Acknowledgements

The author is very grateful to Richard Jefferson of English Nature for all his help and advice. Heather Robertson of English Nature and Derek Wells are particularly thanked for assistance in interpreting the Bratoft data. The author is most grateful to Melanie Leonard and Caroline Moss-Gibbons of IGER library for all their help in obtaining publications and references. Roger Smith, Jo Brealy and Julia Tallowin are thanked for their help with data sorting, figure preparation and compiling. Roger Wilkins and Bob Clements of IGER, Tim Blackstock of the Countryside Council for Wales and Jane MacKintosh of Scottish Natural Heritage are thanked for their valuable comments on a draft of the review. Terry Wells, Steve Peel of ADAS, Bill Elliot and Keith Payne of EN are all thanked for some useful discussions during the preparation of this review.

References

AERTS, J.V., DE BRABANDER, D.L., COTTYN, B.G. & BUYSSE, F.X. 1977. Comparison of the laboratory methods for predicting the organic matter digestibility of forages. *Animal Feed, Science and Technology*, **2**, 337-349.

ADAS. 1975. *The important mineral elements in animal nutrition and their optimum concentration in forages*. ADAS Advisory Paper No. 16. Ministry of Agriculture, Fisheries and Food. London: HMSO.

ADAS. 1983. Mineral, trace element and vitamin allowances for ruminant livestock. MAFF, DAFS, DANI, UKASTA, BVA. *Report of an Interdepartmental Working Party on the ARC (1980) Technical Review : The Nutrient Requirements of Ruminant Livestock*. London: HMSO.

AFRC (Agricultural and Food Research Council. 1991. Technical Committee on Responses to Nutrients. A reappraisal of the calcium and phosphorus requirements of sheep and cattle.*Nutritional Abstracts and Reviews (Series B), C.A.B. International*, **61**(9), 573-612.

ARC (Agricultural Research Council). 1965. *The nutrient requirements of farm livestock. 2. Ruminants*. London: Agricultural Research Council.

ARC (Agricultural Research Council). 1980. *The nutrient requirements of ruminant livestock*. Slough: Commonwealth Agricultural Bureau.

ARNOLD, P.W., HUNTER, F. & GONZALEZ FERNANDEZ, P. 1976. Long-term grassland experiments at Cockle Park. *Ann. Agron.*, **27**, 1027-1042.

BAKER, H. 1937. Alluvial meadows: a comparative study of grazed and mown meadows. *Journal of Ecology*, **25**, 408-420.

BAKER, R.D. 1982. Estimating herbage intake from animal performance. *In*: J.D. LEAVER, ed. *Herbage Intake Handbook*. Reading: British Grassland Society. Pp. 77-93.

BAKKER, J.P., DEKKER, M. & DE VRIES, Y. 1980. The effect of different management practics on a grassland community and the resulting fate of seedlings. *Acta Botanica Neerlandica*, **29**, 469-482.

BAKKER, J P. 1989. *Nature management by grazing and cutting*. Kluwer, Dordrecht. Pp 240-245.

BARBER, W.P. 1985. The nutritional value of common weeds. *In*: J.S. BROCKMAN, ed. *Weeds, pests and diseases of grassland and herbage legumes*. Occasional Symposium No. 18, Reading: Occasional Symposium No. 18, British Grassland Society.

BELL, F.R. AND SLY, J. 1983. The olfactory detection of sodium and lithium salts by sodium deficient cattle. *Physiology and Behaviour*, **31**,307-313.

BLACKSTOCK, T.H., STEVENS, D.P., STEVENS, P.A., MOCKRIDGE, C.P. AND YEO, M.J.M. (Unpublished) Edaphic relationships among oceanic forms of *Cirsio-Molinietum* and related wet grassland communities in lowland Wales. Submitted to Journal of Vegetation Science 1996.*

BORTOLUSSI, G. TERNOUTH, J.H. AND MCMENIMAN, N.P. 1996. Dietary nitrogen and phosphorus depletion in cattle and their effects on liveweight gain, blood metabolite concentrations and phosphorus kinetics. *Journal of Agricultural Science, Cambridge*, **126**, 493-501.

BRENCHLEY, W.E. & WARINGTON K. 1958. *The Park Grass Plots at Rothamsted 1856-1949*. Reprinted 1969. Harpenden: Rothamsted Experimental Station.

BROWN, A.J.E. 1995. Impact of enhanced biological resources on landscape value for tourism: exploring perception of biodiversity through the medium of small groups. *In*: J.R.B. TALLOWIN, ed. *Extensive management of grassland, impact on conservation of biological resources and farm output: Impact of enhanced biological resources on landscape value for tourism*. Supplement to the Final Report to The Commission of the European Community on project AIR3-CT92-0079.*

CAMPLING, R.C., FREER, M. & BALCH, C.C. 1962. Factors affecting the voluntary intake of food by cows. 3. The effect of urea on the voluntary intake of oat straw. *British Journal of Nutrition*, **16**, 115-124.

CHESSON, A., FORSBERG, C.W. & GRENET, E. 1995. Improving the digestion of plant cell walls and fibrous feeds. *In*: M. JOURNET, E. GRENET, M-H. FARCE, M. THERIEZ & C. DEMARQUILLY, eds. *Recent developments in the nutrition of herbivores*. Proceedings of the IVth International Symposium on the Nutrition of Herbivores, Clermont-Ferrand (France). Paris: INRA. pp. 249-277.

COHEN, R.D.H. 1975. Phosphorus and the grazing ruminant. *World Review of Animal Production*, **11**, 27-43.

CROFTS, A. & JEFFERSON, R.G. eds. 1994. *The lowland grassland management handbook*. Peterborough: English Nature/The Wildlife Trusts.

DENTON, D.A. 1982. *The hunger for salt*. Berlin: Springer Verlag, 650pp.

DERRICK, R.W., MOSELEY, G. & WILMAN, D. 1993. Intake, by sheep, and digestibility of chickweed, dandelion, dock, ribwort and spurrey, compared with perennial ryegrass. *Journal of Agricultural Science, Cambridge*, **120**, 51-61.

DODD, M.E., SILVERTOWN, J., McCONWAY, K., POTTS, J. & CRAWLEY, M. 1994. Stability in the plant communities of the Park Grass Experiment: the relationship between species richness, soil pH and biomass variability. *Philosophical Transactions of the Royal Society London* **346**, 185-193.

DODD, M.E., SILVERTOWN, J., McCONWAY, K., POTTS, J. & CRAWLEY, M. 1994. Application of the British National Vegetation Classification to the communities of the Park Grass Experiment through time. *Folia Geobot. Phytotax., Praha*, **29**, 321-334.

EDWARDS, P.J. & HOLLIS, S. 1982. The distribution of excreta on New Forest grassland used by cattle, ponies and deer. *Journal of Applied Ecology*, **19**, 953-964.

EGRO (Extensive management of grassland, impact on conservation of biological resources and farm output). J.R.B.Tallowin, ed. Final Report to The Commission of the European Community on project AIR3-CT92-0079.*

ELLIOT, J.G., OSWALD, A.K., ALLEN, G.P. & HAGGAR, R.J. 1974. The effect of fertilizer and grazing on the botanical composition and output of an *Agrostis/Festuca* sward. *Journal of the British Grassland Society*, **29**, 29-35.

ERDMAN, R.A., HENKEN, R.W. & BULL, L.S. 1980. Effect of dietary calcium and sodium on potassium requirements for lactating dairy cows. *Journal of Dairy Science*, **63**, 538-544.

FAIRBURN, C.B. & THOMAS, B. 1959. The potential nutritive value of some weeds common to north-eastern England. *Journal of the British Grassland Society*, **14**, 36-46.

FORBES, T.J., DIBB, C., GREEN, J.O., HOPKINS, A. & PEEL, S. (1980) *Factors affecting the productivity of permanent grassland.* A National Farm Study. Hurley: Joint GRI/ADAS Permanent Pasture Group.

FORBES, J.M. 1995. *Voluntary food intake and diet selection in farm animals.* Wallingford: CAB International. pp. 226-233.

FRAME, J., FISHER, G.E.J. & TILEY, G.E.D. 1993. Wildflowers in grassland systems. *In*: R.J. HAGGAR & S. PEEL, eds. *Grassland Management and Nature Conservation.* Occasional Symposium No. 28. Reading: British Grassland Society. pp. 104-114.

FREAM, W. 1900. *The Complete Grazier and Farmers' and Cattle-Breeders' Assistant*, forming a compendium of husbandry (from W. Youatt), 14th edn. London: Crosby Lockwood and Son.

GARWOOD, E.A. 1988. Water deficiency and excess in grassland: the implications for grass production and for the efficiency of use of N. *In*: R.J. WILKINS, ed. *Nitrogen and water use by grassland.* Colloquium held at North Wyke Research Station. Hurley: AFRC Institute for Grassland and Animal Production.

GARWOOD, E.A. & TYSON, K. 1978. Productivity and botanical composition of a grazed ryegrass/white clover sward over 24 years as affected by soil conditions and weather. *In*: A.H. CHARLES & R.J. HAGGAR, eds. *Changes in sward composition and productivity.* Occasional Symposium No. 10. Reading: British Grassland Society. pp. 41-54.

GIBB, M.J. & RIDOUT, M.S. 1988. Application of double normal frequency distributions fitted to measurements of sward height. *Grass and Forage Science*, **43**, 131-136.

GILES, N. 1995. A socio-economic valuation of grasslands rich in wildlife resources: using contingent valuation methodology. *In*: J.R.B. Tallowin, ed. *Extensive management of grassland, impact on conservation of biological resources and farm output: Impact of enhanced biological resources on landscape value for tourism.* Supplement to the Final Report to The Commission of the European Community on project AIR3-CT92-0079.*

GILL, M., BEEVER, D.E. & OSBOURN, D.F. 1989. The feeding value of grass and grass products. *In*: W. HOLMES, ed. *Grass its production and utilization.* Oxford: Blackwell Scientific Publications. pp 89-129.

GRIME, J.P. 1973. Control of species density in herbaceous vegetation. *Journal of Environmental Management*, **1**, 151-167.

GRIME, J.P. 1979. *Plant strategies and vegetation processes.* London: Wiley.

GRUBB, P.J. 1977. The maintenance of species-richness in plant communities: the importance of the regeneration niche. *Biological Reviews* **52**, 107-145.

HERBEL, C.H. & NELSON, A.B. 1966. Activities of Hereford and Santa Gertrudis cattle on a southern New Mexico range. *Journal of Range Management*, **19**, 173-176.

HODGSON, J. 1986. Grazing behaviour and herbage intake. *In*: J. FRAME, ed. *Grazing.* Occasional Symposium No.19. Reading: British Grassland Society. pp. 51-64.

HOPKINS, A., GILBEY, J., DIBB, C., BOWLING, P.J. & MURRAY, P.J. 1990. Response of permanent and reseeded grassland to fertiliser nitrogen. 1. Herbage production and herbage quality. *Grass and Forage Science* **45**, 43-55.

HOPKINS, A. JOHNSON, R.H., BOWLING, P.J., PYWELL, R. & PEEL, S. 1996. Techniques for restoring botanical diversity of grassland in Environmentally Sensitive Areas. *In*: *Grassland and Land Use Systems.* Proceedings of the 16th General Meeting of the European Grassland Federation, Grado, Italy. Pp.747-750.

INRA (Institut National de la Reserche Agronomique). 1989. *Ruminant Nutrition: Recommended Allowances and Feed Tables* (ed. R. Jarrige). Paris: John Libby, Eurotext.

IVINS, J.D. 1952. The relative palatability of herbage plants.*Journal of the British Grassland Society*, **7**, 43-54.

JEANGROS, B. & SCHMID, W. 1991. Production et valeur des prairies permanent riches en especes. *Fourrages*, **126**, 131-136.

JENKINSON, D.S., POTTS, J.M., PERRY, J.N., BARNETT, V., COLEMAN, K. & JOHNSTON, A.E. 1994. Trends in herbage yields over the last century on the Rothamsted Long-term Continuous Hay Experiment. *Journal of Agricultural Science, Cambridge*, **122**, 365-374.

JONES, D.I.H. & HAYWARD, M.V. 1973. A cellullase digestion technique for predicting the dry matter digestibility of grasses. *Journal of the science of food and agriculture* **24**, 1419-1426.

JONES, D.I.H. & HAYWARD, M. V. 1975. The effect of pepsin pretreatment of herbage on the prediction of dry matter digestibility for solubility in fungal cellulase solution. *Journal of the Science of Food and Agriculture* **26**, 711-718.

JONES, L. 1986. The effect of ground area cover on the drying rate of of mechanically conditioned grass crops. *Final Annual Report 1984-85.* Hurley: The Grassland Research Institute. pp. 102-103.

KIRKHAM, F.W. & WILKINS, R.J. 1994a. The productivity and response to inorganic fertilizers of species-rich wetland hay meadows on the Somerset Moors: nitrogen response under hay cutting and aftermath grazing. *Grass and Forage Science* **49**, 152-162.

KIRKHAM, F.W. & WILKINS, R.J. 1994b. The productivity and response to inorganic fertilizers of species-rich wetland hay meadows on the Somerset Moors: the effect of nitrogen, phosphorus and potassium on herbage production. *Grass and Forage Science* **49**, 163-175.

KIRKHAM, F.W. & TALLOWIN, J.R.B. 1995. The influence of cutting date and previous fertilizer treatment on the productivity and botanical composition of species-rich hay meadows on the Somerset Levels. *Grass and Forage Science,* **50**, *365-377.*

KIRKHAM, F.W., MOUNTFORD, J.O. & WILKINS, R.J. 1996. The effects of nitrogen, potassium and phosphorus addition on the vegetation of a Somerset peat moor under cutting management. *Journal of Applied Ecology,* **33**, 1013-1029.

KOREVAAR, H. 1986. Production and feeding value of grass from grassland with restrictions in use and fertilization for nature conservation. *Doctoral Thesis. Report 101.* Lelystad, The Netherlands: Research and Advisory Institute for Cattle, Sheep and Horse Husbandry (PR).

KYDD, D.D. 1964. The effect of different systems of cattle grazing on the botanical composition of permanent downland pasture. *Journal of Ecology,* **52**, 139-149.

LARGE, R.V. & KING, N. 1978. The integrated use of of land for agricultural and amenity purposes. Lamb production from Soay sheep used to control scrub and improve the grass cover of chalk downland. *Technical Report* **25**. Hurley: Grassland Research Institute.

LAWES, J.B. & GILBERT, J.H. 1859. Report of experiments with different manures on permanent meadow land. *Journal of the Royal Agricultural Society of England,* 1st Series, **19**, 552-573; **20**, Part II, 228-246, Part III 246-272; Part IV 398-441.

LEAVER, J.D. (1985) Milk production from grazed temperate grassland. *Journal of Dairy Research,* **52**, 313-344.

MAFF (Ministry of Agriculture, Fisheries and Food). 1975. Energy Allowances and Feeding Systems for Ruminants. *Technical Bulletin 33.* London: HMSO.

MAFF (Ministry of Agriculture, Fisheries and Food). 1984. Energy Allowances and Feeding Systems for Ruminants. *Reference Book No. 433.* London: HMSO.

MAFF (Ministry of Agriculture, Fisheries and Food). 1988. *Fertilizer recommendations*. Reference Book 209. London: HMSO.

MASON, V.C. & HARTLEY, R.D. 1988. Upgrading and preservation of straw, hay and whole crop cereal - current trends. *Annual Report 1985-86*. Hurley: Animal and Grassland Research Institute. pp. 114-116.

MARRS, R.H. 1993. Soil fertility and nature conservation in Europe: Theoretical considerations and practical management solutions. *Advances in Ecological Research* **24**, 241-300.

MARRS, R.H., GOUGH, M.W. & GRIFFITHS, M. 1991. Soil chemistry and leaching losses of nutrients from semi-natural grassland and arable soils on three contrasting parent materials. *Biological Conservation*, **57**, 257-271.

MAXWELL, T.J. & MILNE, J.A. 1995. Role of herbivores in sustainable land production systems. Principles and practice - some issues. *In*: M. JOURNET, E. GRENET, M-H. FARCE, M. THERIEZ AND C. DEMARQUILLY, eds. *Recent developments in the nutrition of herbivores*. Proceedings of the IVth International Symposium on the nutrition of Herbivores, Clermont-Ferrand. Paris: INRA. pp 17-31.

MLC (Meat and Livestock Commision). 1995. *Beef Yearbook 1995*. Milton Keynes: Meat and Livestock Commision..

MLC (Meat and Livestock Commision). 1996. *Sheep Yearbook 1996*. Milton Keynes: Meat and Livestock Commision..

MLC (Meat and Livestock Commision). 1981. Sheep Improvement Services: *Feeding the Ewe*. Kilton Keynes: Meat and Livestock Commision.

MILLIGAN, L.P., JOURNET, M. & MAENG, W.J. 1995. Future areas of research and expected advances in the nutrition of herbivores. *In*: M. JOURNET, E. GRENET, M-H. FARCE, M. THERIEZ & C. DEMARQUILLY *Recent developments in the nutrition of herbivores*. Proceedings of the IVth International Symposium on the Nutrition of Herbivores, Clermont-Ferrand (France). Paris: INRA. pp. 587-610.

MILNE, J.A., ARMSTRONG, H.M., SIBBALD, A.R. & GORDON, I.J. 1995. Evaluating the effect of sheep production systems on semi-natural vegetation in the UK - the uses of a computer model. *In*: H.J. SCHWARTZ ed. *Wild and domestic ruminants in extensive land use systems*. Berlin: Humboldt University.

MINSON, D.J., RAYMOND, W.F. & HARRIS, C.E. 1960. Studies in the digestibility of herbage. VIII. The digestibility of S37 cocksfoot, S23 ryegrass and S24 ryegrass. *Journal of the British Grassland Society*, **15**, 174-180.

MOUNTFORD, J.O., LAKHANI, K.H. & KIRKHAM, F.W. 1993. Experimental assessment of the effects of nitrogen addition under hay-cutting and aftermath grazing on the vegetation of meadows on a Somerset peat moor. *Journal of Applied Ecology* **30**, 321-332.

MOUNTFORD, J.O., TALLOWIN, J.R.B., KIRKHAM, F.W., & LAKHANI, K.H. 1994. Effects of inorganic fertilizers in flower-rich hay meadows on the Somerset Levels. *In*: R.J. HAGGAR, R.J. & S. PEEL, eds. *Grassland Management and Nature Conservation.* Occasional Symposium No. 28. Reading: British Grassland Society. pp. 74-85.

MORRIS, M.G. 1971. The management of grassland for the conservation of invertebrate animals. *Symposium of the British Ecological Society*, No. **11**, 527-552.

MWAKATUNDU, A.G.K. & OWEN, E. 1974. *In vitro* digestibility of sodium hydroxide-treated grass harvested at different stages of growth. *East African Agricultural and Forestry Journal*, **40**, 1-10.

NIAB (National Instituteof Agricultural Botany). 1987. Grasses and Legumes for Conservation 1987/88. *NIAB Technical Leaflet No. 2*. Cambridge: National Instituteof Agricultural Botany.

NIAB (National Instituteof Agricultural Botany). 1996/97. Recommended list of Grasses and Herbage Legumes. Cambridge: National Instituteof Agricultural Botany.

NOSBERGER, J., LEHMANN, J., JEANGROSS, B., DIETL, W., KESSLER, W., BASSETTI, P. & MITCHLEY, J. 1994. Grassland production systems and nature conservation. *In:* L.'T MANNETJE & J. FRAME, eds. *Grassland and Society*. Proceedings of the 15th General Meeting of the European Grassland Federation, Wageningen, The Netherlands, pp. 255 - 265.

OLFF, H. AND BAKKER, J.P. 1991. Long-term dynamics of standing crop and species composition after the cessation of fertilizer application to mown grassland. *Journal of Applied Ecology*, **28**, 1040-1052.

OLSEN, S.R., COLE, C.V., WATANABE, F.S. & DEAN, L.A. 1954. Estimation of available phosphorus by extraction with sodium bicarbonate. *US Department of Agriculture Circular* 939.

PARSONS, A.J., COLLETT, B. & LEWIS, J. 1983. Changes in the structure and physiology of a perennial ryegrass sward when released from a continuous stocking management: implications for the use of exclusion cages in continuously stocked swards. *Grass and Forage Science* **39**,1-9.

PAWSON, H.C. 1972. Soil and fertilizers: epoch making experiments at Cockle Park experimental station in Britain. *Agricultural Digest*, **24**, 3-15.

PEEL, S., MATKIN, E.A. & HUCKLE, C.A. 1988. Herbage growth and utilized output from grassland on dairy farms in soth-west England: case studies on five farms, 1982 and 1983. II. Herbage utilization. *Grass and Forage Science*, **43**, 71-78.

PEETERS, A. & KOPEC, S. 1996. Production and productivity of cutting grasslands in temperate climates of Europe. *In*: G. PARENTE, J. FRAME & S. ORSI, eds. *Grassland and Land-use systems,. Grassland Science in Europe*, **1**, pp.59-73. Proceedings of the 16th General Meeting of the European Grassland Federation. Grado, Italy.

PETIT, M., GAREL, J.-P., D'HOUR, P. & AGABRIEL, J. 1995. The use of forages by the beef cow herd. *In*: M. JOURNET, E. GRENET, M-H. FARCE, M. THERIEZ & C. DEMARQUILLY, eds. *Recent developments in the nutrition of herbivores,*. Proceedings of

the IVth International Symposium on the nutrition of Herbivores, Clermont-Ferrand. Paris: INRA. Pp 473-496.

POOLE, A.H., CRAVEN, J.A. & MABEY, S.J. 1984. An analysis of farm management services costed farms, 1983-84. *Report No 40.* Reading: MMB Farm Management Services Information Unit..

PRATT, R.M., PUTMAN, R.J., EKINS, J.R. & EDWARDS, P.J. 1986. Use of habitat by free-ranging cattle and ponies in the New Forest, southern England. *Journal of Applied Ecology*, **23**, 539-557.

RABOTNOV, T.A. 1977. The influence of fertilisers on the plant communities of mesophytic grassland. *In*: W. KRAUS, ed. *Applications of Vegetation Science to Grassland Husbandry.* The Hague: Junk. pp. 461-497.

ROBSON, M.J. 1981. Potential production - what is it and can we increase it? *In*: C.E. WRIGHT, ed. *Plant Physiology and Herbage Production.* Reading: Occasional Symposium No. 13. British Grassland Society. pp 5 -18.

ROBSON, M.J., PARSONS, A.J. & WILLIAMS, T.E. 1989. Herbage production: grasses and legumes. In: W. HOLMES, ed. *Grass its production and utilization.* Oxford: Blackwell Scientific Publications. pp 7-88.

RODWELL, J.S. 1991. *British Plant Communities. Volume 2. Mires and heaths.* Cambridge: Cambridge University Press.

RODWELL, J.S. 1992. *British Plant Communities. Volume 3. Grasslands and montane communities.* Cambridge: Cambridge University Press.

ROOK, A.J., HUCKLE, C.A. & PENNING, P.D. 1994. Effects of sward height and concentrate supplementation on the ingestive behaviour of spring-calving dairy cows grazing grass-clover swards. *Applied Animal Behaviour Science*, **40**, 101-112.

SHEAIL, J., WELLS, T.C.E., WELLS, D.A. & MORRIS, M.G. 1974. Grasslands and their history. *In*: E. DUFFEY, M.G. MORRIS, J. SHEAIL, L.K. WARD, D.A. WELLS & T.C.E. WELLS, eds. *Grassland Ecology and Wildlife Management.* London: Chapman & Hall.

SILVERTOWN, J., WELLS, D.A., GILLMAN, M., DODD, M.E., ROBERTSON, H. & LAKHANI, K.H. 1994. Short-term effects and long-term after effects of fertilizer application on the flowering population of green-winged orchid. *Orchis morio. Biological Conservation*, **69**, 191-197.

SIMPSON, N.A. & JEFFERSON, R.G. 1996. Use of farmyard manure on semi-natural (meadow) grassland. *English Nature Research Reports, No. 150.* Peterborough: English Nature.

SMITH, L.P. 1960. The relation between weather and meadow-hay yields in England, 1939-56. *Journal of the British Grassland Society*, **15**,203-208.

SMITH, R.S. & JONES, L. 1991. The phenology of mesotrophic grassland in the Pennine Dales, northern England: historic hay cutting dates, vegetation variation and plant species phenologies. *Journal of Applied Ecology*, **28**, 42-59.

SMITH, R.S. 1994. Effects of fertilizers on plant species composition and conservation interest of UK grassland. *In*: R.J. Haggar & S. Peel, eds. *Grassland Management and Nature Conservation*. Occasional Symposium No. 28. Reading: British Grassland Society. pp. 64-73.

STEVENS, P.A., BELL, S.A., BRITTAIN, S.A., HUGHES, S. & LOWE, J.A. 1995. Soil/plant interactions in lowland grasslands. Great Orme Study, Final Report. Countryside Council for Wales, Contract FC 73-01-81.*

SUNDSTØL, F. & COXWORTH, E.M. 1984. Ammonia treatment. *In*: F. SUNDSTØL & E.M COXWORTH, eds. *Straw and other fibrous by-products as feed*. Amsterdam: Elsevier Science Publishers. pp. 196-247.

SUTHERLAND, W.J. 1983. Aggregation and the 'Ideal Free' Distribution. *Journal of Animal Ecology*, **52**, 821-828.

TALLOWIN, J.R.B., WILLIAMS, J.H.H. & LARGE, R.V. 1986. Some consequences of imposing different continuous grazing pressures in the spring on sward morphology, herbage quality and the performance of young beef cattle. *Journal of Agricultural Science, Cambridge* **106**, 129-139.

TALLOWIN, J.R.B., KIRKHAM, F.W., BROOKMAN, S.K.E. & PATEFIELD M. 1990. Response of an old pasture to applied nitrogen under steady-state continuous grazing. *Journal of Agricultural Science, Cambridge* **115**, 179-194.

TALLOWIN, J.R.B. & SMITH, R.E.N. 1994. The effect of inorganic fertilizers on botanical diversity and agricultural production on the Somerset Levels. *Eighth and Final Report to the Management Group of the Tadham Project for the Ministry of Agriculture, Fisheries and Food, the Department of the Environment and English Nature.**

TALLOWIN, J.R.B., SMITH R. E. & KIRKHAM, F.W. 1995. Restoration of floristic diversity to a de-intensified species-impoverished grassland in the UK: a case study. *Annales Universitatis Mariae Curie-Sklodowska*, Agricultura-Supplementum, Vol. L. Lublin, Poland. pp. 237-245.

TALLOWIN, J.R.B. & SMITH R.E.N. 1996. Management options to conserve a *Cirsio-Molinietum* and integrate its use into productive livestock systems. *In*: Vegetation management in forestry, amenity and conservation areas: management for multiple objectives. *Aspects of Applied Biology*, **44**, 203-210.

TALLOWIN, J.R.B., SMITH, R.E.N. & KIRKHAM, F.W. In press. Potassium availability decrease in species-rich hay meadows at Tadham on the Somerset Levels and Moors - cause for concern? *In*: R.D. SHELDRICK, ed. *Grassland management in the ESAs*. Occasional Symposium. Reading: British Grassland Society.

TELLE, P.P., PRESTON, R.L., KINTNER, L.D. & PFANDER, W.H. 1964. Definition of the ovine potassium requirement. *Journal of Animal Science*, **23**, 59-66.

TERNOUTH, J.H., BORTOLUSSI, G., COATES, D.B., HENDRICKSEN, R.E. & MCLEAN, R.W. 1996. The phosphorus requirements of growing cattle consuming forage diets. *Journal of Agricultural Science, Cambridge*, **126**, 503-510.

TILLEY, J.M.A. & TERRY, R.A. 1963. A two stage technique for *in vitro* digestion of forage crops. *Journal of the British Grassland Society*, **18**, 104-111.

TILMAN, D. 1982. *Resource competition and community structure*. Princeton, USA: Princeton University Press.

TREWEEK, J.R. & WATT, T.A. 1994. Integration of nature conservation management with low input livestock production. *In*: R.J. HAGGAR & S. PEEL, eds. *Grassland Management and Nature Conservation*. Occasional Symposium No. 28. Reading: British Grassland Society. pp.210-216.

TYSON, K.C., GARWOOD, E.A., ARMSTRONG, A.C. & SCHOLEFIELD, D. 1992. Effects of field drainage on the growth of herbage and the liveweight gain of grazing beef cattle. *Grass and Forage Science*, **47**, 290-301.

WALLIS DE VRIES, M.F. 1994. *Foraging in a Landscape Mosaic. Diet selection and performance of free-ranging cattle in heathland and riverine grassland*. PhD Thesis. The Netherlands: University of Wageningen.

WALLIS DE VRIES, M.F. 1995. Estimating forage intake and quality in grazing cattle: a reconsideration of the hand-plucking method. *Journal of Range Management*, **48**, 370-375.

WALLIS DE VRIES, M.F. 1996. Nutritional limitations of free-ranging cattle: the importance of habitat quality. *Journal of Applied Ecology*, **33**, 688-702.

WARD, L.K. 1990. Management of grass-scrub mosaics. *In*: S.H. HILLIER, D.W.H. WALTON & D.A. WELLS, eds. *Calcareous grasslands - ecology and management*. Huntingdon: Bluntisham Books. pp. 134-139.

WELCH, D. 1984. Studies in the grazing of heather moorland in north-east Scotland. I. Site description and patterns of utilization. *Journal of Applied Ecology*, **21**, 179-195.

WELLS, T.C.E. (1969) Botanical aspects of conservation management of chalk grasslands. *Biological Conservation*, **2**, 36-44.

WELLS, T.C.E. 1976. The management of chalk grassland at Aston Rowant NNR by sheep grazing. Huntingdon: Nature Conservancy Council. *CST Report No. 35*.

WELLS, T.C.E. & COX, R. 1993. The long-term effects of cutting on the yield, floristic composition and soil nutrient status of chalk grassland. *English Nature Research Reports*, No 71. Peterborough: English Nature.

WIEGERT, R.G. & EVANS, F.C. 1964. Primary production and the disappearance of dead vegetation on an old field in Southeastern Michigan. *Ecology*, **45**, 49-63.

WILKINS, R.J. 1981. Improving forage quality by processing. *In*: J.B. HACKER, ed. *Nutritional limits to animal production from pastures*. Proceedings of an International Symposium, St. Lucia, Queensland, Australia. CAB, Farnham Royal. pp. 389-408.

WILKINS, R.J., NEWBERRY, R.D. & TITCHEN, N.M. 1983. The effect of sward height on the performance of beef cattle grazing permanent pasture. *Annual Report*. Hurley: Grassland Research Institute. pp. 82-83.

WILKINS, R.J. 1991. *Economic implications of results from Tadham Moor experiment.* Report to the Department of the Environment, Ministry of Agriculture, Fisheries and Food and the Nature Conservancy Council.*

WILKINS, R. J. & HARVEY, H. J. 1994. Management options to achieve agricultural and nature conservation objectives. *In*: R.J. HAGGAR & S. PEEL, eds. *Grassland Management and Nature Conservation.* Occasional Symposium No. 28. Reading: British Grassland Society. pp.86-94.

WILLEMS, J.H. 1983. Species composition and above ground phytomass in chalk grassland with different management. *Vegetatio,* **52**, 171-180.

WILLIAMS, O.B., WELLS, T.C.E. & WELLS, D.A. 1974. Grazing management of Woodwalton Fen: seasonal changes in the diet of cattle and rabbits. *Journal of Applied Ecology,* **11**, 499-516.

WILMAN, D. & RILEY, J.A. 1993. Potential nutritive value of a wide range of grassland species. *Journal of Agricultural Science, Cambridge,* **120**, 43-49.

WILLIAMSON, P. 1976. Above-ground primary production of chalk grassland allowing for leaf death. *Journal of Ecology,* **64**, (3), 1059-1075.

* Availability of publication subject to agreement by research sponsor

Appendix table 1. Dry matter yields (kg/ha) for uninterrupted growth, regrowths * and total annual yields of some unfertilized and fertilized semi-natural grasslands and some agriculturally improved grasslands.

		cutting dates											
Community type	Fert. input	April	early May	mid-May	late May	early June	mid-June	late June	July	August	September	October	Total	Reference/source
MG8[T] cut/grazed	0		510			1905		3024		5823	3590			Tallowin et al. (1996)
MG5[T] cut/grazed	0		320			1562		3488		4545	2805			Tallowin et al. (1996)
MG5/MG8[T] cut/grazed	0				1680			4720	5480		5730			Kirkham & Tallowin (1995)
MG5/8[T] cut	0								3780				4690	Kirkham & Wilkins (1994)
MG5/8[T] cut	200N75P200K								6960				10460	Kirkham & Wilkins (1994)
MG5[PGE] 3 limed cut	0						1500							Williams. (1978)
MG5a[PGE] Plot 3 unlimed cut	0						1360					1400*	2760	Jenkinson *et al* (1994)
MG1e/7D[PGE] 14 unlimed cut	96N35P225K						5410					2250*	7660	Jenkinson *et al* (1994)
MG5[Bratoft] cut	0								2219			578*	2797	Silvertown *et al.*, (1994), English Nature unpublished
MG5[Bratoft] cut	inorg 40P								3564			794*	4357	English Nature unpublished
MG5[Bratoft] cut	inorg 44N4P52K								3651			644*	4295	English Nature unpublished
MG5[Bratoft] cut	org 88N8P104K12Mg								4044			811*	4855	English Nature unpublished
MG5/6[WRO]	0								1760					Elliot *et al* , (1974)
MG5/6[WRO]	80N28P40K								6780					Elliot *et al*., (1974)
MG13[K] cut	0		318	850	1563	2429	3195	4100					4381	Korevaar, (1986)
MG13[K] cut	200N150P390K						9211						9472	Korevaar, (1986)
MG6/MG13[K] cut	0		1262	1878	2494	3171	3787	4403	5054					Korevaar, (1986)
MG6/MG13[K] cut	0						8164						8163	Korevaar, (1986)
MG6/MG13[K] cut	200N150P390K												11646	Korevaar, (1986)
MG6/7 cut/grazed	100N29P83K								5312					Arnold, Hunter & Fernandez (1976)
MG6/7 cut/grazed	0								2080					Arnold, Hunter & Fernandez (1976)
MG6[H57] grazed	48N21P59K					4890					3000*		8030	Garwood & Tyson (1978)
MG7[Ref] cut	150N33P62K	910	3406	5465	6928	8602	9805							*L. perenne* Ref plots
MG10 cut	0								6083					Tallowin *et al*. (1996)
MG10 cut/grazed	150N33P62K			2250			6120							Tallowin *et al*. (1990)
M24 grazed	0	<100	<100	<100		475		2336	1435	1309	968			Tallowin et al. (1996)
M15 grazed	0	<100	<100					3868			2948			Tallowin et al. (1996)
M23 grazed	0		668			1750		2505	2395	1691	3084			Tallowin et al. (1996)
M23 cut	0								6279				6279	Tallowin et al. (1996)
CG3 cut once/yr	0				1941								1941	Wells & Cox, (1993)
CG3 cut twice/yr	0				1386			379*					1765	Wells & Cox, (1993)
CG3 cut thrice/yr	0				1035			330*	154*				1518	Wells & Cox, (1993)
CG3/5 cut	0									3000				Willems. (1983)

NVC classifications of Park Grass Expeimental (PGE) plots were carried out by Dodd *et al.*, (1994)

[T] = data from species-rich meadows at Tadham Moor on the Somerset Levels

[Bratoft] = data from Bratoft meadows in Lincolnshire

[H57] = data from 20-24 yr old *L.perenne* dominated sward at former Grassland Research Institute

[Ref] = data from IGER's *L. perenne* reference plots

[K] = data from grasslands in the Netherlands (Korevaar, 1986)

[WRO] = data from Alberts Field on Begbroke Hill Farm (former Weed Research Organisation)

Appendix table 2.

Site	Fertiliser	year	mean herbage yield (kg ha^{-1})	variance^{-3}	source
MG5/MG8 cut & grazed.	none	1987	4782.3	62.59	Kirkham & Tallowin 1995
	none	1988	6315.7	68.03	
	none	1989	4607.7	96.63	
	none	1990	3987.0	133.21	
	none	1991	5909.3	48.53	
	none	1992	5441.7	95.25	
MG5/MG8 cut & grazed.	200N, PK replaced	1987	6203.3	79.96	Kirkham & Tallowin (1995)
	200N, PK replaced	1988	6866.7	87.95	
	200N, PK replaced	1989	7641.0	34.16	
	200N, PK replaced	1990	6989.3	97.74	
	200N, PK replaced	1991	8512.7	89.95	
	200N, PK replaced	1992	8818.0	132.19	
MG5/MG8 cut	100N, 0P, K replaced	1987	4894.9	66.61	Kirkham & Wilkins (1994)
	none	1988	5543.7	49.01	
	none	1993	4159.1	75.54	
MG5/MG8 cut	200N,75P,200K	1987	9778.9	100.07	
	200N,75P,200K	1988	8442.0	104.63	
	200N,75P,200K	1993	5145.2	102.59	
MG13	none	1981-85	4218.0	100.80	Korevaar (1986)
MG6/7	none	1981-85	6159.0	58.02	
MG6/13	none	1981-85	8164.0	80.03	
MG13	200N,150P,390K	1981-85	9211.0	101.92	
MG6/7	Fert	1981-85	10190.0	102.12	
MG6/13	200N,150P,390K	1981-85	11646.0	81.81	
MG5	none	1973	2536.4	55.95	English Nature
	none	1974	1480.8	47.56	
	organic 88N, 8P, 104K, 12Mg	1973	5241.0	56.94	
	organic 88N, 8P, 104K, 12Mg	1974	3352.4	62.01	
	inorganic 44N, 4P,52K, 6Mg	1973	4395.4	40.41	
	inorganic 44N, 4P,52K, 6Mg	1974	3091.5	81.92	

Appendix table 3. Exchangeable (ammonium acetate/ammonium chloride) potassium and bicarbonate extractable (Olsen, 1954) phosphorus (mg/100g dry soil) for different mesotrophic (MG), mire and fen-meadow (M), calcareous (CG) and acidic (U) semi-natural grasslands.

Vegetation type	K	P	Sampling depth	
MG1	14.5	0.33	0-15 cm	Stevens, et al., (1995)
MG4 North Meadow	19.7	1.9	?	English Nature unpublished.
MG5/MG8 Tadham	15.1-39.6		0-15cm	EGRO. (1996)
MG5 Bratoft	31.7	0.83	0-10 cm	English Nature unpublished.
MG5 Bratoft(40kg inorg P/ha/yr)	28.6	1.15	0-10 cm	English Nature unpublished
MG5 Bratoft(44N4P52K kg inorganic fertilizer/ha/yr)	33.3	0.79	0-10 cm	English Nature unpublished
MG5 Bratoft (88N8P104K kg organic fert/ha/yr)	37.3	0.77	0-10 cm	English Nature unpublished
MG6	9.0	0.09	0-15 cm	Stevens, et al., (1995)
Semi-improved	10.6	0.16	0-15 cm	Stevens, et al., (1995)
Semi-improved	19.2	0.10	0-15 cm	Stevens, et al., (1995)
M16	40.4		0-15cm	EGRO. (1996)
M23	36.2		0-15cm	EGRO. (1996)
M23		0.31-0.34	0-15cm	Blackstock *et al*., unpublished
M24	33.5		0-15cm	EGRO. (1996)
M24		0.19-0.35	0-15cm	Blackstock *et al*., unpublished
M25		0.30-0.72	0-15cm	Blackstock *et al*., unpublished
M26		0.66	0-15cm	Blackstock *et al*., unpublished
CG1	16.5	0.26	0-15 cm	Stevens, et al., (1995)
CG2	10.6-16.8	0.14-0.26	0-15 cm	Stevens, et al., (1995)
CG3 uncut for 23 yrs	11.5	1.68	0-5 cm	Wells & Cox, (1993)
CG3 cut once/yr	13.4	1.58	0-5 cm	Wells & Cox, (1993)
CG3 cut twice/yr	14.2	1.82	0-5 cm	Wells & Cox, (1993)
CG6	15.6	0.11	0-15 cm	Stevens, et al., (1995)
CG10	5.1	0.09	0-15 cm	Stevens, et al., (1995)
U4	7.0	0.07	0-15 cm	Stevens, et al., (1995)

Appendix table 4. N content (%) of cut dry matter from some semi-natural, agriculturally improved and fertilized grasslands

		cutting dates									
Community type	Fert. input	April	early May	mid-May	late May	early June	mid-late June	July	August	September	October
MG8[T] cut/grazed	0	2.40	2.30			2.00		1.30	1.40	1.20	
MG5[T] cut/grazed	0	2.40	2.50			2.10		1.40	2.30	1.50	
MG5/MG8[T] cut/grazed	0				2.34			1.60	1.46	1.55	
MG5/8[T] cut	0							1.46		2.28	
MG5/8[T] cut	200N75P200K							1.47		3.30	
MG13[K] cut	0						3.30				
MG13[K] cut	200N150P390K				3.78		3.68				
MG6/MG13[K] cut	0						2.36				
MG6/MG13[K] cut	200N150P390K				3.20		2.90				
MG5[Bratoft] cut	0							1.51			1.79
MG5[Bratoft] cut	inorg 40P							2.01			2.31
MG5[Bratoft] cut	inorg 44N4P52K							1.38			1.86
MG5[Bratoft] cut	org 88N8P104K12Mg							1.47			1.85
MG7[Ref] cut	150N33P62K	3.87	2.51	2.16	1.56	1.45	1.20				
MG10 grazed	0 (prev imp)			3.00			2.10	2.40		2.90	
MG10 grazed	120N,P&K			3.90			3.30	3.60		3.10	
M24 grazed	0	1.25		2.10		2.03	1.42	1.17	1.42	1.07	
M23 grazed	0	1.20	2.90			2.35		2.00	1.68	0.98	
M23 cut	0							1.61			
CG3 cut once/yr	0				1.45					1.89	
CG3 cut twice/yr	0				1.73		2.04				
CG3 cut thrice/yr	0				1.83		1.99	2.05			

[Key] = as in Appendix table 1

Appendix table 5. N yield (kg/ha) of cut dry matter from some semi-natural, agriculturally improved and fertilized grasslands.

Community type	Fert. input	Cutting dates April	May	June	July	August	September	October	Total
MG8^{T} cut/grazed	0	48.1	47.1	66.1	66.3	127.9	78.2		
MG5^{T} cut/grazed	0	59.3	46.3	64.3	90.1	170.1	78.6		
MG5/MG8^{T} cut/grazed	0		39.3		75.5	80.0	88.8		
MG5/8^{T} cut	0				55.3		21.8*		77.1
MG5/8^{T} cut	200N75P200K				101		115.1*		216.1
MG13^{K} cut	0			140					140.5
MG13^{K} cut	200N150P390K			339					339
MG6/MG13^{K} cut	0			193					193
MG6/MG13^{K} cut	200N150P390K		335	338					338
MG5^{Bratoft} cut	0				26.9			9.7*	36.6
MG5^{Bratoft} cut	40P				70.8			18.0*	88.9
MG5^{Bratoft} cut	44N4P52K				50.3			11.9*	62.1
MG5^{Bratoft} cut	88N8P104K12Mg				58.7			14.4*	73.2
MG6	48N21P59K	83	48	53	16	11	7	6	224
MG7^{Ref} cut	150N33P62K	35.2	103.8	121.5					
MG10 grazed	0 (prev imp)				55.6				
MG10 grazed	120N,P&K			153					
M24 grazed	0	27.7	23.1	52.5	27.6	29.6	16.2		
M16 grazed	0				47.9				47.9
M23 grazed	0	47.9	37.2	65.6	71.1	43	49.7		
M23 cut	0				95.7				95.7
CG3 cut once/yr	0		28.1						28.1
CG3 cut twice/yr	0		20.6	6.1*					26.7
CG3 cut thrice/yr	0		16.6	5.6*	2.7*				24.9

^{Key} = as in Appendix table 1, * = yield of regrowth

Appendix table 6. Phosphorus content (%) of cut dry matter from some semi-natural, agriculturally improved and fertilized gr

Community type	Fert. input	cutting dates April	May	June	July	August	September	October
MG8^{T} cut/grazed	0	0.13	0.15	0.12	0.10	0.10	0.1	
MG5^{T} cut/grazed	0	0.15	0.15	0.14	0.11	0.1	0.11	
MG5/MG8^{T} cut/grazed	0		0.13		0.11	0.12	0.12	
MG5/MG8^{T} cut/grazed	50N10P50K				0.11			
MG5/8^{T} cut	0				0.12			
MG5/8^{T} cut	200N75P200K				0.26			
MG5^{Bratoft} cut	0				0.14			0.14
MG5^{Bratoft} cut	inorg 40P				0.27			0.26
MG5^{Bratoft} cut	inorg 44N4P52K				0.13			0.15
MG5^{Bratoft} cut	org 88N8P104K12Mg				0.12			0.15
MG10 cut/grazed	0 (prev imp)				0.17			
M24 grazed	0	0.08	0.12	0.11	0.09	0.09	0.07	
M16	0	0.04	0.06	0.07	0.07		0.03	
M23 grazed	0	0.08	0.17	0.12	0.10	0.08	0.07	
M23 cut	0				0.07			
CG3 cut once/yr	0		0.1					
CG3 cut twice/yr	0		0.12	0.14				
CG3 cut thrice/yr	0		0.12	0.13	0.14			

^{Key} = as in Appendix table 1

Appendix table 7. Potassium content (%) of cut dry matter from some semi-natural, agriculturally improved and fertilized grasslands.

Community type	Fert. input	cutting dates April	May	June	July	August	September	October
MG8^{T} cut/grazed	0	0.70	0.86	1.07	1.27	0.59	0.43	
MG5^{T} cut/grazed	0	0.44	0.62	0.94	0.41	0.50	0.24	
MG5/MG8^{T} cut/grazed	50N10P50K				1.15			
MG5/8^{T} cut	0				0.63			
MG5/8^{T} cut	200N75P200K				1.35			
MG5^{Bratoft} cut	0				2.26			2.06
MG5^{Bratoft} cut	inorg 40P				2.39			2.41
MG5^{Bratoft} cut	inorg 44N4P52K				2.38			2.25
MG5^{Bratoft} cut	org 88N8P104K12Mg				2.51			2.28
MG10 cut/grazed	0 (prev imp)				0.91			
M24 grazed	0	0.30	0.90	1.48	1.04	0.52	0.62	
M23 grazed	0	0.35	1.27		1.24	0.74	0.34	
M23 cut	0				1.14	1.15		
CG3 cut once/yr	0		0.98					
CG3 cut twice/yr	0		1.05	1.00				
CG3 cut thrice/yr	0		1.18	1 15	1.10			

^{Key} = as in Appendix table 1

Appendix table 8. Calcium content (%) of cut dry matter from some semi-natural, agriculturally improved and fertilized grasslands.

Community type	Fert. input	cutting dates April	May	June	July	August	September	October
MG8^{T} cut/grazed	0	0.87	0.88	0.59	0.51	0.76	0.53	
MG5^{T} cut/grazed	0	0.79	0.63	0.58	0.45	0.56	0.5	
MG5/MG8^{T} cut/grazed	0		0.69		0.81	0.65	0.69	
MG5/MG8^{T} cut/grazed	0				0.73			
MG5/MG8^{T} cut/grazed	50N10P50K				0.57			
MG5/8^{T} cut	0				1.22			
MG5/8^{T} cut	200N75P200K				0.7			
MG5^{Bratoft} cut	0				0.84			1.28
MG5^{Bratoft} cut	inorg 40P				0.93			1.24
MG5^{Bratoft} cut	inorg 44N4P52K				0.67			1.20
MG5^{Bratoft} cut	org 88N8P104K12Mg				0.67			1.14
MG10 cut/grazed	0 (prev imp)				0.32			
M24 grazed	0	0.29	0.30	0.29	0.29	0.42	0.4	
M23 grazed	0	0.21	0.19	0.27	0 24	0.28	0.28	
CG3 cut once/yr	0		0.83					
CG3 cut twice/yr	0		1.02	1.52				
CG3 cut thrice/yr	0		1.13	1.56	1.85			

^{Key} = as in Appendix table 1

Appendix table 9. Magnesium content (%) of cut dry matter from some semi-natural, agriculturally improved and fertilized grasslands.

		cutting dates						
Community type	Fert. input	April	May	June	July	August	September	October
MG8[T] cut/grazed	0	0.18	0.25	0.27	0.2	0.25	0.18	
MG5[T] cut/grazed	0	0.22	0.27	0.28	0.22	0.3	0.19	
MG5/MG8[T] cut/grazed	0		0.23		0.23	0.22	0.2	
MG5/MG8[T] cut/grazed	50N10P50K				0.18			
MG5/8[T] cut	0				0.3			
MG5/8[T] cut	200N75P200K				0.27			
MG5[Bratoft] cut	0				0.18			0.22
MG5[Bratoft] cut	inorg 40P				0.22			0.23
MG5[Bratoft] cut	inorg 44N4P52K				0.16			0.21
MG5[Bratoft] cut	org 88N8P104K12Mg				0.16			0.21
MG10 cut/grazed	0 (prev imp)				0.12			
M24 grazed	0	0.12	0.13	0.16	0.16	0.16	0.18	
M23 grazed	0	0.06	0.1	0.12	0.12	0.1	0.1	
CG3 cut once/yr	0		0.13					
CG3 cut twice/yr	0		0.16	0.25				
CG3 cut thrice/yr	0		0.17	0.24	0.28			

[Key] = as in Appendix table 1

Appendix table 10. Sodium content (%) of cut dry matter from some semi-natural, agriculturally improved and fertilized grasslands.

		cutting dates						
Community type	Fert. input	April	May	June	July	August	September	October
MG8[T] cut/grazed	0	0.26	0.44	0.63	0.48	0.45	0.31	
MG5[T] cut/grazed	0	0.24	0.43	0.65	0.48	0.72	0.28	
MG5/MG8[T] cut/grazed	0				0.62			
MG5/MG8[T] cut/grazed	50N10P50K				0.41			
MG5/8[T] cut	0				0.60			
MG5/8[T] cut	200N75P200K				0.48			
MG5[Bratoft] cut	0				0.06			0.07
MG5[Bratoft] cut	inorg 40P				0.15			0.16
MG5[Bratoft] cut	inorg 44N4P52K				0.06			0.08
MG5[Bratoft] cut	org 88N8P104K12Mg				0.06			0.09
MG10 cut/grazed	0 (prev imp)				0.21			
M24 grazed	0	0.13	0.14	0.22	0.18	0.1	0.11	
M23 grazed	0	0.1	0.19	0.23	0.23	0.12	0.12	

[Key] = as in Appendix table 1

Appendix table 11. Metabolizable energy value (MJ/kg dry matter) of cut herbage from some semi-natural, agriculturally improved and fertilized grasslands.

Community type (NVC association)	Reference/source	Fertilizer input	early May	late May	early June	late June	July	August	September	October
MG5/8	Kirkham & Tallowin, (1995)	0		10.2			8.9		8.2	8.1
MG5/8	Kirkham & Tallowin, (1995)	0 (prev 200N,P&K)		10.5			8.3		7.7	7.9
MG5/8	Kirkham & Wilkins (1994)	0					7.5			9.7
MG10	Tallowin & Smith (unpub)	0 (prev imp)					7.9			
M23/M24	Tallowin and Smith, (1996)	0					6.5		6.1	
MG6/MG13	Korevaar, (1986)	0	11.3	10.5	9.6	8.7	8.6	8.4		

Average ME of permanent pastures at 16 sites in the UK over 4 yr period receiving either 0N or 150N was 10.9 at 4 weekly cutting
Average ME of permanent pastures at 16 sites in the UK over 4 yr period receiving 300N was 11.0 at 4 weekly cutting
Average ME of perennial ryegrass leys at 16 sites in the UK over 3 yr period receiving 0N was 11.1 at 4 weekly cutting
Average ME of perennial ryegrass leys at 16 sites in the UK over 3 yr period receiving either 150 or 300N was 11.2 at 4 weekly cutting

Average ME of permanent pastures at 8 sites in the UK over 4 yr period receiving 0N was 10.3 at 8 weekly cutting
Average ME of permanent pastures at 8 sites in the UK over 4 yr period receiving either 150 or 300N was 10.2 and 10.4, respectively, at 8 weekly cutting
Average ME of perennial ryegrass leys at 8 sites in the UK over 3 yr period receiving either 0 or 150N was 10.7 at 8 weekly cutting
Average ME of perennial ryegrass leys at 8 sites in the UK over 3 yr period receiving 300N was 10.6 at 8 weekly cutting
Average ME of perennial ryegrass =white clover leys at 8 sites in the UK over 3 yr period receiving 0N was 10.6 at 8 weekly cutting