SIMPLIFIED SYSTEMS FOR FEEDING GRAIN TO CATTLE IN FEED LOTS AND UNDER GRAZING CONDITIONS

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SUMMARY

Cattle feed lots are based on an expensive infrastructure and rely on high levels of grain and sophisticated feeding systems to achieve rapid growth rates. The use of virginiamycin removes the risk of acidosis associated with grain feeding and may provide a basis for developing simplified grain feeding systems which provide more flexibility for cattle producers. The use of virginiamycin removes the need for a gradual introduction to grain-based diets and makes it safe to feed grain and hay separately. It is also makes it possible to feed restricted amounts of grain at weekly intervals and this has application in feeding grain to grazing cattle. Supplementing the diet of grazing cattle with grain allows utilisation of paddock feed which is cheaper, and often of a better quality, than hay and straw used in feedlot diets. Virginiamycin applied at 20g/t grain has been shown to provide good protection against acidosis, even when wheat is fed. The virginiamycin may be mixed with milled grain in the powdered form (Stafac, SmithKline Beecham Animal Health) and there is also potential to develop a liquid formulation to be sprayed onto the grain prior to feeding. Virginiamycin is not yet registered in Australia for use in cattle.

INTRODUCTION

Conventional cattle feed lots are based on an expensive infrastructure and sophisticated feed processing. Confining large numbers of animals in restricted areas creates animal welfare problems and the potential for environmental pollution. By removing the risk of acidosis associated with grain feeding there is no longer a need for expensive feed processing equipment. With this change, smaller scale production systems could prove to be more profitable and flexible alternatives to large feed lots.

The risk of acidosis associated with the rapid fermentation of starch makes it essential to provide a gradual increase in the grain content of feed lot diets over a period of 10 to 14 days. This involves the preparation of different formulations of hay and grain which are normally milled and fully mixed. It also dictates the use of fully mixed diets, combining hay and grain, throughout the feeding period. In addition, the risk of lactic acidosis is the main reason why most beef producers are reluctant to feed grain to grazing cattle. By overcoming the risk of acidosis new methods of feeding grain to cattle can be developed. From work in sheep we know that grains such as lupins, which do not contain starch, may be fed weekly or fortnightly without adverse effect on animal production (Rowe and Ferguson 19826, Morcombe et al 1988). Studies in sheep have also shown that by using virginiamycin to remove the risk of lactic acidosis cereal grains such as barley can be fed at weekly or fortnightly intervals in the same way as is presently done with lupin grain (Godfrey et al 1993).

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This paper summarises some recent research on the use of virginiamycin in feeding grain to cattle. Evidence is presented that the use of virginiamycin removes the need for a gradual introduction of grain in a feedlot diet. Results are also presented on the practice of feeding grain separately from hay. These developments in grain feeding technology are discussed in terms of simplified methods of lot feeding and practical options for feeding grain to grazing cattle.

With increased demand for grain fed beef, particularly for export markets, there has been an increase in the number of cattle lot fed in Australia. The methods of lot feeding have been adopted directly from the American model in almost all situations. These systems rely on economies of scale to justify the use of sophisticated feed processing equipment and an expensive infrastructure for feeding and waste disposal. The problems associated with feeding large numbers of animals in confined areas such as animal welfare and pollution are of increasing concern. It is therefore appropriate to give serious consideration to simplified systems of lot feeding which lend themselves to a smaller scale of operation and the possibility of the simple alternative of feeding grain to grazing animals.

OVERCOMING THE CONSTRAINTS OF CONVENTIONAL LOT FEEDING

The major concerns of beef producers considering finishing cattle using grain include: the risks in introducing animals to the grain based diet; the equipment required to mill and mix diets containing hay and grain; the cost of establishing pens and feeders based on traditional feedlot designs ; and the commitment of labour to daily feeding. The combination of these factors have made grain finishing in large feed lots a specialist business requiring significant capital, expensive infrastructure and high overhead costs. The use of virginiamycin, to remove the risks of acidosis associated with grain feeding, overcomes many of these concerns and introduces the possibility of smaller and more flexible feeding enterprises. Three experiments are summarised below which provide the basis of some practical alternatives to conventional feed lot practices.

Introduction of cattle to grain-based diets

Zorrilla-Rios et al (1991) indicated that cattle could be given direct access to mixed diets containing 90% wheat and virginiamycin (40 g/t) without any signs of acidosis or other adverse effect. The inclusion of virginiamycin at 40 g/t also decreased feed intake and in later experiments we have used virginiamycin at a concentration of 20 g/t. Recently Zorrilla-Rios et al (1993 a) compared performance of cattle given a gradual introduction to the final diet over a period of 10 to 14 days, with others given immediate access to the final diet containing virginiamycin. The results summarised in Table 1 show that a sudden introduction did not produce any decrease in liveweight gain or change in feed conversion efficiency. This finding was supported by a the results of a further experiment (Zorrilla-Rios et al 1993 b) in which there was actually an increase in liveweight gain as a result of a sudden introduction to the final diet (with virginiamycin) compared to a gradual introduction of grain (Table 2).

Sudden introduction of cattle to the final diet containing virginiamycin has practical implications in that the operator has only one diet to produce. This makes management much simpler, particularly when groups of animals enter the feed lot at different times. There is also less hay used which reduces the onerous task of hammer-milling hay.

TABLE 1 Intake, liveweight gain, feed conversion and carcase characteristics of cattle fed a conventional feedlot diet with a gradual introduction to the final diet, an immediate or 'sudden' introduction to the final diet and of grain and long hay, fed in separate bins, from the time they entered the feedlot. The diets fed in the sudden introduction contained virginiamycin at a concentration of 20 g/t. (Zorrilla-Rios et al 1993 a)

	Gradual introduction Mixed	Sudden introduction Mixed + VM	Sudden introduction Choice + VM	SED	Control vs others
Average daily intake					
Grain kg/d	6.47	6.75	6.86	0.253	ns
Hay kg/d	1.66	1.73	0.91	0.086	0.01
Total kg/d	8.13	8.48	7.77	0.300	ns
ME MJ/d	92.2	96.2	90.3	3.43	ns
Liveweight gain (kg/d)	1.26	1.38	1.29	0.07	ns
ME utilisation for liveweight gain (ME/kg)	82.4	78.5	84.1	2.94	ns
Carcase measurements					
Weight (kg)	190	195	186	3.07	ns
Dressing %	51.1	51.3	51.3	0.46	ns
Fat at P8 (mm)	11.4	12.1	11.0	1.00	ns

Feeding long hay and grain separately

The potential to feed grain and hay separately adds further flexibility to feedlotting and removes the need to process hay. The use of long hay reduces the equipment required for feed mixing and makes the option of grain feeding available to more cattle producers.

Zorrilla-Rios et al (1993 a, b) studied three options for feeding long hay separately to grain. In all cases cattle had immediate access to rolled grain with virginiamycin on entry to the feed lot and were fed long hay ad libitum . In the first experiment grain was available ad libitum (see Table 1) and in the second experiment a fixed amount of grain (equivalent to 8.1 kg/d) was fed either once or twice a week. These results (Table 2) show that when the grain was fed ad libitum or at weekly intervals the performance of the cattle in terms of liveweight gain and feed conversion was as good as those on the control treatment fed a mixed diet and given a gradual introduction to the final diet.

When grain was fed twice weekly there was a significant decrease in feed conversion efficiency. A possible reason for the reduced efficiency of feed utilisation is seen in Fig 1 which shows greater variation in feed intake when feeding grain twice weekly compared to weekly. In the case of weekly feeding, intake of grain was lower than average on the day before grain feeding and correspondingly higher on the day on which grain was fed. On the other hand, when fed twice weekly intake was only "average" on 3 days out of the 7. This variation in grain intake would be expected to result in inefficient utilisation of roughage and sub optimal conditions for microbial protein synthesis.

TABLE 2 Intake, liveweight gain and feed conversion of cattle fed a conventional feedlot diet with a gradual introduction to the final diet, an immediate or 'sudden' introduction to the final diet and restricted amounts of grain fed either weekly or twice weekly. Diets with VM contained virginiamycin at a concentration of 20 g/t. (Zorrilla-Rios et al 1993 a)

	Gradual introduction Mixed	Sudden introduction Mixed + VM	Twice weekly Grain + VM	Once weekly Grain + VM	SED	P
Average daily intake						
Grain kg/d	9.2	9.9	8.1	8.1	0.69	.09
Hay kg/d	2.4	2.3	3.1	2.6	0.39	.03
Total kg/d	11.8	12.6	11.3	10.7	0.71	.06
ME MJ/d	111	118	129	124	8.6	ns
Liveweight gain (kg/d)	1.46	2.05	1.26	1.62	0.21	.01
ME utilisation for liveweight gain (ME/kg)	82.6	80.5	131.6	99.4	11.27	.01

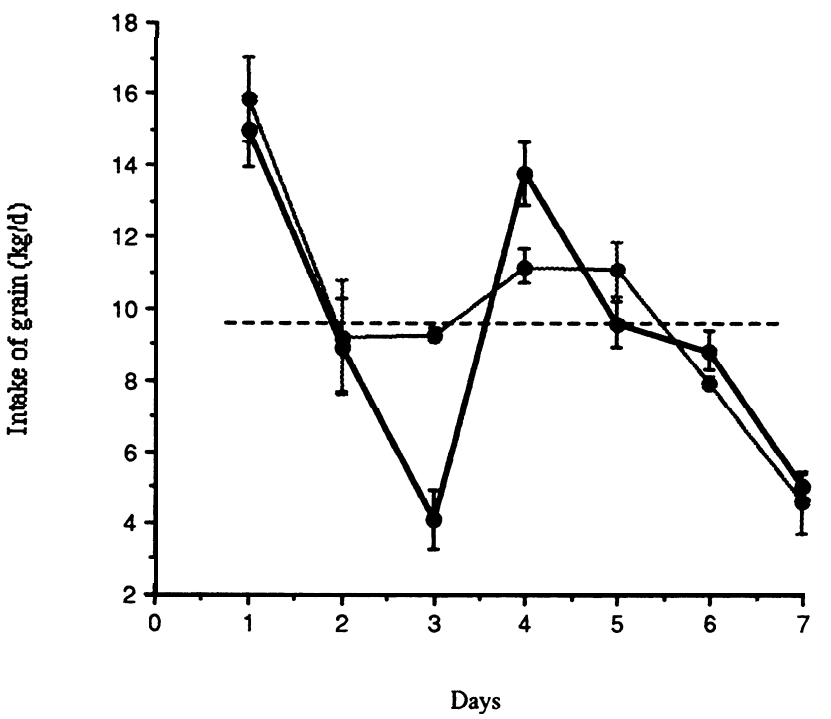

Fig. 1 Intake of grain by cattle fed a mixed diet (- - - -) or a fixed amount of grain at either weekly (O) or twice weekly intervals (●). (Zorrilla-Rios et al 1993 a)

Restricting the amount of grain in the diet

The possibility of feeding restricted amounts of grain may be desirable in order to achieve higher levels of hay intake by lot fed cattle or to feed grain as a supplement to grazing cattle. The simplified grain feeding system based on the use of virginiamycin to

facilitate weekly feeding to grazing animals has application in areas other than finishing cattle for slaughter. There may be benefits in strategic feeding: to ensure that heifers attain mating weight at 14 months; for conditioning steers prior to lot feeding; to facilitate better utilisation of cheap grain (eg seconds wheat); and to make drought feeding easier and safer. Zorrilla-Rios et al (1993 b) conducted an experiment to investigate the response to different levels of barley fed either daily or weekly to penned steers with free access to low quality meadow hay. A barley supplement was fed separately to provide 1, 2, 4 or 6 kg/d, or weekly with virginiamycin (40 g/t) to provide 7, 14, 28 or 42 kg. The results of this trial have been combined with relevant data in Tables 1 and 2 to produce the summary presented in Fig 2.

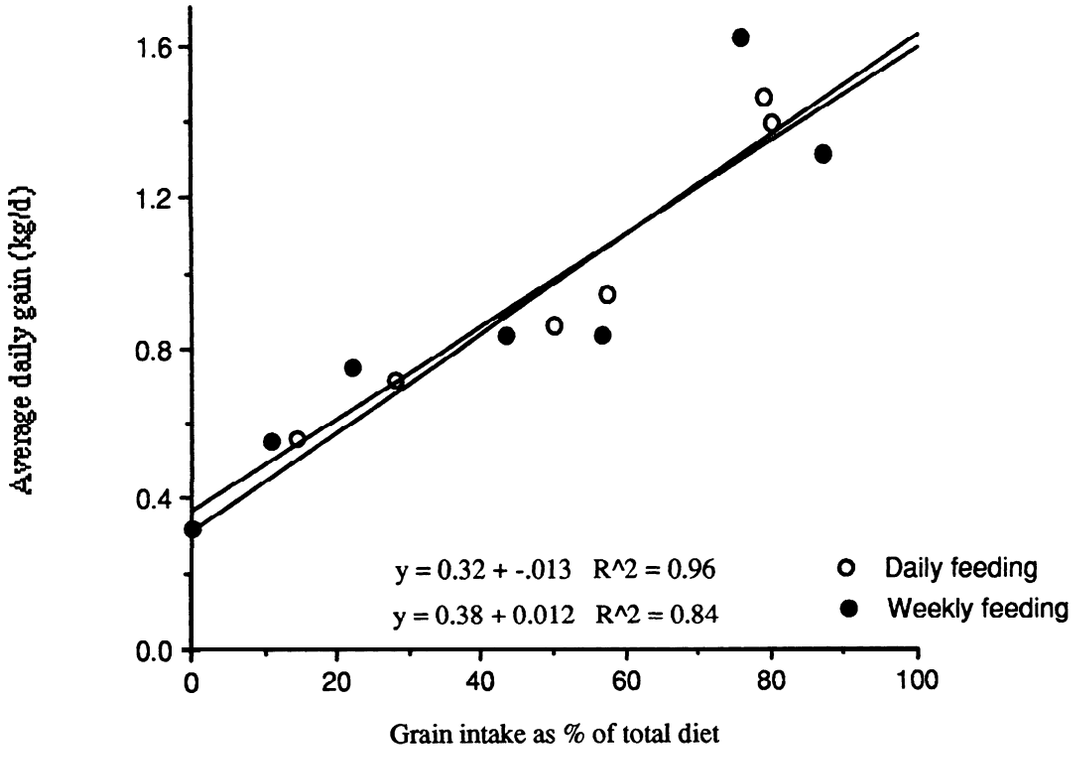

Fig. 2 Relationship between the proportion of grain in the diet and liveweight gain in cattle fed barley grain either daily, on its own, or weekly with virginiamycin (Zorrilla-Rios et al 1993 a, b).

This shows that irrespective of the amount of grain fed there was no disadvantage associated with weekly feeding compared to daily feeding. This suggests a flexible method of achieving the required growth rate to meet target weights in grazing animals. The amount offered can be varied each week depending on the condition of the pasture and performance of the animals. The response in growth rates in response to grain feeding (from 0.3 to 1.5 kg/d) shown in Fig. 2 covers most of the practical production targets for which supplementary feeding or lot feeding would be considered.

There is therefore evidence that, by removing the risk of acidosis, lot feeding can be simplified and made more flexible without reducing the rate of live weight gain or feed conversion efficiency associated with conventional feed lot management. Feeding long hay and grain separately makes grain feeding a relatively straightforward practice for any beef producer and feeding grain at weekly intervals opens up the potential to use paddock roughage by feeding grain to grazing animals.

FEEDING GRAIN TO GRAZING CATTLE

The ability of cattle to select the more digestible components of roughages is removed through the process of harvesting and grinding hay and straw for inclusion in feed lot diets. In addition the price of roughage in feedlot diets is high relative to its nutritional value since there are significant costs associated with baling, transport and grinding which do not add to its nutritional value. For these reasons diets used in most feedlots contain between 70% and 90% cereal grain with roughage added mainly as a filler to maintain normal digestive function. This system fails to capitalise on the major advantages that ruminants have in being able to utilise fibre and harvest roughage efficiently from pasture and crop residues.

The experiment by May and Barker (1984) provides an example of the benefits in utilising roughage by grazing cattle compared to cutting, baling and feeding it in pens. Fig 3 summarises the data from this work and shows an average growth of around 0.7 kg/d in grazing animals compared to the pen fed animals which only maintained weight. It is interesting that supplementary feeding with barley in this experiment of May and Barker did not improve growth rates of the grazing animals and it is possible this is related to disruption of fibre digestion, subclinical acidosis, or insufficient dietary protein. A similar study reported by Smith and Warren (1986) also illustrates that cattle grazing cereal stubble may gain weight even without supplementation (0.5 kg/d) and can grow at rates of around 1 kg/d when fed 1 kg cottonseed meal/d as s supplement.

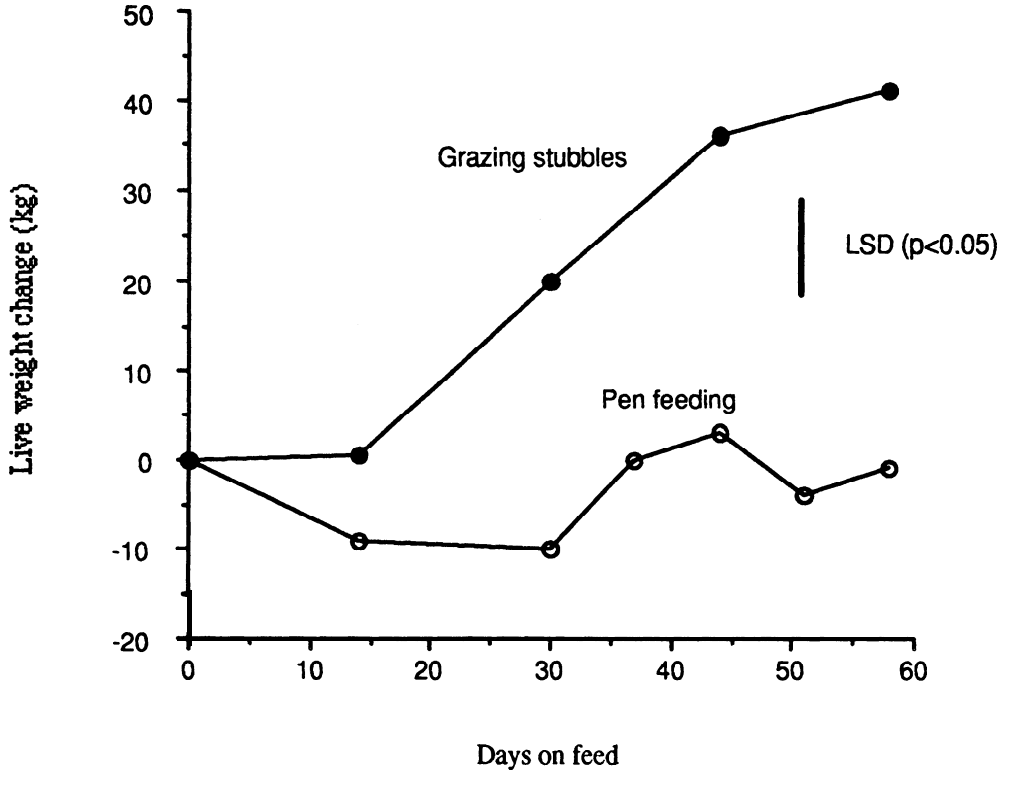

Fig. 3. Liveweight change of cattle either grazing barley stubbles (●) or fed the same stubbles, cut and baled, in pens (O). All cattle received a supplement supplying urea and minerals (May and Barker 1984).

By developing ways of feeding grain to grazing cattle, safely and easily, greater use can be made of good quality paddock feed by grazing animals. Under these feeding

systems less grain will be required to achieve growth rates expected under conventional lot feeding. By feeding grain under grazing conditions, major savings may be achieved through a reduction in the amount of grain used, the utilisation of cheaper roughage, and reduced costs of feed processing.

PROCESSING GRAIN AND GRAIN QUALITY

With the possibility of feeding cereal grain on its own, and not having to mix it with ground roughage, raises the question of whether the grain can be fed directly from the silo without milling or rolling. Apart from oat grain there is general consensus that milling or rolling cereals is cost effective when they are to be fed to cattle (Toland 1976; Nordin and Campling 1976; Hawthorn and Fromm 1977; Axelsen et al 1979; May and Barker 1984). Although there is some variation in the magnitude of the benefits resulting from milling there are some useful guidelines. Axelsen et al (1976) suggested that, in the case of wheat, if the cost of double handling and milling the grain is less than 30% of the cost of the grain, then processing the grain will be cost effective. May & Barker (1984) found even greater benefits from milling barley and suggested that if the cost of labour and machinery is less than 45% of the unit grain price then processing is justified. Although Hawthorn & Fromm (1977) found no change in digestibility in response to milling lupin grain, there appears to be good evidence that rolling or milling lupins improves utilisation to a similar extent as is the case with wheat and barley (Axelsen et al 1979; May and Barker 1984). On the other hand, in the case of oat grain there is general agreement that the benefits associated with milling are far less than for other cereals and that processing is not justified on economic grounds. It is relevant to bear in mind that seconds wheat contains a high proportion of cracked grain and it is possible that milling or rolling this feed source for cattle may not be cost effective. Therefore oats and seconds wheat, which both tend to be cheaper than other grains, appear to well suited to the simplified cattle feeding systems discussed above.

The digestibility of barley, wheat, sorghum and lupins by ruminants is relatively constant compared to oats. In the case of oats it is widely recognised that hectolitre weight, groat to hull ratio and protein content influence its nutritional value. A factor often overlooked is the lignin content of the hull and the effect that this has on digestibility. Hull lignin content is genetically determined (Crosbie et al 1984) and many of the major oat cultivars have a high lignin content which reduces the digestibility by around 10 percentage units compared to cultivars with low hull lignin (Rowe & Crosbie 1989). The effect of lignin content of oat grain in feedlot cattle is demonstrated in the study of May & Barker (1989). They showed that while cattle consumed more of a high lignin (low digestibility) grain and appeared to gain more liveweight on this feed than on the lower lignin cultivar, there was a difference of 2 percentage points in converting live weight to carcase weight, and a better conversion of feed to carcase weight on the low-lignin grain. Rowe and Coss (1992) found that in sheep fed restricted amounts of oat grain the effect of lignin content on carcase gain was even more significant.

CONCLUSIONS

The ability to feed grain to cattle without the need for gradual introduction or mixing with milled roughage simplifies the process of lot feeding and reduces the infrastructure required for feed preparation. The ability to feed grain at weekly intervals, without reducing feed conversion efficiency or liveweight gain, further simplifies feed lot management and introduces the possibility of feeding grain to grazing cattle. There

appears to be sufficient scope in weekly grain feeding to produce growth rates similar to feed lot performance or simply to maintain the growth of young animals during variability in the availability and/or quality of pasture. Feeding grain to grazing animals has potential advantages over the use of fully processed feed lot diets since it allows selection by animals of the more digestible plants and plant parts and thereby reduces the amount of grain required to achieve comparable growth rates using mixed diets. The use of virginiamycin to overcome the risk of acidosis and make grain feeding easier and safer should make it possible for more beef producers to take advantage of grain finishing as an extension to their existing enterprise. While virginiamycin may be mixed with milled grain in the powdered form (Stafac) there is also potential to develop a liquid formulation for spraying onto the grain prior to feeding. Virginiamycin is not yet registered in Australia for use in cattle.

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