. North America (Canada, Mexico, USA) produces more than 25% of the global total. Salt's uses are many and varied, including; for preserving food; preservation of skins and hides prior to tanning; in food preparation and processing; as a raw material in the production of sodium bicarbonate, soda ash, caustic soda, sodium chromate and sodium sulphate; to produce chlorine for bleaches and disinfectants; in water treatment systems; in medicine for the production of saline drips, haemodialysis fluids, eye washes and toothpaste; in agriculture for fertiliser and stock licks; in making up brines for chiller tanks; and for de-icing roads. 15M tonnes are used on USA Highways each year.

NZ salt production 1.3

New Zealand's only salt production field is at Lake Grassmere, Marlborough. Solar salt is produced by evaporating seawater using sun and wind during the summer months. In March the salt crust is lifted and stockpiled for processing throughout the year. Yearly production from Lake Grassmere is not sufficient to meet New Zealand's salt needs with shortfalls being imported as raw salt for refining in New Zealand, or as refined salt. Major uses are skins and hides processing, food manufacturing, agriculture and water treatment. Supermarket sales account for less that 4% of trading volume. Usage for road and pavement de-icing is minimal but growing.



Sodium in Plants and Animals 2.0

- Sodium (Na) is vital for animals but is not necessary for plant mineral nutrition
- Ruminant livestock require Na to regulate the composition of all extracellular fluids including blood and for maintenance of a constant pH in the rumen
- Livestock requirements vary but as a general rule 0.10% Na in pasture dry matter (DM) is needed for animal production
- Plant species differ in their ability to transport Na to their leaves. Plants with a greater %Na in their root DM than in their shoots are natrophobes, those with more Na in their shoots (a shoot:root ratio of more than 1.0) are natrophiles
- Lucerne is an example of a natrophobic species; the Na% in herbage dry matter for natrophobes is usually under 0.1% Na
- Ryegrass and white clover are examples of natrophilic species; they normally have more than 0.1% Na in their herbage but are often deficient for livestock when soil Quick Test (QT) values for Na are less than 5

Sodium in plants 2.1

Natrophobes 2.1.1

Plants that normally have low sodium content in their herbage dry matter (DM) are known as natrophobes. While their roots may absorb Na from the soil they do not transport much of it to their leaves. Examples of plants which have low herbage Na are lucerne, red clover, Caucasian clover, browntop, timothy and kikuyu grass. Natrophobic species will all normally have herbage which is deficient for ruminants. Values of 0.01% to 0.05% Na will be expected. As ruminant livestock require about 0.1% Na in their diet, pastures which are dominated by natrophobic species will be deficient.

Natrophiles 2.1.2

Natrophiles accumulate Na in their herbage and can provide sufficient Na for ruminant nutrition. However, in inland areas away from the main influences of coastal salt spray, the low soil Na content results in most natrophilic species being unable to take up enough Na to satisfy ruminant requirements. For example, with a QT Na of 2, white clover (0.02% Na) and cocksfoot (0.01% Na) were deficient at "Mt Grand" near Hawea Flat in west Otago. On the same farm in a sown paddock with QT Na of 3 the herbs chicory and plantain both had sufficient Na for ruminant nutrition but all other species in the pasture were deficient with 0.05%Na or less (3). Examples of %Na in herbage dry matter of natrophobes and natrophiles when grown in soil with adequate Na and in Na deficient soil are presented in Table 2.1

Table 2.1

Pasture and forage species listed as natrophiles and natrophobes with typical Na% values for herbage dry matter when grown in fertile soils inland and near the coast. Inland soils were Na deficient with an average QT Na of 3 while the coastal sites were Na sufficient with an average QT Na of 10. Numbers in ( ) refer to numbers of samples from different sites (3).

Species	Soil Na < 5 (deficient)		Soil Na > 5 (sufficient)	
Natrophiles				
Plantain	0.25	(3)	0.60	(11)
Chicory	0.09	(3)	0.70	(10)
Turnip leaf	0.08	(3)	0.13	(2)
Perennial ryegrass	0.07	(2)	0.14	(6)
Cocksfoot	0.06	(5)	0.16	(4)
Sub clover	0.02	(2)	0.34	(2)
White clover	0.05	(10)	0.16	(15)
Natrophobes				
Browntop	0.05	(2)	0.11	(2)
Lucerne	0.05	(10)	0.06	(33)
Caucasian clover	0.02	(2)	0.02	(2)

Other species which are natrophiles are phalaris, Yorkshire fog, prairie grass, *Lotus pedunculatus,* (e.g. Maku), and tall fescue. Sub tropical natrophobic grasses like kikuyu grass, paspalum and maize are all low in Na.

Note that the species in Table 2.1 are listed in order of their herbage Na contents. Natrophiles have been defined as plants which have higher Na% in their shoots than their roots. Hence their shoot Na/root Na ratio is more than 1. In contrast natrophobes have shoot Na/root Na ratios of less than 1 because they retain Na in their roots (4).

While this definition of high or low Na herbage species is valuable, there is clearly a continuum from extremely natrophilic species with high shoot Na/root Na ratios of more than 3 (phalaris, Yorkshire fog), marginal species such as tall fescue 1.3 and browntop 0.9 and extreme natrophobes such as paspalum, kikuyu grass and timothy with a ratio of 0.2 (4).

The MAF Quick Test (QT) is used for measuring soil Na. It is available from many soil testing laboratories in NZ.

Function of sodium in ruminants 2.2

Role of sodium in ruminants 2.2.1

The role of sodium (Na) in ruminants is two fold:

(a) Na plays a critical role as the principle cation in the extracellular fluid and in the regulation of the composition of the blood in all animals, ensuring that all the cells of the body are maintained in a constant environment.

(b) The most important function of Na in ruminants is the role Na plays in maintaining a constant pH in the rumen environment (rumen homeostasis). Recycled Na in the form of sodium bicarbonates in the saliva is mixed with rumen constituents to maintain an optimal rumen pH of around 5.8-6.3 (5). At this pH range the fibre digesting microbes exhibit maximum growth and the digestion of plant and forage dry matter (DM) is optimized. The end result of active digestion in the rumen is the production of soluble volatile fatty acids - acetic, butyric and propionic acids - it is these that require buffering by the sodium bicarbonate in the saliva to maintain the constant rumen pH. The implication of a depressed digestion of DM at low ruminal pH can be evaluated in terms of the effect it has on a reduction of metabolisable energy (ME). When the pH decreases below its optimal 5.8-6.3 range, a loss of approximately 0.7MJME/kg of pasture DM occurs.

Ruminants produce large volumes of saliva - sheep 10-15l/day and cattle 50-150l/day. At any one time the rumen may contain about 50% of the sodium available in the body. This demand for Na cannot be met by dietary intake alone. Sodium must therefore be recycled by the animal from the gut before entering the extracellular fluid. The kidneys are an efficient mechanism for conserving or excreting sodium as the occasion demands. Thus, animals may remain on sub-optimal Na intakes for extended periods before signs of acute Na deficiency become apparent.

Minimum daily requirements of sodium 2.2.2

The minimum Na requirements for different classes of stock are not known with any degree of accuracy and are based on very restricted experimental data. The principle sources of reference are from the British Agricultural Council (ARC) and the American National Research Council (NRC) (6). Towers & Smith (7), two New Zealand researchers, cite similar reference material based on limited New Zealand trial work. It would appear that these dietary requirements are based on the requirement to avoid clinical deficiency and not optimize production.

The following table contains recommendations for grazing animals. ***Note that salt contains 40% sodium by weight. When converting Na requirements to salt equivalent multiply by 2.5***

Table 2.2

Estimates of minimum dietary sodium required by sheep[a] and cattle, adapted from Underwood & Suttle (1).

	Live weight (kg)	Growth rate or milk production	Gross[b] Na requirement, g Na/day
Lamb	20	0.1 kg/day	0.35
		0.2 kg/day	0.47
	40	0.1 kg/day	0.58
		0.2 kg/day	0.71
Ewe	75	0	1.0
Pregnant ewe	75	1 fetus-12 weeks	1.0
		term	1.0
Lactating ewe	75	1 kg/day	1.2
		2 kg/day	1.8
		3 kg/day	2.2
Steer	200	0.5 kg/day	2.3
		1.0 kg/day	3.1
	400	0.5 kg/day	3.9
		1.0 kg/day	4.7
Cow (Dry)	600	0	4.5
Cow (pregnant)	600	-12 weeks	4.3
		term	7.2
Cow (milking)	450	10 kg/day	10.0
		20 kg/day	15.8
		30 kg/day	22.3

[a]Values for sheep reduced by using a lower value for faecal endogenous loss of 5 as opposed to 20 mg Na/kg LW.

[b]Absorption coefficient = 0.91.

For grazing animals pasture containing 0.09% Na is sufficient for sheep, 0.1% Na is sufficient for beef cattle and 0.12% Na is sufficient for lactating dairy cows (7).

Sodium in New Zealand Pastoral Systems 3.0

- Soil sodium (Na) content is influenced by Na input in rainfall which in turn depends on distance from the sea, prevailing winds, mountains and rainfall
- In general herbage Na is most likely to be deficient in inland areas where soil Quick Test (QT) Na values are 5 or less
- A combination of inland location and pasture dominated by a natrophobic species such as browntop or a weed free lucerne stand will almost certainly present a Na deficient diet to both sheep and cattle
- Areas where Na deficiency in livestock is likely to be common are the Central Plateau in the North Island and inland areas of Marlborough and Canterbury, and Central Otago
- Where Na deficiency occurs animals can be supplemented with salt. There are various methods available (see chapters 4 and 5)
- Signs of deficiency include loss of appetite, abnormal licking and chewing, haggard appearance, loss of production
- Precise diagnosis of Na deficiency is not always reliable or practical

Sodium content of soils 3.1

The map of New Zealand (Figure 3.1) indicates Na levels for grass growing in unfertilized soils (8). The darkest zone on the map indicates areas in the west and south where grass DM had over 0.15% Na. The medium coloured zones had grass with between 0.05 and 0.15% Na and the light coloured inland zones had less than 0.05% Na. These data refer to sweet vernal which is present in most undeveloped land in the country. The map suggests that the main influences on sea spray and therefore on soil Na are strong westerly and southerly winds, mountain barriers, distance from the sea and rainfall. Clearly all inland areas of the South Island are likely to be Na deficient along with the pumice soil regions of the Central Plateau in the North Island.

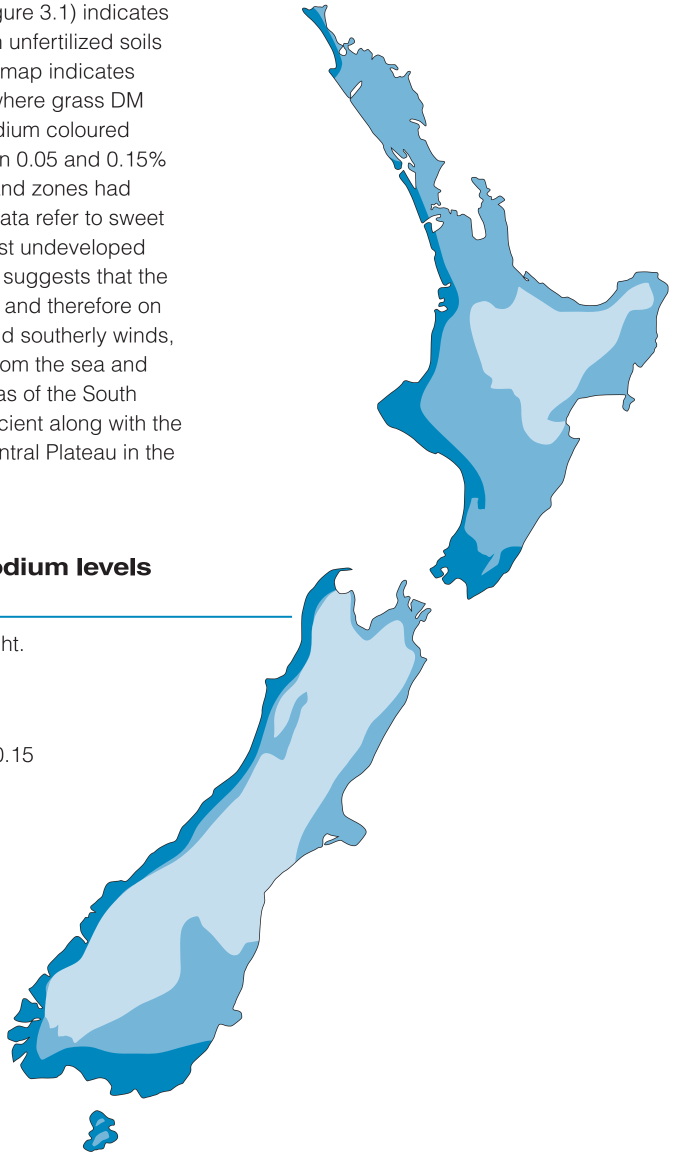
Figure 3.1 Pasture sodium levels in unfertilized soils

Percentage on oven-dry weight.

Over 0.15

Between 0.05 and 0.15

Less than 0.05



Of the four exchangeable cations in soil (Ca, Mg, K and Na), Na is usually present in lowest concentration. Typical soil Na QT values range between 5 and 10 and it is rare for soil Na to exceed 20-25 QT units. Inland deficient areas have QT Na values of less than 5. However, because Na is the least strongly held cation on soil cation exchange sites, it is frequently the main cation in soil solutions. (9, 10)

Inputs of Na from rainfall in the North Island range from about 120 kg Na/ha/year near the west coast down to about 5 kg Na/ha/year in central districts. It is highly likely that the central regions of both islands are in negative Na balance and that soils will be depleted of Na over time. This depletion of Na in inland areas is likely to be worse in regions with a low cation exchange capacity (CEC) such as the pumice soils in the Central Plateau. Low CEC means that soils have a reduced capacity to hold Na ions against leaching.

Sodium budgets on dairy farms have been presented for Southland (11) and Waikato/Taranaki (12). These regions are considered to have adequate soil and plant Na. Rainfall is the greatest source of Na and leaching is the largest loss. Table 3.1 shows that both regions are in negative Na balance. So even though inputs of Na are high it is likely that losses will lead to declining Na levels in soils and pastures over time. This is particularly the case for intensive dairying where Na output in milk from dairy farms is likely to be greater than from meat production on sheep and beef farms.

The data in Table 3.1 are for typical dairy farms. There will, however, be considerable variation between farms and from year to year in salt inputs and leaching of Na. This variation will be driven mainly by rainfall but grazing management will also have some impact on leaching especially during winter. Variation in leaching losses from Waikato pastures ranged between 13 and 40 kg Na/ha/year depending on rainfall and similar variations in inputs from rainfall may also be expected. (10)

Table 3.1

Sodium nutrient budgets for typical dairy farms in Southland and Waikato.

	Southland	Waikato
Inputs:	**kg Na/ha/annum**	**kg Na/ha/annum**
Fertiliser	1	1
Rainfall	20	35
Outputs:		
Milk and meat	4	6
Transfer	2	2
Leaching	29	40
Balance:	**-14**	**-12**

Sodium content of pasture 3.2

Much of the data on pasture Na comes from mixed samples collected from developed pasture on intensively farmed properties. The botanical composition of those samples is normally about 80-90% ryegrass and 10-20% white clover. Both species are natrophiles and can be expected to contain sufficient Na for lactating cows if the soil QT is greater than 5. Where soil test Na levels are low (<5) ryegrass/white clover pasture herbage should be tested for Na%. Estimated pasture DM requirements for various livestock classes are presented in Chapter 5.

If natrophobic species dominate pastures in inland areas and soil Na is deficient all pastures are likely to be Na deficient and livestock will benefit from salt supplementation. Spreading salt as fertiliser on natrophobic species such as browntop, kikuyu grass or lucerne will not lift Na% in the herbage as much as in natrophilic species such as ryegrass, cocksfoot or white clover. Topdressing salt in these situations is not likely to be as effective as other means of salt supplementation such as blocks or drenching.

Sodium deficiencies in grazing livestock 3.3

Diagnosis of sodium deficiency in livestock:

Sodium levels in many NZ pastures are low, and falling, as a result of continued leaching and the low proportion of farmers adding salt to their fertiliser requirements. This is possibly due to the fact that sodium is not required by the plant to increase pasture yield and so may be overlooked when considering fertiliser requirements, or farmers may be choosing to supplement Na in other ways. Also, sodium deficiencies are difficult to diagnose as specific clinical signs are not directly attributed to sodium and blood tests are not specific to a deficiency.

Clinical signs of deficiency 3.3.1

In ruminants, the initial sign of Na deficiency is the development of a depraved appetite, or pica, which is manifested as an intense craving for salt. Signs include abnormal licking or chewing of wood, soil (see section 6.2) or the licking of the sweat from other animals. These early signs normally become apparent after 2 to 3 weeks of the animals being placed on a sodium deficient diet. In a prolonged deficiency, loss of appetite is accompanied by the development of a haggard appearance, lusterless eyes and a dry and harsh coat, with reduced milk production and rapid weight loss and/or decreased growth rates. In extreme and prolonged sodium deficiencies, the animals will shiver, become uncoordinated, show general weakness, develop heart arrhythmias eventually collapsing and dying.

Some examples of Na deficiency:

Example 1: A classic example of Na deficiency symptoms was recorded in a herd of 45 lactating Holstein-Friesians in 1975. The cows showed increased urination (polyuria), and a 40% decrease in herd milk production. Other signs in the herd included salt hunger, pica and loss of body condition. Cows were seen to be eating the urine soaked straw bedding in preference to hay. These cows were supplemented with 60g salt/cow/day and there was a decrease in urine output and an increase in milk yield over the ensuing 10 days. (13)

Example 2: In New Zealand it has been shown that weaner beef Angus cattle grazing pastures that contained 0.08% sodium (0.8g Na/kg DM) did not grow as well as those on pastures with a sodium content of 3.2g Na/kg DM, whereas weaners on pasture with 1.1g Na/kg DM grew as well as weaners on pasture with 1.7g Na/kg DM. These observations suggest that the requirements for Na, while not met by herbage containing 0.8g Na/kg DM, is met if the herbage concentration exceeds 1.1g Na/kg DM. (7)

Example 3: Mike O'Connor in 2000 in a salt supplementation trial of milking dairy cows was able to show a 12.8% increase in milk production after the cows were supplemented with 35 g of salt/day. This response occurred within 2 weeks and continued throughout the trial period. (14)

Grazing ruminants in NZ are unlikely to suffer extreme Na deficiency, but sub-optimal production may be occurring in dairy herds where Na intakes are not optimal as a result of low herbage Na concentration or mixed rations that includes maize silage or palm kernel (PKM, PKE). Addition of these supplements is now commonplace on many intensive dairy farms throughout NZ.

Diagnosis of sodium deficiency 3.3.2

1) *Analysis of dietary sodium content:* The analysis of sodium in the diet is one method used to estimate the Na status of animals and is frequently used for this purpose. If the dietary Na concentrations are below the minimum suggested (Table 2.2) for the appropriate category of livestock, there is an immediate suggestion of Na deficiency. It is, however, insufficient to base recommendations solely on dietary Na content given the ability of livestock to select patches of pasture which are high in sodium and the large variation in pasture Na content. Nevertheless, carefully collected pasture samples that are representive of the diet of grazing ruminants are extremely valuable and used extensively in predicting Na status. Pasture samples can be collected by hand but plastic gloves should be worn to avoid contaminating the sample with Na from sweat.

2) *Blood samples:* Blood sampling for Na status is of little value. Sodium levels in the blood are maintained within a very narrow range. Even in cases where cows were severely deprived of Na and production responses to Na were apparent, no changes in blood Na occurred.

3) *Urine analysis:* The Na status of ruminants is maintained largely by regulating the amount of Na that is excreted in the urine. Low urinary Na outputs will therefore reflect low Na intakes. Average Na concentrations of less than 3 mmol/l are indicative of Na deficiency, while those greater than 7 mmol/l indicate an adequate Na intake. However, accurate diagnosis requires the measurement of 24-hour urine volume and the Na concentration over several days, which under field conditions is not practical. In the field, 10 animals can be urine sampled to increase the likely chance that a deficiency is detected. The results can then be collated in conjunction with pasture analysis and saliva Na content to formulate a better indication of the Na status of the animals.

4) *Saliva analysis:* The most reliable criterion for diagnosing Na deficiency is to analyse the relative Na and potassium (K) concentrations in the parotid saliva. Saliva samples are collected by placing an absorbent sponge between the cheek and the molar teeth of the upper jaw with forceps. The sponges should be held in place for 1-2 minutes then removed and placed in a sterile container. Ruminants attempt to maintain the total Na plus K concentration of the parotid saliva at 150 ± 15 mmol/l in cattle and 180 ± 15 mmol/l in sheep. In the Na replete animal the Na concentration greatly exceeds that of K, but as the animal becomes increasingly Na deficient the Na concentration falls while the K concentration increases to maintain total ionic strength. However, as the animal's Na deficit grows the fall in Na exceeds the increase in K concentration and the total Na plus K concentration may fall by around 20%. Below 130 mmol/l Na the animal first tries to maintain Na status by reducing the loss from the kidneys. As Na deficiency increases the Na levels can fall to <70 mmol/l at which time we see clinical signs developing. It should be noted that within any group of animals a wide variation occurs in individual Na:K ratios and that at least 15 animals should be sampled to ensure the test is validated.

A normal Na:K ratio in the saliva is greater than 10.0. A ratio below 10.0 indicates the Na status is insufficient. Unfortunately this test is difficult for a farmer to undertake and must be done by a veterinarian.

Table 3.2

Tentative criteria of Na status of cows from Na and K concentrations from the parotid saliva glands.

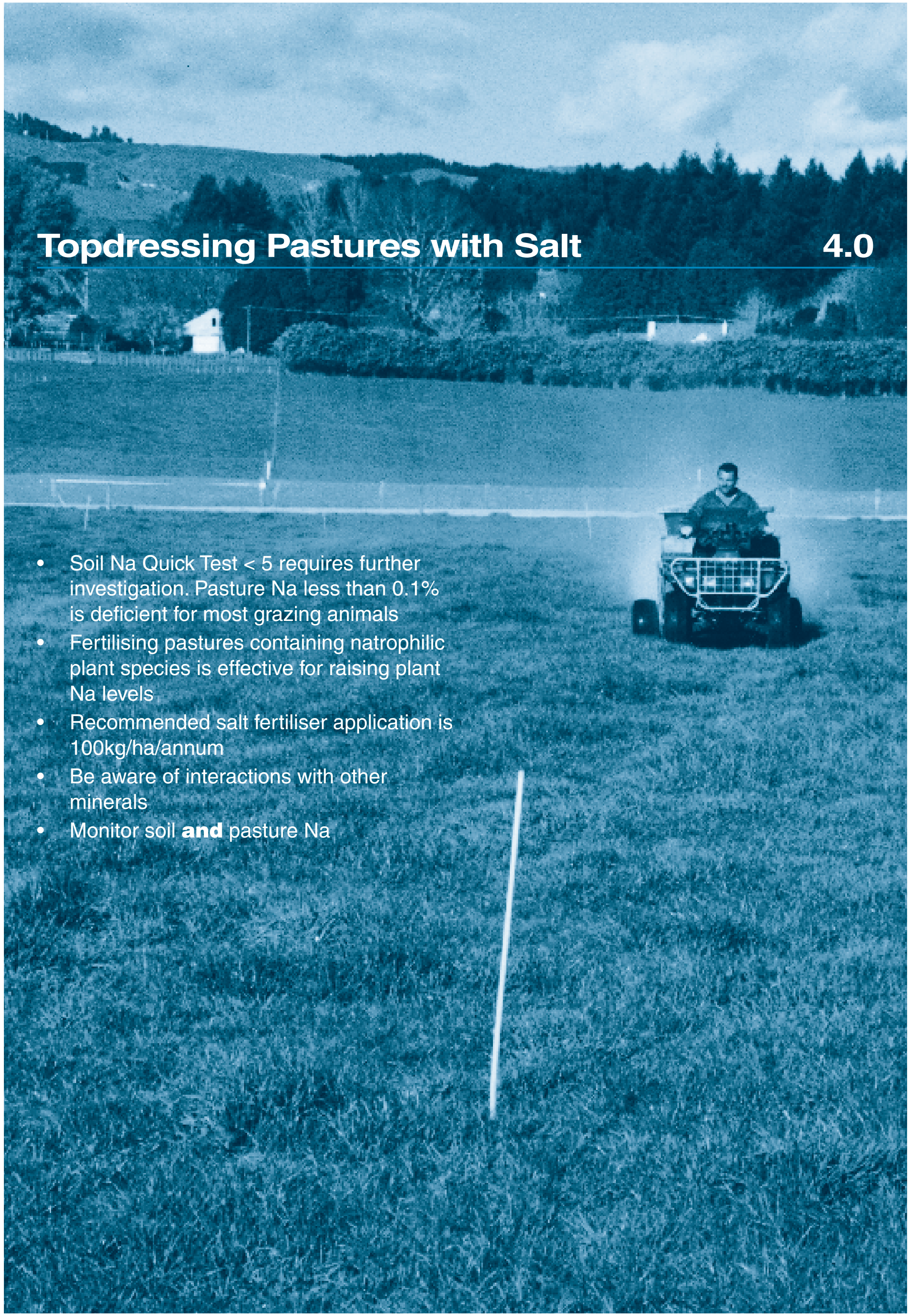
Na Status	Clinical Signs	Saliva composition		
		Na mmol/l	K mmol/l	Na:K Ratio
Sufficient	None	>130	<13	>10.0
Possibly insufficient	None	87-130	13-38	2.3-10.0
Insufficient	Sometimes	43-87	38-64	0.7-2.3
Severe Deficiency	Always	<43	>64	<0.7

The following table shows saliva Na and K concentrations and their respective ratios taken from Mike O'Connor's Salt Drenching Trial in 2000 (14). These cows represent the typical variation observed within the treated and control groups. The table highlights the low Na:K ratios in the milking cows that were not receiving salt supplementation.

Table 3.3

Individual Cow's from the Waikite Valley Salt Trial.

Cow Tag Number	Drenched with Salt (Yes or No)	Saliva composition		
		Na mmol/l	K mmol/l	Na:K Ratio
281	Yes	139.7	5.2	26.9
279	Yes	145.4	7.6	19.1
253	Yes	138.4	8.7	15.9
91	No	85.6	37.9	2.3
298	No	110.1	34.4	3.2
116	No	121.9	20.4	6.0
Average for Salt Drenched Cows	Yes	141.2	7.2	19.6
Average for Non Drenched Cows	No	105.9	30.9	3.4



Topdressing Pastures with Salt 4.0

- Soil Na Quick Test < 5 requires further investigation. Pasture Na less than 0.1% is deficient for most grazing animals
- Fertilising pastures containing natrophilic plant species is effective for raising plant Na levels
- Recommended salt fertiliser application is 100kg/ha/annum
- Be aware of interactions with other minerals
- Monitor soil **and** pasture Na

Background 4.1

Sodium (Na) is not required for plant growth but is essential for animal health and production. One way of providing Na to animals is to topdress pastures with salt. Topdressing with salt will increase the Na content of pastures and provide Na to the animals grazing those pastures. However, not all pasture plants will take up Na (see chapter 2 for a description of natrophobes and natrophiles) but the common pasture plants like ryegrass, white clover, cocksfoot and Yorkshire fog are all capable of absorbing more than 0.1% Na into their leaves.

Sodium deficiency is likely to be more common in inland areas away from the sea (see chapter 3). Recent estimates suggest 20% of New Zealand dairy farms and 5% of sheep farms could be deficient. Dairy farm figures could become even higher in future as on-farm nutrient balances suggest Na is in negative balance (- 12 to -14 kg Na/ha/annum) on many dairy farms (table 3.1). Rainfall is the major source of Na and leaching is the major loss.

Diagnosing Na deficiency 4.2

Soil tests 4.2.1

Of the exchangeable cations in the soil (Ca, K, Mg and Na) Na is normally present in the lowest concentration. Using the MAF Quick Test (the test supplied by the major soil testing laboratories in New Zealand) a Na value of less than 5 units in a soil sample suggests that soil Na levels are low. What needs to be done then is to confirm that Na is deficient in the pasture using chemical analysis.

Pasture chemical analyses 4.2.2

Pasture samples should be taken from representative paddocks across the farm and sent to the laboratory for major element analyses including Na. Care needs to be taken in the sampling process in the field. The person taking the sample needs to wear plastic gloves to ensure the pasture sample is not touched by bare hands (there is salt in sweat); the sample needs to be representative of what is growing in the paddock and being eaten by stock and it needs to be as clean as possible and not contaminated by mud or dust. Soil contamination will give a false Na reading. Getting a correct Na reading can be difficult hence the care needed in the sampling process.

Interpreting the pasture analysis: if the Na value is 0.10% or less in the herbage Na deficiency is likely in the animals grazing those pastures.

Salt topdressing 4.3

Fertiliser grade salt (as supplied by Dominion Salt) is available from fertiliser companies and rural merchants. It can be readily mixed with fertilisers other than nitrogen. Mixing is best done by the fertiliser companies. Salt purchased for topdressing should be stored under cover and used soon after receipt. Prolonged storage of salt in damp conditions tends to make it go hard and lumpy, making application through spreading gear very difficult.

Rates and frequencies of application 4.3.1

Field trials on rates and frequencies of application of salt to pasture have been undertaken in a number of areas. Results suggest that rates of salt application mirror those of muriate of potash. Conclusions from a series of trials conducted in the Waikato in the late 80's (15) recommended an annual rate of salt application of 100 kg/ha. This rate lifted Na levels in the herbage 2-3 times above the critical level and maintained them there for at least 30 weeks (Table 4.1). There was no effect on pasture production. A rate of salt application of 50 kg/ha lifted Na levels in the herbage above the critical level but only for a short period of approximately 6 weeks. Rainfall was approximately 1300mm/annum in the Waikato situation. Where areas have low annual rainfalls (less than 600mm) the 50kg/ha rate of application may suffice.

In situations where K is deficient (and this could be farms which have intensified in recent times) salt (Na) application can substitute for K (16) to a limited extent and benefit pasture production. These situations are likely to be rare as the normal practice would be to apply muriate of potash fertiliser.

Increases in % Na in pasture and its duration 4.3.2

When salt is applied to pastures it dissolves rapidly and is taken up quickly by plants. An indication of the increase in pasture % Na from different rates of salt application is shown in a field trial on a pumice soil conducted by MAFTech in the late 1980's (Table 4.1). The pasture was deficient in Na to start with (the critical level for animals is 0.10 % Na). Six weeks after salt application % Na had increased up to the highest rate applied but by 30 weeks had fallen across all rates. However, with the exception of the 50 kg rate, % Na was still well above the critical level.

Similar increases were observed in soil Na status with the 100 kg rate effectively raising soil Na level from 5 to 13 at 6 weeks then falling back to 8 at 30 weeks.

The recommended salt application rate to lift and maintain % Na in the herbage is 100 kg/ha/annum. Lower rates, although useful for an initial lift in % Na in the pasture, will not last for more than 6 weeks. No appreciable benefit is obtained by applying higher rates (15).

Table 4.1

Effect of applied salt on the % Na content of pasture and its duration on a pumice soil near Putaruru.

kg salt/ha	50	100	200	400
	% Na in pasture			
At start (Sept)	0.07	0.07	0.07	0.07
After 6 weeks	0.15	0.23	0.24	0.34
30 weeks	0.11	0.15	0.16	0.21

Effects of other elements 4.3.3

Where salt is being applied as part of a pasture maintenance fertiliser programme it can be mixed in with other fertilisers like superphosphate, potassic superphosphate and serpentine super. It should not be mixed with N fertilisers like urea or DAP. If there is any depression in K, Ca or Mg contents in herbage as a result of applying salt it is likely to be relatively minor and unimportant at 100kg salt/ha. However, in situations where there may be a deficiency of Ca, K or Mg the application of salt could make the situation worse for those elements. These situations can be easily averted by applying appropriate fertilisers or by ensuring animals are given the appropriate mineral supplementation of Ca and Mg.

Monitoring 4.3.4

Regular soil testing of the farm every 2-3 years should highlight any downturn in soil Na status. Once levels reach 5 or less then pasture monitoring should be done. As explained above care needs to be taken in taking pasture samples to prevent contamination. If remedial action is being taken, ie. salt is being applied as a fertiliser, then pastures should be sampled annually prior to fertiliser application. The aim should be to raise the Na status of pastures above the critical level of 0.10 % Na (preferably to around 0.15% Na or higher) and maintain this level throughout the year. Timing of sampling soil or pasture for Na status is not important although for annual monitoring purposes sampling should occur during the same month each year. This will ensure pasture composition, namely the proportion of grass/ clover/ weeds, is about the same. Remember with pasture monitoring you are trying to analyse the Na content of what the animals are eating and this can vary amongst the pasture components.

Fertiliser and lime effects on pasture Na status 4.3.5

Potassium and lime can depress the Na status of pastures. This is simply due to K^+ or Ca^{++} increasing and Na^+ needing to reduce to maintain ionic balance in the plant.
Potassium applied at 100 kg K/ha or more can depress Na status by 30-40%. This will have implications if the Na status is already in the marginal range.
There is the potential for lime to do the same although in practice Mg seems to be the element most likely to be depressed by Na and K applications.
The advice is to always be aware of the interactions which can occur when different fertilisers and lime are applied to pastoral land. Any effects will be most pronounced in the 6 weeks following their application.

Some detrimental effects of salt 4.4

Pasture burning 4.4.1

Recommended applications of salt (up to 100 kg/ha) will not burn pastures. Rates higher than 100 kg/ha have the potential to burn.
The burning effect is similar to that experienced sometimes when potash is applied at similar rates. It is a temporary setback in pasture growth which will recover after rain.

Salination effects on soil structure 4.4.2

Large parts of Australia and other dryland continents suffer from salination. This occurs when salt crystallizes out as a result of hot, dry conditions over long periods of time. These are extreme conditions. The resulting land is useless for agriculture as it forms a deep crust of salt across the landscape. The closest NZ gets to areas of salination is in small areas of Central Otago. Where the problem is not too serious remedial action can be taken by irrigating the land and allowing salt to leach out of the soil profile.

Tidal effects of seawater 4.4.3

This can be a problem where tidal flats are used for agriculture. Northland has a number of these areas. The problem is that seawater containing salt replaces the groundwater. Some plants are more tolerant of salty water than others. The first approach to growing pastures on such land is to prevent the ingress of the seawater by building permanent weirs. Thereafter normal rainfall will gradually leach Na from the soil and it can be used for pastoral agriculture. Excellent pasture production can eventuate on such land. Plant species which tolerate saline soils are strawberry clover, tall fescue, phalaris, balansa clover, lucerne, annual medics and barley.

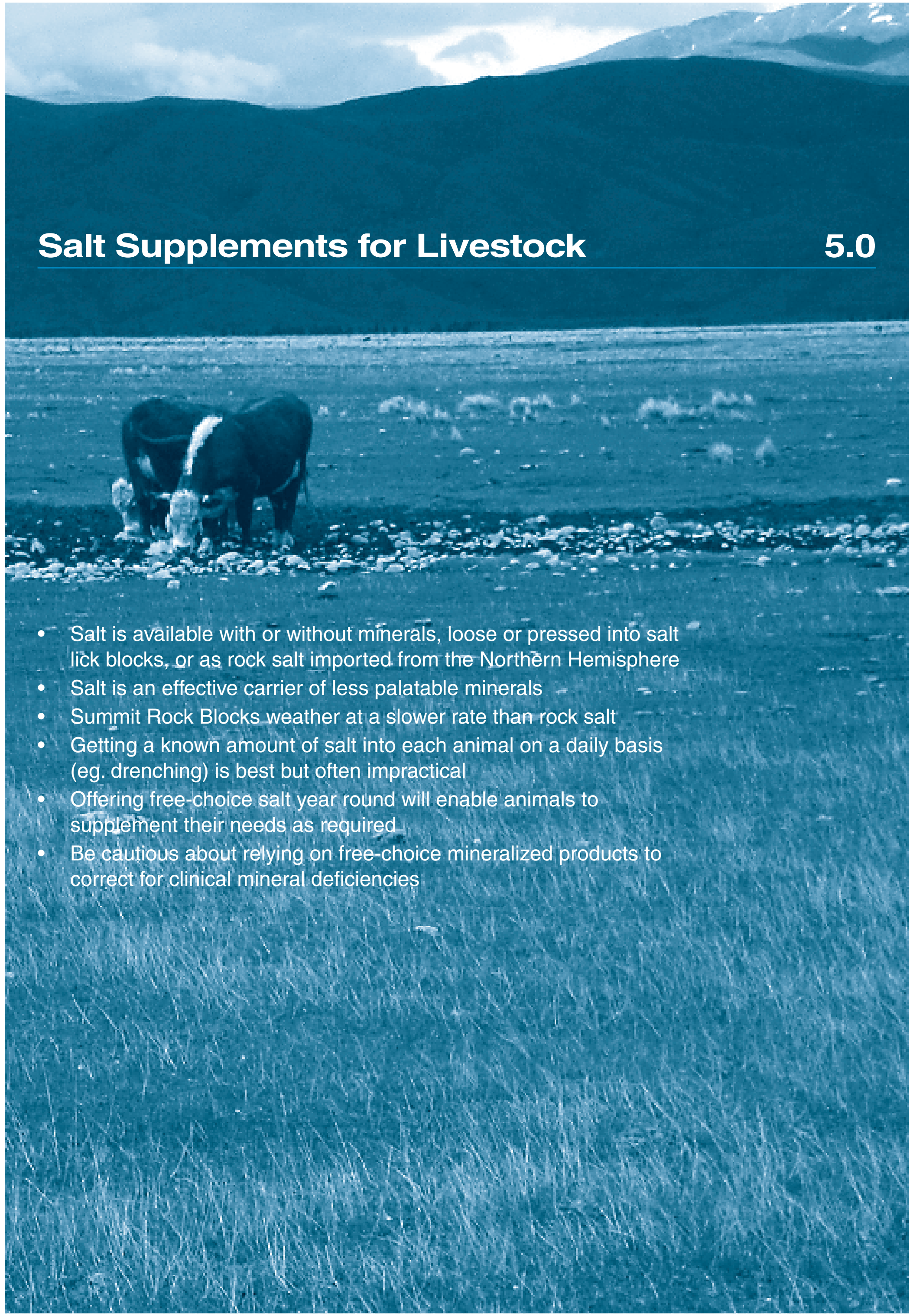
Applying effluents high in Na 4.4.4

There are a number of examples of industrial effluents being recycled back onto land. Many of these contain high concentrations of Na. These include dairy factory effluents, paper mill effluent, human sewage and household effluent, meat works effluent and various other processing effluents. Often the main source of Na is from chemicals used in wash waters for cleaning processing equipment. All these effluents can be useful sources of nutrients for pastoral production. The problem comes when application rates get too high and/or the soil types are not suited to land application. Often soil structural breakdown occurs as a result of very high Na inputs. Rates of 800 - 1000 kg/ha Na (up to 2500 kg salt/ha/year) are not uncommon. Such schemes need very careful planning, a large area of the right soil type (free draining) and, most importantly, careful management to be successful.

Examples of salt use on pastures 4.4.5

There are various mixes that have been tried. These include applying fertiliser grade salt alone, mixing salt with normal fertiliser, substituting a portion of the potash in potassic superphosphate with salt, mixing a dusting grade salt with MgO for dusting onto pastures.

It should also be mentioned that a way to complement natrophobic pasture species (which do not take up Na) is to plant companion natrophilic species such as chicory or plantain. Salt can then be applied for uptake by the companion species. Other examples of this include lucerne sown with phalaris and kikuyu undersown with ryegrass.



Salt Supplements for Livestock 5.0

- Salt is available with or without minerals, loose or pressed into salt lick blocks, or as rock salt imported from the Northern Hemisphere
- Salt is an effective carrier of less palatable minerals
- Summit Rock Blocks weather at a slower rate than rock salt
- Getting a known amount of salt into each animal on a daily basis (eg. drenching) is best but often impractical
- Offering free-choice salt year round will enable animals to supplement their needs as required
- Be cautious about relying on free-choice mineralized products to correct for clinical mineral deficiencies

Range of salt products 5.1

In New Zealand a wide range of salt based products is available for direct supplementation in animal diets. Some are used to increase sodium intake only while others use salt as a carrier for less palatable minerals. A number of products have been designed to provide daily requirements for sodium **and** selected minerals. Salt, with or without added minerals, is available loose, pressed in a salt lick block, or as mined rock salt from the Northern Hemisphere.

Salt 5.1.1

New Zealand salt is solar evaporated salt from the sea. It is available in different grain sizes. When feeding stock and making up brines for water treatment use refined salt as this will contain minimal insoluble contaminants that can block water lines. Brines for water treatment systems can be made from fine or coarse salt - fine salt will dissolve faster than coarse but it is recommended that the mixing tank has mechanical stirring. When mixing salt with other minerals or feeds choose a grain size that is easily mixed with the other ingredients - this will reduce separation of salt from the other ingredients and reduce waste.

Salt with minerals 5.1.2

There are numerous salt mineral mixes on the market with appropriate usage instructions. Salt inputs will vary depending on whether the salt is added as a filler, added to make the mineral mix more palatable, or added to supply a minimum daily Na dose to the diet. Mineral mixes can be fed on their own with stock having free access as required, or added to feeds. Mineral balancers containing salt are available for specific low Na feeds like maize. Soluble mixes are available for water treatment systems and drenching. Usage instruction for the animal class should be followed to avoid over or under dosing.

Salt blocks 5.1.3

Salt and mineralized salt blocks are readily available throughout New Zealand. Placed on the ground or in a purpose-built salt block holder, stock have access to the blocks as required. Individual animal intakes will vary depending on need - the highest producing animals are likely to require more salt. Salt blocks can be left out year round. Salt is very soluble so salt blocks will weather. In high rainfall areas protecting the block from rain is advisable.

Mineralised Salt Blocks. Although salt contains minor quantities of other minerals these are not significant enough to contribute to daily requirements. The addition of minerals, especially trace minerals cobalt, iodine and selenium, can enable significant intakes to come from salt blocks. Flavour enhancers such as molasses are often added to improve palatability and ensure regular intake of the block and the minerals it contains.

"By adding minerals which are lacking in soil and pasture, stock are able to be trickle-fed these in the salt block. In our case special emphasis is placed on iodine, zinc and selenium."
- Mark Urquhart, Grays Hills.

"At Forest Range we have over many years corrected a widespread sodium deficiency with salt blocks. The applications have been regular and are strategically placed for stock to utilise in a high country environment.

Also of immense benefit are the trace elements that are available in this product. These Summit Littlix are applied with a helicopter and an 'Airmec applicator' which discharges 50 blocks in ten dumps with the flick of a switch.

We have also top dressed salt onto paddocks at rates varying from 100 kg to 700 kg per hectare with some very satisfied stock and no problems whatsoever.

Sodium and trace element supplementation is a routine exercise for our Ultra Fine Merinos and an important aspect of our animal health programme." - RS & J Emmerson, Tarras.

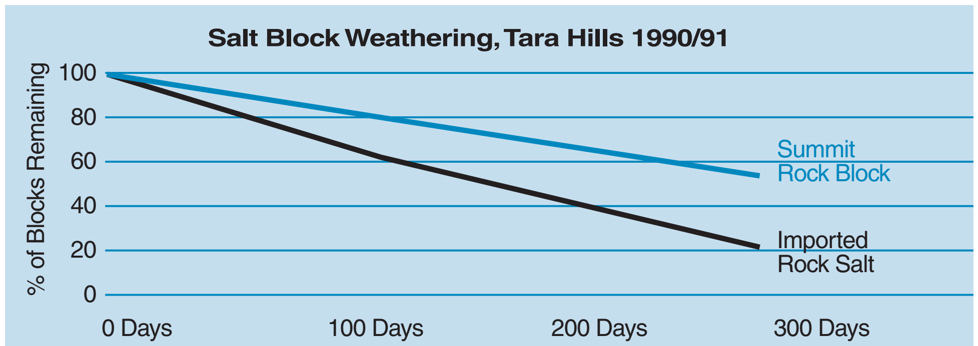
Rock salt 5.1.4

There are no deposits of rock salt in New Zealand, in fact, there are very few in the Southern Hemisphere. Rock salt deposits were formed underground about 150M years ago and mining them is carried out in a similar way to coal. Rock salt is often naturally coloured with minor quantities of minerals but as is the case with other types of salt these minerals are usually not present in enough quantity to significantly contribute to daily intakes, even if what is present is readily absorbed.

Rock Salt Weathering. In 1990 MAF conducted trials on block weathering at Tara Hills and Ruakura Research Stations. For a number of years farmers had been claiming that rock salt weathered at a slower rate than pressed salt blocks. When Dominion Salt developed Summit Rock Block as a longer lasting product its weathering rate was tested against imported rock salt. The results were conclusive - Summit Rock Block showed a markedly slower rate of erosion/weathering when compared to imported rock salt at both locations. At Tara Hills, Summit Rock Blocks lasted 1.8 times longer when exposed to weathering elements (Table 5.1). Composition and processing will influence salt block weathering. Although not tested, differences in disappearance of rock salt and salt blocks in a paddock may arise from palatability issues.

Table 5.1

Salt block and rock salt weathering rates



Free-choice salt 5.1.5

Animals have a strong appetite for salt but individual salt needs will vary. Factors influencing salt needs include:

- Sodium and chloride levels in the pasture
- Sodium and chloride levels in the water
- The production cycle - growth, lactation and reproduction will increase requirements
- Temperature and/or humidity - sweating can increase sodium requirements
- Sodium levels in supplementary feeds
- Potassium levels in the diet

Offering free-choice salt year round will enable animals to supplement their needs as required. Where mineralized products are offered free choice, mineral intakes will vary according to salt needs. Free-choice mineralized salt products should not be relied upon on their own to correct for clinical deficiencies of minerals. Adequate supply of stock drinking water should always be available when stock have access to free-choice salt.

"Salt blocks are used sporadically throughout the year to provide a fortified mineral formula. The formula was adjusted over two years ago to complement the drench programme, supplementary feed programme and grazing programme which includes a higher content of lucerne and forage cereals. It is likely the formula will change as the flock develops and new ideas and possibilities arise..."
- Snow Loxton, Sawdon Station.

Indications for use 5.2

There are a number of options available for correcting low Na intakes. Getting a known amount of salt into each animal on a daily basis (eg. drenching) is the best option but often impractical. To meet the changing Na needs of individual animals, access to free-choice salt year round will provide a useful backstop.

Table 5.2

Indications for use of salt in pastoral farming.

	Limit Test	Fertilise with Salt	Drench with Salt	Add Salt to Water	Add Salt to Feed or Supplement	Free-choice Salt Licks and Blocks
Soil	<5 Na (Quick Test)	Min. 100kg/ha Annual application				As required
Pasture	<0.12% Na DM, Lactating Cow		35g salt/ cow/day	35g salt/ cow/day	35g salt/ cow/day	As required
	<0.10% Na DM, Beef Yearling		Up to 15g salt/head/day	Up to 15g salt/head/day	Up to 15g salt/head/day	As required
	<0.09% Na DM, Sheep		Up to 5g salt/head/day	Up to 5g salt/head/day	Up to 5g salt/head/day	As required
Supplementary Feeds	<0.25% Na DM - all animal classes				Up to 25kg salt /tonne of feed	As required

Specific applications 5.3

Dairy cows 5.3.1

- For pasture fed dairy cows the critical Na level for supplementing with salt is 0.12% Na in DM. This is equivalent to 1.2g Na/kg DM
- Salt can be applied in fertiliser, as a drench, in water treatment systems, added to supplementary feeds or offered free-choice in the form of licks
- Getting a known amount of salt into each animal on a daily basis is best eg. drenching
- The economics of supplementing with salt where there is a known Na deficiency are significant. For the Waikite Valley trial at 2007 prices, for every $1 spent on salt the return is +$50 in additional milk receipts

Methods of salt supplementation 5.3.1.1

Salt can be given to dairy cows in various ways. All methods have their place.

Drenching
Drenching is seen as perhaps the most appropriate method for milking cows. One can be sure all cows are receiving the same dose and the rate can be varied according to their production. Recommended salt dose rates are shown in Table 5.3. (as calculated from Towers and Smith, (7)). It is important if Na deficiency is diagnosed to use the correct rates of salt as indicated. Lower rates will not provide the full benefit.

Table 5.3

Salt dose rates according to cow liveweight and production.

	Liveweight kg	Milk kg/day	g Na/day	g salt/day
Lactation	450	10	10.0	25
		20	15.8	40
		30	22.3	56
Maintenance	450	-	3.0	7.5

In the Waikite Valley trial mentioned below (section 5.3.1.2) the Na intake of the unsupplemented cows was half the recommended amount of Na. As a result they produced significantly less milk than the salt drenched cows. Salt dissolves easily in hot water and can be mixed with other materials like bloat materials, magnesium compounds and trace elements.

Water treatment
This method is widely used in water troughs and automatic dosing devices for supplementing animals with salt. It is appropriate for situations where there is only marginal Na deficiency or where the farmer feels salt may be beneficial. Other additives can be added also. The downside of water treatment is that not all animals drink the same quantity of water on a daily basis so the salt intake can vary between animals. It is also possible to overdo the rate (especially for water troughs) and make the water too salty to drink. Nevertheless, the method is convenient to use and will provide salt to animals.

Blocks and licks
Both have a convenience factor associated with their use but like water treatment individual animal salt intake is not guaranteed. Again, the salt can be available along with other additives like trace elements and magnesium.

Pasture topdressing
Salt is often mixed with other fertilisers like superphosphate or potassic superphosphate. This can be done by most fertiliser companies. It should not be mixed with N fertilisers like urea as it can cause caking and be difficult to spread. Salt is taken up quickly by pastures. In this way it is similar to potassium. In general terms 100 kg/ha/annum of salt will lift pasture Na levels appreciably and prevent Na deficiency in grazing dairy cows (see chapter 4). However, some plants (natrophobes) will not take up Na to any extent. Lucerne, kikuyu and browntop are examples of natrophobes. Typical ryegrass/ clover pastures in dairying situations will take up Na satisfactorily. Pasture topdressing is a convenient method of providing Na to cows. It is important that the rate is not compromised if pasture Na levels are to be maintained throughout the year. In some instances where pasture K levels are high the fertiliser mix can be lowered in K and increased in salt.
There have been instances of Na reducing pasture Mg content and causing grass staggers. This will not be a problem where adequate Mg supplementation is practiced.
It should also be noted that supplements like maize silage need to have salt added at feedout as the reduced pasture intake will not provide sufficient Na for this purpose.
Pasture dusting with salt (and MgO) is another useful way of getting salt into dairy cows in late winter/ early spring. The salt adheres to the leaves and is eaten by the cows.

Drenching trial results 5.3.1.2

Waikite Valley, Rotorua trial (14)
In 1999/2000 a trial was conducted in Waikite Valley, Rotorua (property of Jim and Beverley Rotheram). 90 cows from the herd were grouped into 45 pairs based on breed, age, calving date and milk production. One group was drenched with 35g salt/day the other group left as an undrenched control. Fortnightly milk production was measured using the LIC Herd Testing Service. The pasture on 5 paddocks was sampled monthly and analysed for % Na. The farm water supply was tested for Na content.
Milk yield responses. Over a 3 month period milk production increased by 12.8% - a statistically significant increase. The production increase occurred within 2 weeks of commencement and continued for the 3 month duration of the trial.
Milkfat and protein content. There was no effect on milkfat or protein in the milk over the duration of the trial.
Pasture Na status. Pasture samples were deficient in Na averaging 0.05% Na over the 3 months of the trial.
Saliva Na: K ratios. Saliva Na: K ratios of the drenched and undrenched cows was measured towards the end of the trial. The undrenched cows had a ratio of 6.7 and the drenched cows 16.8. This aspect is discussed further in section 3.3.2.

"..have not stopped drenching with salt since those trials because of the vast improvement we achieved."
- Jim Rotheram, Waikite Valley Dairy Farmer.

Ruakura trial, No 2 Dairy (17)
A trial with 188 cows on 10 farmlets was conducted in January/February 2001. Cows were allocated to a salt drenched or control group on the basis of age, genetic merit and milk production. Stocking densities on the 10 farmlets differed. Again cows in the treated group were given 35 g salt/day.
Milk yield responses. There was no benefit in milk production over the duration of the trial.
Milkfat and protein content. No effect noted.
Pasture Na status. Pasture samples collected twice over the trial period averaged 0.10% Na. This trial allowed very close monitoring of cow intake and Na intake/cow/day. In all cases the Na intake from pasture indicated that a Na content of 0.10% in pasture was sufficient. This occurred where cows were fed either *ad libitum* down to 66% of cow requirements.

Critical pasture Na levels for dairy cows 5.3.1.3

Overall these two trials have indicated that pasture Na status less than 0.10% Na is likely to be deficient in Na for high producing dairy cows. A value of 0.10% Na in one trial gave no response; a value of 0.05% in another trial gave a 12.8% response in milkfat production. As indicated in Table 5.2 a safe optimum would be 0.12% Na in pasture. Pasture composition may be important at times with various herbs like chicory and plantain being high in Na. Nevertheless, these need to be present in high amounts or as special purpose pastures to really influence Na intake to any extent.

Other sources of salt 5.3.1.4

Animals can obtain salt from ingesting soil. This may be involuntary as soil or dust contamination on leaves or voluntary as in licking banks (see section 6.2) or wooden fixtures.
Water supply is an obvious source of Na.
Na concentration will be dependent on the source of the water and the geological status of ground from where it comes. Salt on fence posts, fence wire and other fixtures is likely to be rain borne and is particularly prevalent near the coast. Again, animals can be seen licking such fixtures. Remember that the sight of animals licking such structures does not mean they are necessarily deficient in salt. Animals and humans like the taste of salt. Proper diagnosis of deficiency as outlined in section 3.3 is necessary as a basis for treatment.

Economics of salt supplementation 5.3.1.5

Where Na deficiency is diagnosed and applying the Rotorua trial response figure of 12.8%, for a cow producing 350kg milk solids (MS) this would, with salt supplementation, produce an additional 45kg MS. At $6/kg MS this would equate to an additional $270/cow income. The additional costs entail 35g salt/cow/270 day lactation or 9.45 kg salt/ cow. With drenching grade salt at 50c/kg or $4.73/ cow, plus any additional labour costs, drenching would still give a very economical outcome.

Cautions with salt supplementation 5.3.1.6

There have been instances of salt drenching causing contraction of the oesophageal groove in dairy cattle. It is then possible for salt and any bloat additives to bypass the rumen and end up in the abomasum causing the animal to suffer a bloat attack. This is seen as a very rare occurrence (18). The rate of salt addition may need to be reduced in such situations. Salt can be detrimental to animals given in excess. Toxic animals display a nervous disposition. It is important to ensure an adequate water supply is available at all times.

"....animals need salt... Summit Amaize (mineral balancer) is sprinkled over maize silage which is fed in troughs on a feed pad. Multimineral salt blocks are available all year round on the feed pad as well."
- Peter Spreeuweenburg, Dairy Farmer, Ngatea

Beef cattle 5.3.2

- Cattle on low Na diets respond to salt supplementation
- Use salt blocks or loose salt when feeding lucerne and other natrophobic plant species
- Pasture Na 0.1% DM is adequate for beef cattle production
- Salt can be used to manage grazing intensity and location

Many studies have been carried out overseas, particularly in USA, on the role of salt in animal nutrition. Dr Larry Berger (19) reports that feed represents about 70% of the total cost of beef production and numerous studies have shown that sodium chloride supplementation is an essential part of a balanced diet required for efficient beef production. In Kansas State studies (20), calves that were self fed salt, gained twice as much as those not receiving any salt and they consumed more total daily feed. In another study, steers fed salt gained 29kg more than those without supplemental salt over a 327 day period. In a 1971 trial (21), steers on full feed consumed more feed but gained approximately 23kg more than steers not receiving salt. A 1973 Australian report (22) showed that salt supplementation significantly increased the gains of lactating beef cows and their calves while grazing native pastures.

In New Zealand studies have been carried out on cattle feeding low sodium diets. Sodium supplementation trials were conducted between 1974-1975 by Dr. J.P. Joyce (23) at Wairakei Research Station, Taupo, using beef cattle. In each of the two indoor trials, groups of five cattle were fed freshly harvested lucerne which was supplemented with 200g NaCl per day (15.7g Na/animal/day), sprinkled over their feed. In the first trial lasting 84 days from January - April and using 5 month old Angus weaner heifers weighing 130-140kg, those fed to appetite plus salt gained liveweight 48% faster than the control animals. In the August - March trial, using 12 month Angus steers weighing 200kg, the liveweight gain was 16% faster. Dry matter intakes of NaCl supplemented cattle were 3.1% and 8.6% greater in the 1974 and 1974-75 trials respectively, than the comparable control cattle, suggesting gains came from increased appetite and better feed conversion. At current (2007) rates the salt input would cost 2 cents/head /day and the carcass weight gain would be worth 18 cents/head/day. In both trials, growth rates during the summer period were extremely low.

A salt block supplementation trial was conducted in 2001/2002 on a large grazing property in the Taupo district using mobs of dairy heifers (24, 25). The study investigated the performance of salt blocks on a low herbage sodium site on cattle liveweight gain during the spring/summer period. Two mobs of 100 dairy heifers were offered salt blocks *ad libitum* for the duration of the trial and two mobs had no access to salt blocks.

Results were not conclusive. While there was a significant response in liveweight gain to salt over the period January to February, it was only with one of the two salt supplemented mobs of dairy heifers. Over the trial period (5 months) for the mob that responded the salt blocks cost $7/head and the extra carcass weight was estimated to be worth $34/head. There was no trend for the period October to January. While the herbage sodium levels were low, particularly at the commencement of the trial, pasture dry matter on offer was high throughout the trial. Herbage intakes for the liveweight gains were measured and the sodium requirements were met by this level of herbage on offer, without the need for salt supplementation. The result may have been different if dry summer conditions prevailed and pasture quantity and quality was reduced.

“Salt blocks may be a cheaper alternative than mixing salt with fertiliser because of mixing issues, particularly if nitrogen is being used in the mix.” - Sheep & beef farmer, Rotorua.

Animal behaviour was observed in this trial. The grazing rotation of each group resulted in the same paddocks being grazed by the control and salt mobs at different times. It was observed that the control mobs sought out the areas where salt had been available in troughs to the salt mob, to the extent that holes were dug in the soil presumably to find the salt (Figure 5.3). Animals are often seen licking fence posts, rails and concrete structures, to obtain their sodium requirements. However, at the trial site, calves were not seen chewing rails so readily which may reflect weather conditions and the higher availability of sodium in the pasture diet.

Figure 5.3

Control animals searching for salt.

Estimated Na requirements of cattle 5.3.2.1

The Na requirement for beef cattle depends on their weight and growth rate. Lactation lifts Na requirements even higher. From Table 2.2 a 200kg steer growing at 0.5kg/day will have its Na requirement met by pasture offering Na at 0.07% DM (assuming a DM intake of 3.3kg). For a lactating cow the Na requirement is 0.12% DM. Towers and Smith (7) suggest Na requirements for non-lactating cattle will be met if pasture contains Na 0.10% DM.

Salt and grazing distribution 5.3.2.2

Because beef cattle have a strong appetite for salt, it can be used as a management tool as well as a source of nutrient. For example, salt blocks can be used to increase the carrying capacity on pastures by causing more even grazing. On areas where less palatable forage is available, salt blocks distributed over those areas will encourage more even utilization (22). (See section 6.1 also)

Feedlots 5.3.2.3

With feedlots becoming more common in New Zealand, the use of salt becomes an important consideration. A salt deficiency can cause cattle to choose an imbalanced diet in order to get additional sodium or chloride. When this occurs, animals may eat more supplement containing higher sodium concentrations, thus increasing the cost of the feed (26). It is important to have balanced diets and these can be made up to go through the mixer prior to feeding out on the pad or in troughs.

High concentrations of salt have been used to regulate feed intake, particularly overseas, in a range of situations. In New Zealand, it is more applicable to feedlot situations. While the science of using salt to regulate intake has been well researched, the 'art' of using this technology is still developing. A clean, plentiful water supply is a must when using salt to control intake

"We have also used them (salt blocks) in attempts to seal dams. i.e. build a stock water dam with a digger or bulldozer and put salt block in bottom so stock trample and seal the ground so the dam holds water. Works best with big mobs of cows and calves."
- John Ford, Sheep & Beef farmer, Rotorua.

Sheep 5.3.3

- Sheep and lambs on low Na diets respond to salt supplementation
- Use salt blocks or loose salt when feeding lucerne and other natrophobic plant species
- Pasture Na 0.09% DM is adequate for sheep production
- Measurement of Na deficiency in grazing sheep on commercial farms is not very practical
- Care should be taken when offering salt to severely Na deficient sheep to prevent smothering
- Salt can be used as a tool in grazing management

Many sheep and beef farmers will have been faced with the dilemma of whether or not to put out salt for their stock.

They may have put it out in the past because stock seemed to want it, but the introduction or reintroduction of salt has resulted in craving and stock losses through smothering. While opting for a constant supply of salt can reduce this problem, the expense and logistics of continually feeding stock with salt persuades some to stop using it. This is reinforced by the fact that after removing salt from the diet there is no obvious or apparent detrimental affect on production.

Marlborough trials 5.3.3.1

A trial (27) undertaken on Marlborough hill country establishing the effectiveness of small (2.5kg) salt blocks in reducing the incidence of smothering also showed several production benefits. Trial ewes had access to salt blocks from 3-4 weeks pre-lambing until tailing. The results included: -

- a significantly greater weight gain (10%) in ewes between tailing/docking and weaning. This coincided with the period when all ewes were run together without access to salt. This perhaps indicates that previous access to salt may be an important component of live weight gain. There was also some suggestion that there was a carryover advantage to those that had access to salt, in terms of body Na levels, for they maintained higher urinary Na levels at weaning 2 months after salt removal. As weaning weight in dry summer environments can be a good indicator of the following tupping weights the importance for ewes to gain lost weight before weaning cannot be over-emphasized. While wool production was not measured in this trial other trials have shown sheep supplemented with salt, when sodium deficient, have produced more wool.

- a trend towards more lambs tailed and weaned per ewe mated and lower lamb loss between scanning and weaning. There is much anecdotal evidence that the level of mis-mothering and cross- mothering is reduced when ewes have access to salt over lambing. Some farmers believe that the amount of interference at birth by other ewes is reduced if they have access to salt prior to and over lambing. It is felt that salt depleted ewes are attracted to foetal fluids.

"We find at lambing that ewes with good access to salt are more settled and mother their new lambs well." - Mark Urquhart, Grays Hills.

"We have also found the problem of thieving (ewes stealing other ewes lambs) during lambing has also declined (with access to salt)."
- Doug Avery, Lake Grassmere, Marlborough.

This argument is supported by one Marlborough high country farmer's finding (Steve Satterthwaite, Muller Station) when in 1995 he split his mixed age twin bearing merino ewes into two mobs prior to lambing and gave one mob salt. At tailing those that had had access to salt tailed 154% while those without only tailed 127%. He repeated the exercise the following year but swapped the blocks with the treated ewes running in the previous year's control mob block. Those that had access to salt still tailed 165% - 20% more than the controls.

- a trend towards greater weight of lamb weaned per ewe mated (approx 2kg) when ewes had access to salt. At a value of $1.45/kg live weight and over a 2000 ewe flock the advantage to the best salt treatment would be around $6000.

This trial clearly indicated that salt "deficiency" could affect production through its influence on ewe behaviour and lamb survival, milk production and body weight recovery after lambing.

Salt with natrophobes 5.3.3.2

The Marlborough trials all took place on over-sown topdressed pastures. The response, however, is likely to be even greater if stock graze pasture species that contain low levels of Na such as lucerne. Dr J P Joyce described in the 1975 Ruakura Farmers Conference Proceedings (23) the results of trials with weaned lambs, young beef cattle, and lactating dairy cows grazing lucerne. Salt treated lambs gained twice as much carcass weight (69 v 36 g/day) and (64 v 31 g/day) over untreated controls when drenched once weekly with 8.4g Na. In the beef cattle experiment (described in section 5.3.2) weaners fed to appetite gained liveweight 16% to 48% faster when supplemented with salt.

They also consumed more feed. The dairy cows responded to salt supplementation with a 14% increase in milk production.
Another advantage of putting out salt blocks to sheep on lucerne is that the incidence of bloat amongst ewes and lambs has been observed to diminish once they have had access to salt (see section 7.2).

Running cows and ewes in the same block 5.3.3.3

It is also possible that salt deficient beef cows could respond in a similar manner to dairy cows when given salt with an improved milk production and hence calf growth rate. However of more importance could be the reduction in new-born lamb mortality through the interference with lambing by salt deficient cows when ewes and cows are run together. Salt deficient cows have been observed licking and sucking on newly born lambs - perhaps attracted to the salty taste of foetal fluids. This tendency stopped once salt was placed in the blocks.

"'Aschworth runs only merino sheep and cattle. The flock is made up of merino ewes, wethers, and mixed sex hoggets. We run cows and fatten all progeny. Salt use can be put into three groups. We use salt two weeks before and throughout mating of ewes. This, I am sure, has helped us with a very consistent lambing percentage over the last few years. Salt is again used several weeks before lambing. This coincides with calving and salt enables cows and ewes to run on the same blocks. Salt is also used on Aschworth to draw sheep, especially wethers, onto un-grazed parts of rougher blocks.

Littlrox block is the preferred salt, especially when cattle and sheep are grazed on the same country." - Tim and Sally Wadworth, Marlborough.

Testing for sodium deficiency. 5.3.3.4

While it is always useful to know in advance whether or not supplementation of salt is likely to be beneficial or cost effective, testing is not altogether that easy or straightforward. The recommended test is to measure saliva sodium. However, this test is time consuming, difficult to do well, expensive to analyse and subject to many possible errors and, except for research purposes, probably impractical in most situations.

Because of the variation in urinary Na output from different individuals at any one time, and the diurnal variation of any one individual under normal circumstances, urinary Na has not been accepted as a useful measure of a flock's Na status. However, when salt demand is high, measured by salt consumption, the urinary Na levels can be less than 1 mmol/l with very little variation between individuals. Only excess Na is excreted in the urine as kidneys are very efficient at conserving Na when the occasion demands. Urinary Na is therefore a useful indicator of sodium status when it is low. A mean urinary Na concentration less than 3 mmol/l in a sample of 10 ewes would indicate Na deficiency and the need to supplement. (7)

However, probably the best determinant of a salt deficient mob is whether or not stock crave salt. Despite all ruminants being halotrophic (ie. they seek out salt whether or not they need it) it was noticeable in the trials in Marlborough that most salt was consumed on the trial properties that were the most deficient in soil and herbage sodium. Consumption of salt was also less where improved pasture species, especially natrophilic (sodium loving) ones such as ryegrass, cocksfoot and white and subterranean clovers, become more dominant in the sward.

Na requirements of sheep 5.3.3.5

Although farmers are generally unlikely to feed salt to a level in excess of 0.5 kg/ewe/yr consumption per ewe can be in excess of 1 kg/ewe/yr on sodium deficient sites from a month prior to lambing and up until tailing if salt is freely available. Caution should be applied when offering salt to craving animals a few days prior to lambing (refer to section 7.2). The actual requirement for ewes at this time varies depending on body weight, whether she is carrying a single or twins and during lactation how much milk she is producing. For instance a twin bearing ewe in late pregnancy requires about 2g salt/day while during lactation may require up to 3.5 g salt/day. The maintenance requirement for a ewe is about 1g salt/day as is that of a 30 kg lamb growing at 150 g /day. Towers and Smith (7) suggest Na requirements for sheep will be met if pasture contains Na 0.09% DM.

Cautions 5.3.3.6

As excessive intakes of salt are possible and can be toxic care must be taken especially when re-introducing stock to salt. Deaths can occur as a result of smothering if stock crave salt and the use of smaller blocks can go a long way to reducing this possibility. Access to a ready supply of salt can also be fatal if water is not freely available. High intakes of salt can also depress plasma Mg and Ca levels and may increase the risk of metabolic problems.

Salt as a grazing management tool 5.3.3.7

This attraction of stock for salt was the reason behind a FITT funded project in Marlborough in 2002-2004. A trial was conducted to determine whether the aerial application of a mixture of salt (100 kg/ha) and molasses (130 l/ha) and urea (40 kg/ha) would attract stock to specific areas and whether it encouraged sufficient extra grazing in the treated areas to reduce the amount of "tag" and form a fire break.

The areas chosen were usually the more unattractive poorly grazed areas with a high % of rank pasture. Nevertheless, stock were attracted to the treated areas. Although pasture control was improved on these areas it is debatable whether the extra grazing pressure would have been effective in producing practical "fire breaks". However, better quality pasture did result after the treatments with more vigorous grass and clover and less dead matter. Pasture improvement being the result of both direct nutrient application from the treatments and an animal impact effect. The animal impact effect - trampling, urinating and defecating in a confined area - could be an effective means of introducing and getting new pasture species established and improving poor quality hill country pastures.

Other species 5.3.4

Goats 5.3.4.1

NRC salt feed recommendations for goats are the same as those for sheep. It is noted that placing salt in less frequently grazed pastures may influence goats to move to these areas (28). For goats grazing hill country with low soil Na offering free-choice salt blocks provides a practical supplementation solution. Goats producing large amounts of milk will require higher levels of salt to replace Na and Cl lost in the milk.

Pigs 5.3.4.2

Salt is an essential part of the diet for growing pigs. Studies in the USA showed that a deficiency of salt decreased daily gain and feed efficiency in the pig (29, 30). In one trial it was calculated that one pound of salt saved 185 pounds of feed. (31). NRC recommends that 0.2% to 0.25% sodium chloride is necessary to meet the dietary Na and Cl requirements of fast-finishing pigs fed a corn-soybean meal diet (32). Salt poisoning is unlikely providing adequate water is available.

Horses 5.3.4.3

The need for salt varies depending on the horses' level of work, riding and heat stress. Sweat contains about 0.7% salt so the more a horse sweats the more salt is lost and the greater the salt needed in the diet. Free-choice feeding of salt is recommended to ensure adequate intake at all times. The use of electrolytes will also replace lost Na.

Poultry 5.3.4.4

Salt deficiency has the same negative growth effects in poultry as in other animal classes. Salt is not self-fed to poultry so their needs must be met by adequate levels in the diet. Commercial poultry feeds will include salt if the other feed ingredients are deficient in Na.

Deer 5.3.4.5

There is very little information available on salt requirements of deer . At times deer will take free-choice salt licks and blocks and at other times they will leave them alone for months. However, it should be assumed that deer have similar requirements for Na as sheep until experimental work indicates otherwise. Mineralised salt products, especially containing copper, are often made available free-choice to improve trace mineral intakes of deer.

Salt and supplementary feeds 5.3.5

Sodium and chloride are essential for all livestock and required on a continuous basis. Na is needed most during growth and lactation. Salt is critical for maximizing appetite and feed intake as well as for digestion of fibrous feeds and rumen pH buffering and function.

Sodium intake in NZ comes predominantly from grazed pasture. Many other strategic feeds are low in sodium. To maximize the benefit these feed supplements provide to dairy production they need to be re-balanced for Na levels. It is critical that levels of Na in pasture are known as that source usually makes up the largest proportion of the diet. Grains (maize, barley, wheat), palm kernel meal (PKM), coprameal and lucerne are generally low in Na. They are deficient to the point where feed intake and rumen output may be limited if salt is not supplied to re-balance the diet.

Recent estimates suggest up to 20% of NZ dairy farms could be deficient in sodium. Diets with palm kernel, grains and maize silage exacerbate this problem even further.

United States NRC (33) give minimum requirements of Na 0.2 - 0.34% DM for lactating dairy cows using sample diet models. Dry matter and milk yield responses to Na over the range of 0.11% to 1.2% were maximized at 0.7-0.8% Na in 15 trials referenced by NRC .

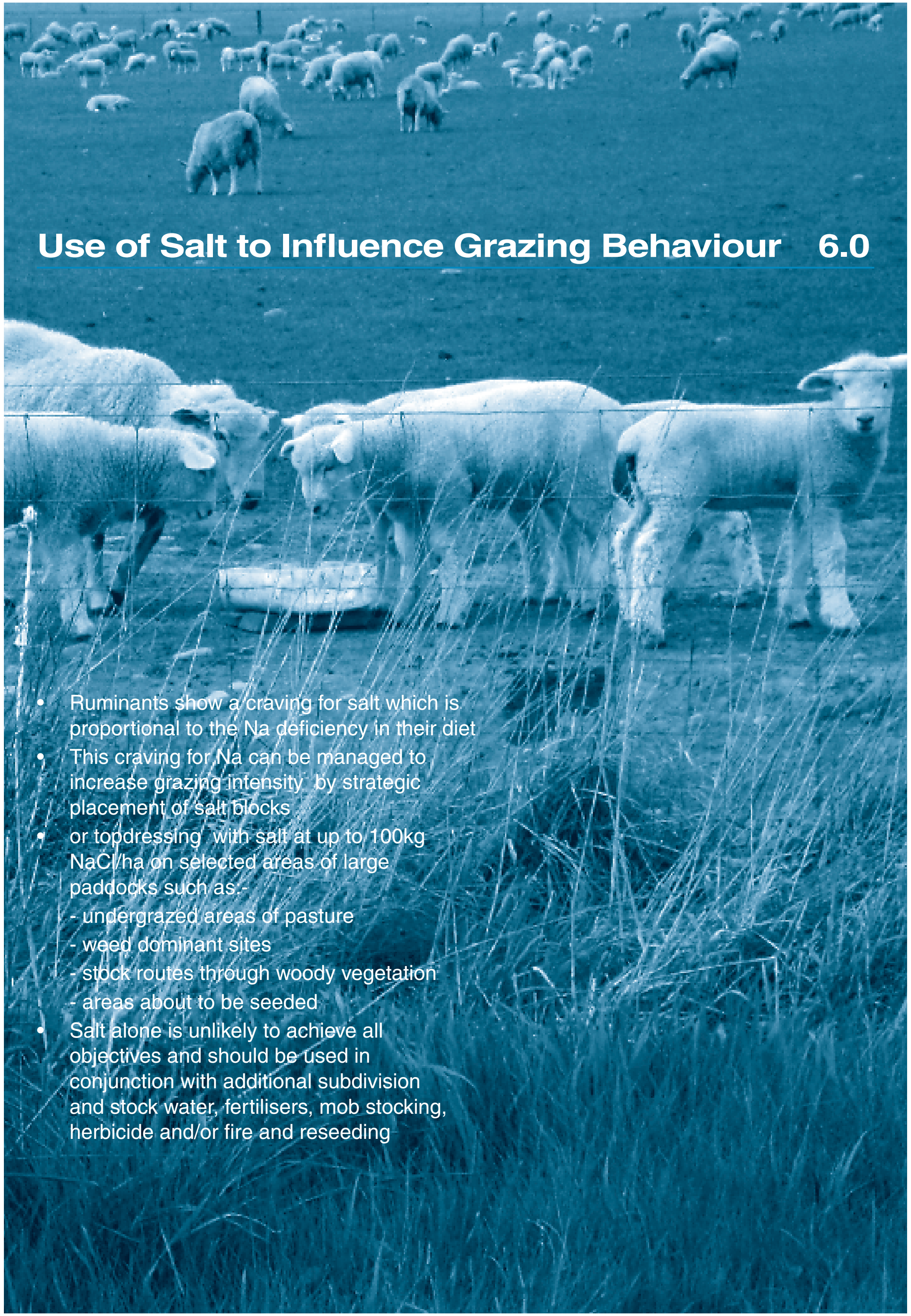
Some basic rules of thumb (from Grant Richards, Nutritionist):
When feeding high potassium pasture, low Na feeds (palm kernel, maize silage, grains) and highly fibrous feeds (NDF +40%), Na should be increased to ensure 0.4-0.5% Na on a DM basis along with ample fresh and clean water. Increase salt to 5-10 grams per cow per day for every 1kg of PKM, PKE or maize silage being fed. For every 5% NDF rise in the diet, increase salt by 5-10 grams per cow per day. Having a coastal farm should not preclude proper investigation into what cows really need given the Na deficiencies present in so many strategic, non pastoral feeds.

Table 5.4

This is a guide for adding salt when using supplementary feeds. The minimum sodium of 0.25% is within the NRC range and the optimum is based on the trials NRC has referenced.

Supplamantary Feed Source	Na in Feed % in DM	Recommended Minimum Na 0.25% DM (based on NRC)		Optimum for maximising production Na 0.8% DM (based on NRC trials)	
		Salt to add per tonne of feed	Salt g/cow/day/kg of supplementary feed	Salt to add per tonne of feed	Salt g/cow/day/kg of supplementary feed
Grains	0.01	7.5kg	7.5g	25kg	25g
Maize silage	0.01	7.5kg	7.5g	25kg	25g
Palm Kernel, PKM	0.01	7.5kg	7.5g	25kg	25g
Triticale	0.02-0.04	7.0kg	7.0g	20kg	20g
Whole Crop Cereal	0.02-0.14	4-7kg	7.0g	20kg	20g
Lucerne	0.04	7.0kg	7.0g	20kg	20g

Note: Calcium and magnesium are also low in many of the above feeds that require balancing
Salt (coarse and fine) can be added to the feed or top-dressed on feed pads. Higher levels of salt should be at least partially mixed with the feed.
For standing crops salt licks or salt blocks can be used. Ensure continual access to salt and water.
Do not feed salt to transition springer cows unless advised by a professional expert.



Use of Salt to Influence Grazing Behaviour 6.0

- Ruminants show a craving for salt which is proportional to the Na deficiency in their diet
- This craving for Na can be managed to increase grazing intensity by strategic placement of salt blocks
- or topdressing with salt at up to 100kg NaCl/ha on selected areas of large paddocks such as:-
  - undergrazed areas of pasture
  - weed dominant sites
  - stock routes through woody vegetation
  - areas about to be seeded
- Salt alone is unlikely to achieve all objectives and should be used in conjunction with additional subdivision and stock water, fertilisers, mob stocking, herbicide and/or fire and reseeding

Use of salt to influence grazing intensity in hill pasture 6.1

Salt is used on some inland, salt deficient properties to encourage livestock into less favoured areas. This has been a successful strategy for keeping stock routes open and for the expansion of grazeable areas in difficult terrain. Suppressing fern and scrub by hoof and tooth may also be preceded by herbicide and/or fire.

Pasture seed will be trampled more effectively if high stocking rates can be applied to limited areas. Salt spread immediately after seed will generate high grazing intensity and enhance the treading effect. Fertiliser (P, S, K, Mo etc) spread with the salt will give the young pasture seedlings a competitive chance against resident vegetation. Legume species will benefit most from the pulse of fertiliser. When regrowth of the native vegetation allows, let the newly established legumes reseed in the first year. Cattle can be used to eat the mature high sodium herbage and help spread the legume seed further.

The intensity of grazing on areas where salt is spread will depend on the relative Na deficiency of the rest of the fenced block/paddock and the intensity of Na craving by the livestock. It is therefore unwise to spread salt widely on properties where livestock are to be used as tools for development. Keep the class of stock to be used as workers at least marginally Na deficient. Place the salt only where you want the stock to graze more intensively. Clearly this technique must be done with care in relation to the potential danger of smothering sheep. To help avoid smother deaths several mini salt blocks or rock salt lumps should be spread rather than a single large block. The frantic competition within the flock for a lick of salt is then dispersed over a wider area.

Apart from the smothering issue salt placement in a paddock requires some thought to get the most out of predictable livestock behaviour. While it is convenient to place salt near a gate or beside the track or on flat well grazed benches in a steep paddock, consider other options which can lead to improved control of scrub and/or rank grass in less favoured areas of pasture. Avoid placing salt near water troughs and especially not near streams. The extra livestock traffic and congregation will create mud and stream pollution.

In hill country, livestock camp at the highest point in a fenced area. Fertility is transferred to those camps and they tend to be dominated by weeds (barley grass, mallow, thistles) or mat forming grasses such as Kentucky blue grass (*Poa pratensis*). On less steep areas away from the main stock camp, pasture is grazed intensively and with the extra nutrient returns in dung and urine a high quality sward normally develops. This effect is also seen on benches beside stock tracks in contrast to the steep banks between the tracks. In a lot of hill country the steeper mid-slope areas of each block tend to be neglected by stock and grass becomes rank, clovers are shaded out and low grazing pressure means there is little nutrient return from stock. Salt can be used to encourage animals onto these steep under-grazed mid-slope areas (34). See Figure 6.1.

Figure 6.1

Sheep grazing plots one day after applying salt. Before application of salt the hill area was occupied by very few sheep but after application high numbers of stock grazed the area attracted by the salt (3).

"The placement of salt (blocks) in less grazed areas ie. dark, cold faces, can attract more stock to those areas and encourage more browsing behaviour as the animals travel and eat."
- Mark Urquhart, Grays Hills

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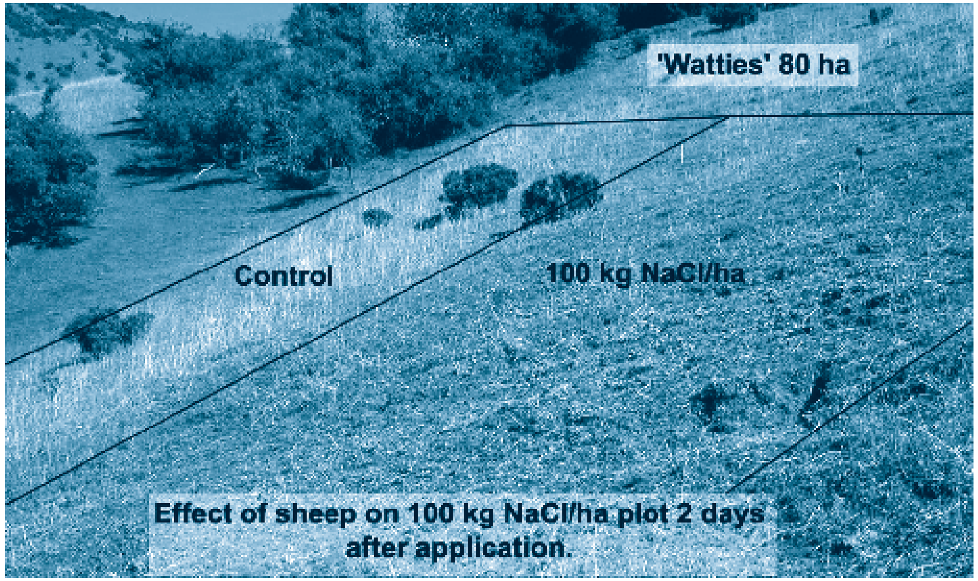
"We use salt blocks to hold the cattle on the flats in winter and to attract cattle and sheep onto the higher slopes in summer."
- Mike King, Mt Albert Station.

Fine salt rather than coarse is less easily eaten from the soil surface immediately after it is spread but both grades will attract stock. On small areas (eg 20m x 5m plots) the vegetation is decimated and up to 50% bare ground is created in a few days. (See Figure 6.2).

Figure 6.2

The result of 2 days grazing on a salt treated plot at Mt Grand (3).



In country prone to erosion this generation of bare ground is not desirable. Extreme effects on vegetation of frenzied salt seeking can be modified by adjusting the rate of salt application, the proportion of the paddock treated and the number of animals available to do the work. In general, spread fine or coarse salt at 100 kg/ha on a maximum of 10% of a paddock and use a stocking rate of at least 10 su/ha for several days. If all animals are drawn to the salt treated 10% of the paddock that would result in a grazing pressure of 100 su/ha on the salted area. In a subsequent year a new 10% of the same paddock may be treated if the pasture on the previously treated area continues to be grazed more intensively (34).

Precise aerial spreading of granular salt on mid-slopes is probably more expensive than putting out mini-blocks or rock salt. A problem with rock salt lumps is that stock move them down hill towards scrub filled gullies and streams while brick shaped mini-blocks tend to stay put. A cunning trick to hold salt lumps and blocks on the mid-slope placement sites needs to be devised!

The subtleties of using salt to influence grazing intensity in hill country involves several important variables and best practice needs to be developed for different properties integrating the following general issues:-

1. the degree of salt deficiency in the soil and herbage.

2. the intensity of salt craving of the livestock and their physiological state.
3. the ability to apply a high paddock stocking rate with an appropriate class of stock soon after salt is spread.
4. seasonal timing in relation to plant growth potential and livestock physiological state (eg pregnancy, lactation, etc).
5. influence of rainfall washing salt off herbage and into soil soon after it is spread.
6. the balance of natrophobic and natrophilic plant species in the pasture.

All the above issues feed into decisions on the proportion of large paddocks to be treated with salt and the rate and form of salt to be used. If pasture legume seed is to be broadcast then the optimum time for sowing seed has to be integrated with points 1-6.

Livestock "salt mines" 6.2

Deer, chamois and thar appear to thrive in the New Zealand back country. Much of their natural range covers inland Na deficient environments. There are also some inland farms where little or no salt is used. Furthermore, there appears to be no plant species with high Na content which is favoured by the wild ungulates and farmed sheep and cattle. Where do these animals get their Na?

"Mount Grand", the Lincoln University farm at Hawea Flat, was an ideal property to study the behaviour of grazing animals in a Na deficient environment. It presented a dilemma; no salt had been used on Mt Grand for many years, all top soil QT values showed very low Na ranging between 1 and 3, and herbage on the hill blocks ranged between 0.02 for white clover and less than 0.01 for tall oat grass. Clearly it was a Na deficient environment but animal productivity was comparable to other farms in the district where salt is used. A clue towards solving the dilemma came with the observation that sheep seemed to regularly visit steep eroded sites where the subsoil was exposed. Closer inspection revealed sheep tooth marks where the subsoil was free of course schist grit (see Figure 6.3). Six subsoil samples were analysed. The 3 from shady sites had an average QT of 4 which was twice the Na in the top soil but still deficient. The 3 sites from the sunny face had 9, 28 and 57 QT Na. The site with 57 came from the tooth marked face in the photograph. It can reasonably be called a sheep salt mine! It is therefore probable that Mt Grand sheep supplement their Na deficient pasture diet by ingesting subsoil on north facing banks where the Na content is much higher than normal soil.

Figure 6.3

A Sheep Salt Mine (3).

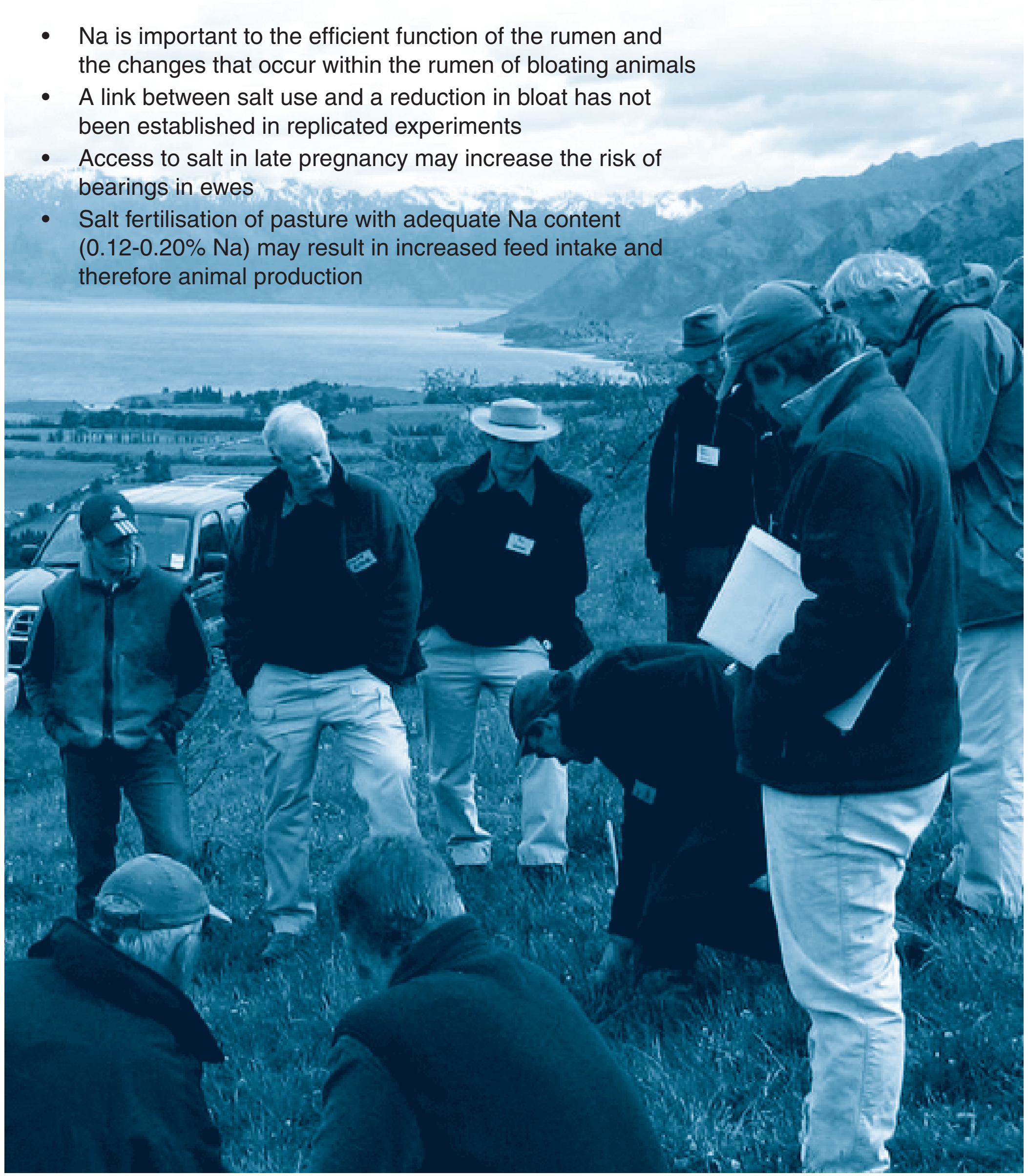
Similar sites can be seen on many properties where animals congregate and contribute to the exposure of subsoils. It is possible that soil ingestion contributes Na to livestock diets from these sites. While animals can increase their Na intake by soil ingestion it is undesirable because of increased tooth wear and dust in wool. Also, if large amounts of soil are eaten feed intake and hence animal productivity will be reduced (35).

The use of salt blocks or salt fertilisation of pastures are obvious solutions to reducing the need for livestock to eat soil.

"...Those without salt also eat a lot of soil - this is hard on teeth and gets into the wool."
- Mark Urquhart, Grays Hills.

Areas of Uncertainty 7.0

- Na is important to the efficient function of the rumen and the changes that occur within the rumen of bloating animals
- A link between salt use and a reduction in bloat has not been established in replicated experiments
- Access to salt in late pregnancy may increase the risk of bearings in ewes
- Salt fertilisation of pasture with adequate Na content (0.12-0.20% Na) may result in increased feed intake and therefore animal production



Sodium and bloat 7.1

Bloat, primary ruminal tympany or acute frothy bloat, is an important digestive disorder on many dairy farms in NZ. It can also affect sheep. Bloat occurs when the normal mechanism for eructation of rumen gas is inhibited or impaired. Under NZ farming conditions this eructation mechanism is commonly inhibited by the frothy rumen contents which trap the gas causing the animal to bloat. Rapidly digested, high protein forages cause the greatest risk eg. legumes (clovers, lucerne) and young lush leafy grasses.

Research on the workings of the rumen has provided the following observations:

- Increasing rumen pH can reduce frothiness
- Ruminal cations, Na^+ and K^+, and Mg^{++} and Ca^{++}, are important and are correlated with bloat
- Low ruminal liquid clearance rates are observed in bloating animals
- Bloating animals have reduced feed intake
- Rapidly digestible, high protein forages increase the risk of bloat

So will salt eliminate bloat? Sodium is important in buffering rumen pH (ref section 2.2). The theory suggests salt may have a role to play but research experiments to date have failed to offer evidence that supports the use of salt to control bloat. Turner in 1981 (36) reported that a Na:K ratio of >1:20 in pasture may exacerbate bloat but other studies (37, 38) found no relationship between Na, K or Na:K in soil or pasture with the incidence or severity of bloat. In Canada, Hall *et al.* (39) tested whether manipulation of cations through supplementation might provide a means of controlling bloat - their conclusion was that Na supplements were ineffective at preventing bloat. Farmer observations suggest that salt may be a useful tool in reducing bloat.

"Many years ago we started using Customblend fertiliser supplied by Bob Edmeades. Included with the mix was salt which was applied at 50kg/ha twice yearly with the capital fertiliser. Bloat has not been an issue on the farm for years. We purchased a neighbouring farm that was experiencing bloat. Our current fertiliser supplier is Ravensdown and after 3 years of salt application at 50kg/ha twice yearly bloat is no longer an issue. Neither farm uses bloat oil. The common factor appears to be the salt application. I don't know how it works but salt is cheap, probably the cost of a couple of drums of bloat oil, and I appreciate the fact that I don't have bloated cows".
- Rex Bates, Dairy Farmer, Tokoroa.

"With a drying climate here in south east Marlborough adaptation is the name of the game. Eight years of almost continuous drought between 1996 and 2004 has led us to make some fundamental changes to our farm system.

The heart of the changes revolved around matching our dry matter production curve with our dry matter requirement curve. With rainfall reducing in our already dry area ryegrass and clovers have proved to be of little value. Our only hope to maximise our opportunities is to grow plants which grow product quickly during our always too short spring.

Eight years ago we started replacing our grass pastures with lucerne. Like any change some problems were encountered. One of these was bloat. I had never had a problem with bloat in sheep, but suddenly we had a huge problem. One night I was discussing with a neighbour this problem. "Do you feed salt" he asked?

"Not much" I replied. Half an hour later I was out in the dark placing a salt block for each mob of ewes. From this point on our problem has all but gone. Lucerne is very sodium deficient, so adding sodium is essential.

For the last two years we have achieved average growth rates of 390 g per day in all our ewes' lambs and 275 in our hoggets lambs. This means we wean big healthy ewe lambs which are easy to get in lamb and have 90% our export lambs all processed by mid December.

Our ewes and cows now lick their way through three tonne of multi mineral blocks, and this along with other supplements like Lamb Survival Drench are key to our wonderful healthy production system."
- Doug Avery, Lake Grassmere, Marlborough.

Sodium and bearings 7.2

Bearings (vaginal prolapse) are most common in ewes near lambing. Most farms experience a low level of incidence (<1% of ewes affected) but serious outbreaks on individual farms can affect 10% of ewes. M&WNZ R&D Brief #120 (40) estimate that financial losses in a 2,500 ewe flock with 1% bearings to be round $3,000 each year. In addition, there are animal welfare issues to consider.

An epidemiological farm study carried out by R.Hilson *et al.* (41) reported access to salt in late pregnancy as a potential risk. It was hypothesized that higher salt intake could lead to higher water intake, and bladder/muscle interactions could promote prolapse. This theory has not been tested with controlled trials. The study involved 113 farms in 2000 and 88 farms in 2001. Farms were located in Hawkes Bay and Southland. Hilson cautioned the transfer of these conclusions to wider sheep populations.

Farmer observations suggest that offering salt blocks to salt-starved ewes a few days before lambing is not a good idea. Salt can stimulate appetite so this combined with salt gorging may increase the risk of bearings through the mechanisms hypothesized by Hilson. Salt gorging is rarely observed in flocks that have continuous access to salt.

Salt fertilisation may increase pasture intake 7.3

Chiy *et al* (42, 43) reported that the application of sodium fertiliser to perennial ryegrass modified dry matter digestibility, water soluble carbohydrates, protein contents and increased rumen pH. In separate experiments they noted the productivity of ruminants is increased when pasture is fertilised with sodium because cows eat more (44). The intake of DM increases, there is an increase in the rumen turnover rate and this promotes more post-ruminal digestion. This research was carried out in the UK and published in several scientific papers. Their grazing experiments were conducted on ryegrass dominant pasture with adequate Na content (0.2%). Salt fertilisation increased herbage Na to 0.5%. Milk production increased 20% from 12 kg/cow/day to 14.5.

Chiy and Phillips work has attracted a lot of attention. There are, however, few positive reports from other similar experiments. The responses reported by Chiy and Phillips may be due to short-term effects on cow grazing preference or rumen physiology rather than alleviation of Na deficiency (1)

References 8.0

(1) Underwood, E.J. and Suttle, N.F. 1999. The mineral nutrition of livestock (3rd edition). *CAB International, UK.*

(2) Kurlansky, M. 2002. Salt: a world history. *Jonathan Cape*

(3) Aspinall, R.J.; Mandaluniz, N.; Hight, L.J.; Lucas, R.J. 2004. Sodium deficiency in Canterbury and Central Otago sheep pastures. *Proceedings of the New Zealand Grassland Association 66:* 227-232.

(4) Smith, G.S., Middleton, K.R., Edmonds, A.S. 1978. A classification of pasture and fodder plants according to their ability to translocate sodium from their roots into aerial parts. *New Zealand Journal of Experimental Agriculture 6:* 183-188

(5) Kolver, E.S. (1999). Pasture digestion in response to change in ruminal pH. Proceeding of the New Zealand Society of Animal Production 1999, vol 39.

(6) Hemingway, R.G (1995). Requirements for sodium by livestock and dietary allowances. *Sodium in Agriculture* - C.J.C Phillips & P.C. Chiy 1995. 145-161.

(7) Towers, N.R.; Smith, G.S.1983. Sodium (Na). In Grace, N.D.ed., The Mineral Requirements of Grazing Ruminants. *New Zealand Society of Animal Production*, pp 115-124

(8) Metson, A.J. 1962. *New Zealand single factor maps*. Wellington, DSIR.

(9) Edmeades, D.C., Wheeler, D.M., Clinton, O.E. 1985. The chemical composition and ionic strength of soil solutions from New Zealand topsoils. *Australian Journal of Soil Research 23:* 151-165

(10) Edmeades, D.C.; O'Connor, M.B. 2003. Sodium requirements for temperate pastures in New Zealand: a review. *New Zealand Journal of Agricultural Research 46:*37-47.

(11) Monaghan, R., Paton, J., Smith, C. 2001. Cation balances on dairy farms and implications: South Island. *News you can use.* Hamilton, New Zealand, Celentis Analytical

(12) Ledgard, S.F., Roach, C., Sprosen, M., Rajendram, G. 2001. Cation balances on dairy farms and implications: North Island. *News you can use.* Hamilton, New Zealand, Celentis Analytical

(13) Chiy, P.C. & Phillips, C.J.C (1995). Sodium in Ruminant Production, Reproduction and Health. *Sodium in Agriculture.* CJC Phillips and PC Chiy

(14) O'Connor, M.B.; Hawke, M.F.; Waller, J.E.; Rotheram, J.R.; Coulter, S.P. 2000. Salt supplementation of dairy cows. *Proceedings of the New Zealand Grassland Association* 62: 49-53

(15) O'Connor, M.B.; Addison, B.; Miller, A.D. 1989. The effects of topdressing dairy pastures in the Waikato with sodium chloride. *Proceedings of the New Zealand Grassland Association 50:* 83-87

(16) Smith, G.S.; Young, P.W.; O'Connor, M.B. 1983. Some effects of topdressing pasture with sodium chloride on plant and animal nutrition. *Proceedings of the New Zealand Grassland Association 44:* 179-185

(17) McDonald, K.A.; Lile, J.A.; Lancaster, J.A.S.; Coulter, M.; O'Connor, M.B. 2002. Salt supplementation of lactating dairy cows. *Proceedings of the New Zealand Society of Animal Production 62:* 236-239

(18) McLeay, L. M.; Waller, J.E.; O'Connor, M.B.; Hobson, B.L. 2002. Reticular groove contraction in dairy cattle following drenching with an anti-bloat solution or a combination of anti-bloat and NaCl. *New Zealand Veterinary Journal 50 (2)*, 77-80

(19) Berger, L.L 2001. Salt and Trace Minerals for Livestock, Poultry and Other Animals. *The Salt Institute*

(20) Smith, E.F.; Parrish, D.B. 1950. The influence of salt on the gains of steer calves. *Kansas Agr. Exp. Sta. Circular* 265.

(21) Smith, E. F.; Parrish, D.B.; Splitter, E.J. 1971. The effect of withholding salt on the growth and condition of steers. *Kansas Agr. Exp. Sta. Cir.* 273

(22) Murphy, G.M.; Plasto, A.W. 1973. Live weight response following sodium chloride supplementation of beef cows and their calves grazing native pasture. *Australian Jour. Exp Agr. And An. Husb.* 13:369.

(23) Joyce, J.P.; Brunswick, L.C.F. 1975. Sodium supplementation of livestock grazing lucerne. *Ruakura Farmers Conference Proc.*

(24) Hawke, M.F.; O'Connor, M.B. 2002. Salt Block Supplementation to Cattle. *Report prepared for Dominion Salt Ltd.*

(25) Hawke, M.F.; O'Connor, M.B.; Waller, J.; Macdonald, K.A.; Hobson, B.; Coulter, S. 2002. Salt (NaCl) use in New Zealand pastoral agriculture - a summary of recent trial results. *Proc. NZ Grassland Association* 64: 191-196

(26) Harbers, L.H.; Harrison, K.F.; Richardson, D.; Smith, E.F. 1972. Whole corn rations for finishing heifers: A comparison of self- fed and mixed supplement, with and without salt. *Kansas Agr. Exp. Sta. Bull.* 557, p.46

(27) Anderson, P., Miller, A.D., Blair, I. Marlborough Salt Trials - not published

(28) NRC. 1981. Nutritional Requirements for Goats. *National Academy Press.* Washington, DC

(29) Meyer, J.H., R.H. Grummer, P.H.Phillips and G Bohstedt. 1950. Sodium Chloride and Potassium Requirements of Growing Pigs. *J. An Sci.* 9:301

(30) Hagsten, I. and T.W.Perry. 1976. Evaluation of Dietary Salt Levels for Swine. I. Effect on Gain, Water Consumption and Efficiency of Feed Conversion. *J.An. Sci.* 42:1187

(31) Estal, C.M. *Purdue University Agr. Exp. Sta. Mimeo Circulars* No.18 (1945): No.20 (1946); No.23 (1947); and No.28 (1947)

(32) NRC. 1998. Nutrient Requirements of Swine 10th Ed. *National Academy Press.* Washington, D.C.

(33) NRC. 2001. Nutrient Requirements of Dairy Cattle: Seventh Revised Edition. *National Academy Press.* Washington, D.C.

(34) Gillespie, B.J.; Lucas, R.J.; Moot, D.J.; Edwards, G.R. 2006. Can topdressing with salt increase oversowing success and pasture quality on steep, south facing slopes in hill country pastures? *Proceedings of the New Zealand Grassland Association* 68:349-353

(35) Pownall, D.B.; Lucas, R.J.; Ross, A.D. 1980. Effects of soil-contaminated feed on dry matter and water intake in sheep. *Proceedings of the New Zealand Society of Animal Production,* 40: 106-110.

(36) Turner, M.A. 1981. Dietary potassium sodium imbalance as a factor in the aetiology of primary tympany in dairy cows. *Vetirinary Research Communication*

(37) Carruthers, V.R.; Norton, D.H.; O'Connor, M.B. 1988. The incidence of bloat on pastures differing in K: Na ratio. *Proceedings of the New Zealand Grassland Association* 49: 169-170

(38) O'Connor, M.B.; Ledgard, S.F.; Carruthers, V.R.; Upsdell, M.P.; Feyter, C.; Edmeades, D.C. 1988. results from the spring 1986 bloat survey: South Auckland-Waikato. *Proceedings of the New Zealand Grassland Association* 49: 167-168

(39) Hall, J.W. and Majak, W. 1992. Rapid screening of feed supplements for the prevention of legume bloat. *Can J. Animal Sci* 72: 613

(40) Meat and Wool New Zealand, June 2006. Coping with bearings. *R & D Brief* #120

(41) Hilson, R., Jackson, R., Perkins, N.R., West, D.M., Roe, A. 2003. An epidemiological study of vaginal prolapse in ewes. *Proc Soc of Sheep and Beef Cattle Vets of NZ Vet Assoc* 33: 203-217

(42) Chiy, C.P. and Phillips C.J.C. 1993. Sodium fertiliser application to pasture. 1. Direct and residual effects on pasture production and composition. *Grass and Forage Science* 48: 189-202

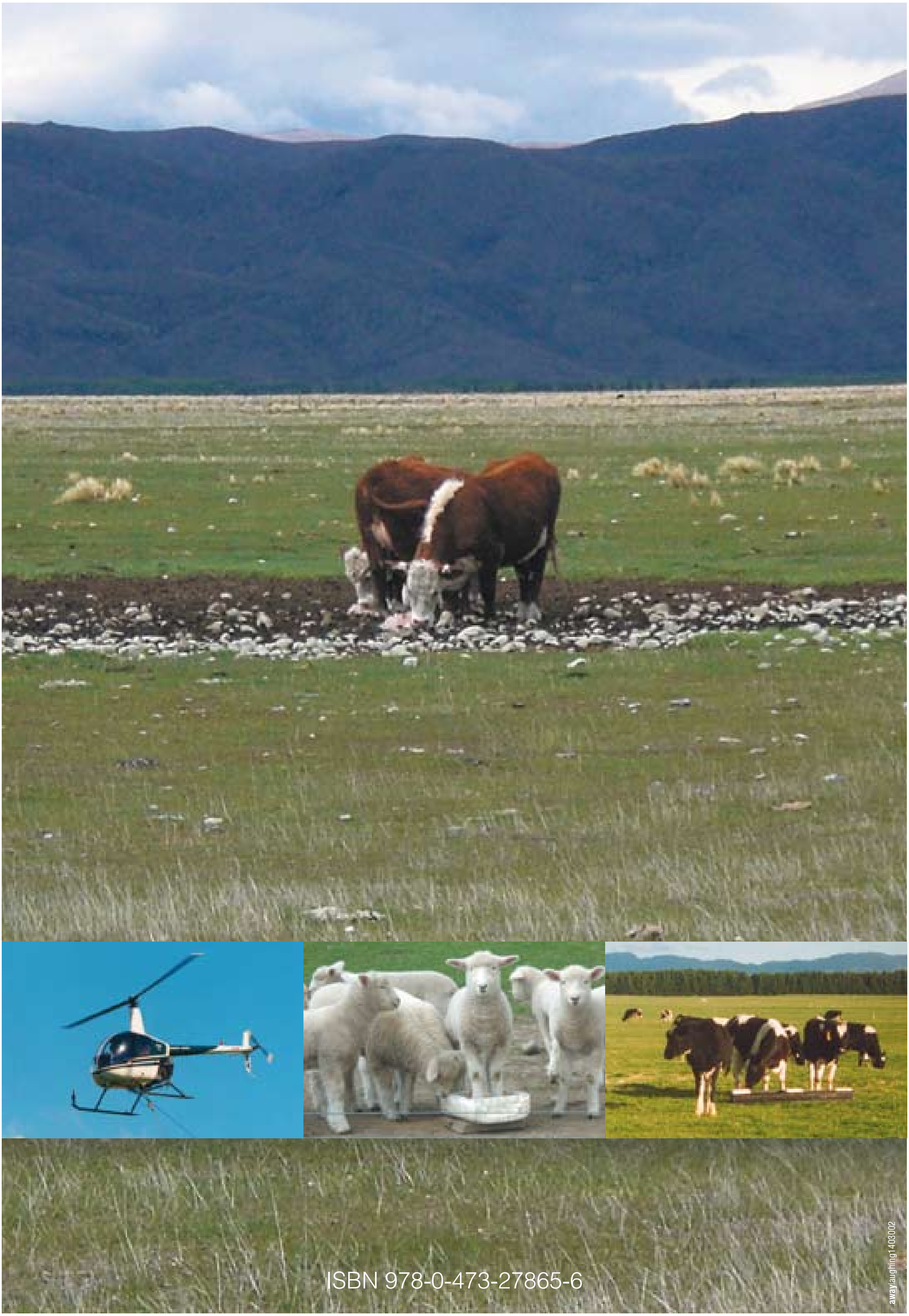
(43) Chiy, C.P. and Phillips C.J.C. 1993. Sodium fertiliser application to pasture. 3. Rumen dynamics. *Grass and Forage Science* 48: 249-259

(44) Chiy, C.P. and Phillips C.J.C. 1991. The effect of sodium chloride application to pasture, or its direct supplementation, on dairy cow production and grazing preference. *Grass and Forage Science* 46: 325-331

Notes

Notes

Helicopter with Airmec
salt block applicator



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