Proc. Aust. Soc. Anim. ***Prod. (1978)*** 12: 68

METABOLIZABLE ENERGY IN FEEDING SYSTEMS FOR GRAZING ANIMALS IN AUSTRALIA

J.C. RADCLIFFE*

Summary

Attention is drawn to several comparisons of the ARC feeding system with other systems. Recent Australian adaptations of ME standards for drought feeding of sheep and for cattle feeding are described. There is a need to adapt any feeding standards to the biology of the pastoral system. It is concluded that the Australia-wide adoption of ME based feeding standards would be helpful in promoting an understanding of pasture-animal productivity relations but that direct use of the standards would be restricted in commercial livestock production to enterprises where grazing was restricted or absent.

INTRODUCTION

Within Australia, there has been little consistency in the adoption of feeding standards for ruminants. Those chosen have varied within and between States. Departments of Agriculture in New South Wales and Victoria have even in recent years continued to place emphasis on Starch Equivalent (SE) systems (Vere and Saville 1972, Bailey 1973). Queensland' farmers have been offered advice based on the Total Digestible Nutrient (TDN) system (Young 1970). In South Australia, woolgrowers have-been advised in SE terms (Anon 1972) while dairy farmers have been encouraged to make use of a Digestible Energy (DE) system (Cochrane 1975). DE has 'also been introduced in Western Australia (Bettenay, pers. comm.).

The SE system is inherently in error in that it assumes that a unit quantity of SE from any feed supplies a constant quantity of energy for maintenance or production. The TDN system suffers from the assumption that DE is used with equal efficiency irrespective of source. These deficiencies have resulted in the development of Net Energy (NE) based systems in the U.S.A. (NRC 1970) and Britain (ARC 1965), the latter being expressed in terms of Metabolizable Energy (ME). The extent to which a feeding system described in ME terms should be universally adopted in Australia is of current concern.

The ARC system seeks to take account of variations in feeding level and efficiency of utilisation of ME for different functions and feeds. However, it has not been widely accepted due to its complexity and the time consuming nature of the iterative procedures required (Harkins, Edwards and McDonald 1974).

---

*Northfield Research Centre, Department of Agriculture and Fisheries, Adelaide, south Australia. 5001

II. COMPARISONS OF FEEDING SYSTEMS

Numbers of workers have examined the use of the NE systems by applying them to sets of completed experimental data. Dickie, Wilton and Burgess (1973) found the ARC system predicted gains by bulls over a six year period more accurately than either the NRC (1970) system or the older TDN system (NRC 1966). However, Burroughs, Fowler and Arthaud (1970) examined the ARC and NRC systems with steers and found the NRC system underestimated gains by 6% while the ARC system over-estimated gains by 26%.

Joyce et al. (1975) examined the results of 150 New Zealand beef cattle feeding experiments involving both feedlot and grazing studies. ME intake requirements predicted from the ARC and NRC systems were compared with ME intakes derived from the observed data. The ARC estimates, which predicted directly in ME terms, overestimated the observed values by 8%. To permit a comparison, the NRC estimates were transformed from NE to ME terms using three alternative pairs of values for efficiencies of utilisation of ME' for maintenance and fattening corresponding to ME concentrations of 11.3, 10.5 and 9.5 MJ/kg DM. . These predictions were -2%, +3.5% and +13.5% of the observed ME intakes respectively. It was concluded that the NRC feeding standards predicted ME intake more accurately than those of the ARC. Important sources of error were considered to be the inadequacies of converting digestible organic matter, digestible dry matter, DE and dry matter values of feeds used into equivalent ME values. It was suggested that prediction errors would not be reduced until ME values could be determined for a wide range of feeds, particularly pasture species at different stages of growth. The altered relationship between ME intake and liveweight gain during periods of compensatory growth was also suggested as a factor affecting the accuracy with which predictions could be made from published feeding standards.

III. NUTRITIONAL MANAGEMENT OF GRAZING ANIMALS

The principal applied uses of feeding standards for ruminants are when the animals do not obtain a significant intake from grazing. Within Australia, these circumstances will be found on opportunity beef cattle feedlots, dairy farms managed on limited areas of high-capital-value land near urban growth centres, and sheep enterprises such as those based on the Middle East live sheep export trade. Each of these enterprises depends on the economical incorporation of purchased feedstuffs into the production system, In addition, feeding standards may be used in time of drought to develop least-cost rations to ensure survival of livestock untiladequate grazing intake can be obtained.

It is generally accepted to be uneconomic to provide a supplementary production ration to animals grazing commercially in Australia (Wheeler and Hutchinson 1973). The one exception is in the case of dairy cows where ration supplementation may not only be aimed at establishing and maintaining a high level of lactation during periods of restricted grazing, but may also be used to induce composi-

tional changes in the milk through changes in rumen metabolism.

The energetics of grazing animals cannot be as readily predicted as those of stall-fed animals. NRC (1970) suggests that maintenance allowances may need to be increased by 25-100% to allow for the energy cost of grazing. Although the ARC feeding standards state that the energy cost of grazing does not warrant any additional energy allowance, Van Es (1974) considered that the maintenance requirement when grazing should be increased by 30%. Further variability is introduced when environmental heat losses are considered. In an extreme case, Clarke (1977) recommends that feed requirements of newly shorn sheep should be increased by 200% in cold windy conditions.

In proposing the adoption of a new feeding system for use with grazing animals, it is necessary to consider the potential users of such a system. These will be predominantly research workers, extension workers and farmers. Research workers will usually have access to feedstuff analysis and animal production facilities which will allow them to adopt a system appropriate to the degree of accuracy required. For a system to be accepted by extension workers and farmers, it must have the practical requirement of simplicity, even though this may be at the expense of accuracy. The complexity of the original ARC system has resulted both in criticism and in the subsequent preparation of the simplified Bulletin 33 by the U.K. Ministry of Agriculture Fisheries and Food (1975).

IV. SIMPLIFIED METABOLIZABLE ENERGY- SYSTEMS

Bulletin 33 contains equations from which tables of energy allowances for maintenance, lactation, liveweight change and pregnancy have been developed. Provision is also made to determine appetite limits of animals. For growth and fattening of sheep and cattle, the tables are relatively simple. However calculating the ME requirements of lactating dairy cows must take into account milk yield, milk fat and solids not fat concentrations, live weight, liveweight change and stage of pregnancy. The accuracy of the formulae appears to be adequate for practical purposes. For example, when applied to the Friesian feedlot experiments of Wickes (1974), predicted intakes were found to be identical to those observed.

Another simplification in the bulletin is the inclusion of formulae which allow calculation of the ME concentration in feedstuffs. This permits use to be made of locally determined in vivo or in vitro digestibilities of pastures, hay and silage. These forages which usually constitute the majority of the diet of grazing animals, can vary considerably in ME value.

However, the detailed discussions and comprehensive formulae of Bulletin 33 are still likely to daunt many advisers and most farmers. Recognising this, Clarke (1977) has incorporated ME feeding standards into a New South Wales drought feeding publication using a nomogram to determine maintenance requirements of dry sheep of known live weight when given access to feed of known ME concentration (expressed on a 90% dry matter basis). Feedstuff composition tables are provided. A range of correction factors are given, to be used as multipliers on

the maintenance requirements to allow for pregnancy or lactation. A further maintenance multiplier (60%) is provided for cold blustery weather. The simple and pragmatic nature of Clarke's bulletin may be appreciated from its concluding discussions of felling techniques for edible scrub - a far cry from the detailed metabolism studies used to derive accurate feeding standards.

In Queensland, Moir (1975) has also endeavoured to encourage adoption of ME feeding standards through preparation of a booklet which includes 38 tables giving dry matter feed requirements for cattle of known live weight when offered feedstuffs of known ME concentration for particular states of production. This approach allows the development of local metabolisable energy concentration information whilst avoiding dependence on tables of average values and is a further attempt at simplifying the use of ME standards. Moir avoids a detailed discussion 'of the underlying principles.

V. CONCLUSION

The maintenance requirement of the grazing animal may vary two-fold because of changes in the environment. The quality of available pasture for grazing is subject to rapid change, particularly with advancing physiological maturity of the plant species. These changes are reflected'in marked intake responses by the grazing animal. Selective grazing may to some extent offset these effects, but in commercial livestock production, there is little opportunity to monitor animal intake with precision. Attempts to supplement this intake are likely to be confounded by substitutional feeding responses. Unpredictable intra and interseasonal variability in pasture growth further exacerbate the difficulty of matching pasture availability to animal production needs. An understanding of the biology of pastoral production is a basic requirement. The promotion of this appreciation is being encouraged by such techniques as "feed budgeting" (Hill 1977) in areas of intensive pasture use. These techniques offer as much assistance to the manager of grazing animals as do any direct considerations of systems of feeding standards. In these circumstances, the adoption of ME based energy standards is likely to lead to only marginal practical improvements in feeding accuracy of grazing animals.

Nevertheless, the adoption of a uniform ME feeding system within Australia would encourage greater communication and understanding in the field of pasture-animal relationships between agricultural educators, research workers, advisers and farmers. The national adoption of such a system would encourage the accumulation of locally based feedstuff analytical data which could be readily incorporated into ration calculations. However in commercial livestock production, detailed use of ME standards would occur to only a limited degree with ruminants. The standards would be used predominantly where grazing is restricted or entirely absent.

VI. REFERENCES

ANON. (1972). Dep. Agric. S. Aus. Ext. Bull. No. 41-72.

ARC (1965). "The Nutrient Requirements of Farm Livestock. No. 2 Ruminants" (Agricultural Research Council: London).

BAILEY, P.J. (1973). J. Agric. Vict. Dep, Agric. 71: 32.

BURROUGHS, W., FOWLER, M.A. and ARTHAUD, U.H. (1970). J. Anim. Sci. 30: 450.

CLARKE, A.R. (1977). N.S.W, Dep. Agric. Anim. Ind. Bull, No. A 264.

COCHRANE, M.J. (1975). Dep. Agric. Fish. S. Aus. Ext. Bull. No. 5.75.

DICKIE, D.I., WILTON, J.W. and BURGESS, T.D. (1973). Can. J. Anim. Sci. 53: 471.

HARKINS, J., EDWARDS, R.A. and McDONALD, P. (1974). Anim. Prod. 19: 141.

HILL, L.J. (1977). N.Z. Jl Agric. 134(4):

JOYCE, J.P., BRYANT, A.M., DUGANZICH, D.M., SCOTT, J.D.J. and REARDON, J.T. N.Z. Jl agric. Res. 18: 295.

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD (1975). Tech. Bull. Minist, Agric. Fish. Fd. No. 33 (HMSO: London).

MOIR, K.W. (1975). "The Food Requirements of Cattle" mimeo, (Dep. Primary Industries: Brisbane).

NRC (1966). "Nutrient requirements of domestic animals. 4, Nutrient requirements of beef cattle" (National Academy of Science: Washington, D.C.).

NRC (1970). 'Nutrient requirements of domestic animals. 4. Nutrient requirements of beef cattle" (National Academy of Science: Washington, D.C.).

VAN ES, A.J.H. (1974). Livest. Prod. Sci. 1: 21.

VERE, D.T. and SAVILLE, D.G. (1972). Agric. Gaz. N.S.W. 83: 102.

WHEELER, J.L. and HUTCHINSON, K.J. (1973). In "Pastoral Industries of Australia" (Ed. G. Alexander and O.B. Williams)(Sydney University Press: Sydney).

WICKES, R.B. (1974). Proc. Aust. Soc. Anim. Prod. 10: 78.

YOUNG, J.G. (1970). Qd. agric. J. 96: 477.