INTRODUCTION OF NATIONALLY UNIFORM FEEDING STANDARDS FOR LIVESTOCK

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It was long recognised by educators, nutritionists and producers that among the many feed evaluation systems in use, none was totally satisfactory. Work to establish within Australia one that could be more widely accepted has proceeded at scientific and official levels, and was discussed at the 1978 Conference of this Society.

An Expert Panel on Australian Feedstuffs was set up by Animal Production Committee (APC in J'uly 1974. In 1978 it recommended:

(a) national adoption of the following primary standard measure of energy value for ruminant and poultry feeds - "megajoules of metabolisable energy (ME) per kilogram of dry matter, as measured at maintenance plane of nutrition in each species of animal";

(b) use of the British ME System as the basis for formulating advisory material on livestock feeding.

These recommendations were endorsed by APC together with a proposal by the Convener of the Expert Panel (N.McC. Graham) and the Director of the Australian Feeds Information Centre (T.F. Leche) that a national committee be formed to implement them. The Standing Committee on Agriculture (SCA) at its 116th meeting in January 1979, following receipt of the APC recommendations, agreed to the establishment of a Working Party for Introduction of Nationally Uniform Feeding Standards for Livestock (INUFSL) with the following terms of reference:

"(a) to. implement feeding systems for ruminants and poultry based on ME;
(b) to seek extension of these systems to pigs;
(c) to develop corresponding standards for protein
(d) to seek standards of analytical methods for feeds in /these connections/ "

The membership of the INUFSL Working Party established in 1979 is:

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T.F. Leche, CSIRO, Division of Animal Production, Technical Secretary
E.F. Annison, University of Sydney
J.L. Corbett, CSIRO, Division of Animal Production, Armidale
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It has commenced work, evolved its *modus operandi* and appointed four specialist Sub-Committees, charged to prepare reports on feeding standards for the major animal species groups and analytical techniques. The conveners are:

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Feeding Standards for Poultry Sub-Committee D.J. Farrell
Feeding Standards for Pigs Sub-Committee E.F. Annison
Standardization of Analytical Methods Sub-Committee D.J. Minson

The Sub-Committees are consulting widely. It is the definite objective of the Working Party to have their reports published as soon as possible after receipt and approval by SCA. These should provide material that is relevant locally, scientifically sound yet suitable for teaching and practical use, and that will highlight areas of research and development requiring special attention.

The INUFSL Working Party is collaborating closely with the Australian Feeds Information Centre including possible involvement in South East Asia. The Animal Production and Health Commission for Asia, the Far East and South-West Pacific has indicated interest in the project and is to be kept informed on progress. The Australian publications may also find wide application in South East Asia. Close liaison has been established with international bodies with comparable objectives, including the Agricultural Research Council of the UK and the National Research Council of the U.S.A. Progress reports of the Sub-Committees follow.

FEEDING STANDARDS FOR RUMINANTS

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The development of feeding, standards has occurred primarily where livestock industries are heavily dependent on economical purchase and use of feeds. Important sections of Australian ruminant livestock industries, dairying and specialised cattle and sheep meat production are in this situation,' and generally there is a continuing trend towards intensification of management and an increasing need for quantitative nutritional information. In pastoral production enterprises, effective and financially sound nutritional management of flocks and herds to improve their performance, or for their survival in drought, depends on- knowledge of animal requirements and how various feeds meet these. This knowledge is also necessary in longer-term planning and budgeting of the enterprises (e.g. Rickards and Passmore 1971) which involves assessment of the varying demands for feed by various classes of animals, of feed supply patterns, and of strategies such as fodder conservation, forage cropping; and usage of supplementary feeds, fertilizers, and irrigation.

Radcliffe (1978) pointed out that "the adoption of a uniform ME (metabolisable energy) feeding system within Australia would encourage greater

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communication, and understanding . . . between educators, research workers, advisers and farmers", and encourage more additions to and use of the data bank of the Australian Feed Information Centre. These are important objectives, and the State Departments of Agriculture have already made considerable progress in the formulation and publication of feeding standards based on ME. This paper outlines development of the work to underpin and promote that progress.

PROBLEMS IN THE DEVELOPMENT OF FEEDING STANDARDS

Every system of feeding standards comprises simplifications of biological complexities which reflect the current extent of knowledge, vary in type and degree with the type and intensity of livestock production being serviced, and vary with the precision required and attainable in practical nutritional management. The approximations and generalizations made in a system for Australia will therefore differ to some extent from those made overseas, but they must be specified and must not impede progressive development of the system as further knowledge accrues.

Much relevant information can be taken from the detailed reviews in the overseas publications on feeding systems, but their primary purpose is to assist the livestock industries in the countries of origin and particularly those that employ intensive hand-feeding. These publications do not deal adequately with a number of matters of crucial importance in pastoral production, nor with major nutritional problems encountered in Australia including sustained and recurrent periods of undernutrition, requirements for wool production, and the variety that occur with tropical and other breeds of cattle grazing native or improved tropical pastures. Consequently, while bases of overseas feeding system can be adopted here, it is necessary to evolve a system to meet the needs of our own livestock industries.

Feed intake

For realistic formulation of cations in hand-feeding it is necessary to know what an animal could eat before determining what it should eat to attain a desired level of production. Equations for predicting maximum dry matter intakes by various classes of livestock given feeds of various qualities are published by MAFF (1975), INRA (1978) and ARC (1980); choice among these will depend on experience from their use.

The framework adopted for predicting herbage intakes by grazing animals is the model of Christian et *al.* (1978). Essentially, the intake by any particular class of animal is expressed as a potential intake which is reduced variously according to a range of characteristics of the pasture being grazed. Intake within a class of animals is related directly to live weight (W) rather than $W^{0.75}$. Intake is also related directly to plant maturity (metabolisability) over its whole range, an assumption supported by the weight of evidence (Hodgson 1977). Pasture characteristics to be defined include herbage mass (kg/ha) and its spatial distribution which, as shown by Stobbs (1973), affects bite size and in consequence daily intake, its botanical composition, and the division of total herbage into digestibility classes. Vickery *et al.* (1980) have developed an inexpensive electronic capacitance meter, simple to use, that measures pasture dry matter (DM) and can measure yields by strata within the canopy. It makes possible the standardisation of measurements of herbage mass. These are at present made by a variety of means, including visual and harvesting to a variety of stubble heights, so that it is difficult to make comparisons between and generalise from relationships of intake to herbage availabilities reported by different workers. In practical use by advisers and graziers the instrument would assist quantitative assessments of pastures on a regular basis.

There is need for more information on intakes, especially from tropical areas, in association with appropriate, standardized, measurements of the pastures. Increasing knowledge of animal requirements is increasing the reliability of indirect information: intakes predicted from the observed live weights and performance of the animals. Predicted intakes have then to be assessed in terms of the quantities of energy and nutrients yielded to the animals and compared with their requirements to determine the extent of, and possible means to correct, nutritional inadequacies.

Energy

(i) Feeds The number of direct determinations of the ME of feeds (MEF, MJ/kg/DM) is steadily increasing (e.g. RRI 1975, 1978), allowing refinement of prediction equations, and there is no evidence that equations used overseas are inappropriate for Australian feeds. Predictions can be made from digestible proximate constituents (Weende) but these should not be determined simply to allow use of such equations. If only the Weende analyses are available for a feed, equation (6) of van Es (1978) is recommended rather than equation (2) in MAFF (1975), especially if digestibility values from sheep are applied in cattle feeding. Other analyses are more useful generally. There are reliable methods for predicting MEF from the digestible organic matter (DOM) content of dry matter determined *in vitro* (DOMD), and this and other variables are used to predict MEF in equations from RRI (1975, 1978) with residual SD of about ± 0.4 MJ. The relationship ME=0.81 (digestible energy) applies generally to fresh and dried fodders, including the sub-tropical species that have been examined (Graham 1967). Its derivative, MEF=0.15 DOMD% (MAFF 1975), will yield values sufficiently accurate for many circumstances; van Es (1978) presents similar equations and another that (or an alternative from RRI 1978) should be used for silages. The various grains each appear to have rather constant MEF (RRI 1975, 1978), though with the possible exception of oats. The MAFF (1975) equation (0.16 DOMD%) can be used for these and related feeds, but when grains are given whole and there is a loss in faeces (Toland 1978) predicted MEF will be greater than the actual values to the animals and should be discounted.

(ii) Animal requirements The maintenance requirements of housed animals are rather well-defined and have been simply related to W by MAFF (1975). The animal at pasture has additional requirements for its activities in grazing and for response to ambient temperatures below critical; heat stress may also increase requirement though a major effect will be a reduction in feed intake. The increments have been assessed factorially from information on the duration of standing, grazing and ruminating, and distances walked on the level and in ascent, combined with knowledge of the unit costs of these various types of work (e.g. Graham 1966). There has also been direct estimation in the field. Some of the results obtained by regression of intake on W and change in W, to give DOM (or ME) for constant W, have indicated maintenance requirements two or more times greater than for housed animals with similar body condition, but these are now known to be in error (Corbett 1980). Other results from this approach and from calorimetric measurements (e.g. Corbett *et al.* 1980), have shown good agreement with factorial estimates and in general indicate increments of around 50% for animals in extensive grazing conditions, not cold-stressed. There is, however, a serious lack of information from tropical areas, and there has to be systematic study of the activities and energy expenditures of cattle and sheep grazing in a wide range of defined conditions to increase confidence in and informed use of factorial estimation which is the chosen method for determining maintenance requirements.

Information on the energy content of cow and ewe milk is reliable, and that for the products of conception is adequate, though it should be noted the ME allowances of MAFF (1975) for pregnant ewes are insufficient (Russel *et al.* 1977; Corbett *et al.* 1980). Fortunately a major part of the information available on the energy content of the sheep body has been contributed by workers in Australia. There are problems in defining the energy of body gains including compensatory gains of various classes of sheep and of the energy lost as W decreases, though for cattle as well as sheep the present evidence indicates an efficiency of 0.8 in the use of the energy of catabolised tissues. The information for cattle on energy in the body and in gains is less, satisfactory. There is little for *Bos indicus* breeds, and the values vary substantially between dairy breeds such as Friesian, 'traditional' beef breeds such as Hereford, 'new' breeds such as Charolais, and among these between bulls, castrates and females (cf INRA 1978; ARC 1980). Pending the outcome of the work in progress, energy values of body gains of sheep and cattle can be estimated as by MAFF (1975).

(iii) Conversions This section is a discussion of some of the 'rules' for expressing animal requirements in the same terms as feed values. Values for metabolisability (MEF for feeds, or M/D in the same units for rations) are for the maintenance level of feeding (L=1), and MAFF (1975) does not reduce these . for greater L. Compared with the common range of feeds in the UK, the quality of Australian feeds varies more widely, and reductions in metabolisability are greatest at low MEF or M/D (Blaxter 1974) especially'when these values are 8 MJ/kg/DM or less as with poorer quality roughages. On the other hand the voluntary intake and possible range in L for these feeds is rather small, and adjustment for L may be unnecessary. For dairy cows, van Es (1978) reduces M/D by 1.8% per multiple of the maintenance feeding level.

Blaxter (1974) has foreshadowed the adoption by ARC (1980) of a new set of equations for predicting the net availability of ME to the animal for maintenance (km) and growth and fattening (kf). The value of km varies directly with M/D which is a particularly important matter for drought feeding. There are separate equations for predicting k_f for (i) pelleted feeds, (ii) first growth forages, (iii) aftermath forages and (iv) mixed diets of roughage plus concentrates. The present view of the Sub-Committee is that (ii) should be used only for temperature legumes and that (iii) should be used for all grasses, fresh or conserved, temperate and tropical, and for tropical legumes. MAFF (1975) adopts a constant 0.62 for net availability of ME for milk production (kl). Dairy cows in Australia may have to be given poorer quality feeds than those normal in UK rations, and equation (14) of van Es (1978) predicts k_l varying from 0.56 to 0.63 for M/D of respectively 7.4 to 13. It is considered that the realities of dairy farming here can warrant the use of variable k_l.

Protein

Digestible crude protein is a grossly inadequate measure of the protein value of feeds. It is being superseded by systems that take account of' degradation of protein in the rumen, of the efficiency of microbial protein synthesis and the direct link with dietary energy supply, of the digestibility in the small intestines of the quantities of microbial plus undegraded dietary protein predicted to flow from the stomach, and of the efficiency of use of absorbed amino acids by the animal. Systems of this type are described by Roy et *al.* (1977) and Verité *et al.* (1979), and in these, constant factors are used to predict the outcome of complex interactions among the nitrogenous and energy yielding substrates and other components of feeds and their rates of degradation and outflow. In addition, the profile of amino acids absorbed is ignored and the nitrogen in the total is assumed to be used by the animal with constant 0.75 efficiency; this is unlikely to be valid in, for example, production of wool.

The protein nutrition of ruminants was discussed by the Sub-Committee jointly with a number of those in Australia expert in this subject. It was agreed that efforts should be made to establish a protein feeding system that inherently is interactive, and that the dynamic model of Black *et al.* (1980) is an appropriate basis for such development. Detailed information is required on matters such as the potential degradability and rate of degradation in the rumen of various chemical components of diets, and fractional outflow rates of these and fermentation products. Dr. Minson, Convener of the Standardization of Methods Sub-Committee, is coordinating definition of methods of measurement.

Drought and supplementary feeding

To minimise the cost of drought-feeding, the greatest possible precision is required in the definition of feed values, including allowance for variation in k_m, and of animal requirements including variation between breeds and the possibility of defining the decline in basal metabolic rate with progressive undernourishment and so a safe progressive reduction in energy allowance. Better definition of feeding standards in general 'will assist feeding for production rather than just survival during drought, when the economic climate is favourable, and there is the possibility that special feeds can be devised to increase wool production from maintenance rations.

A major problem in drought feeding and supplementary feeding is that while the average response of animals in a group can be defined, there is usually great variation in individual intake, and there is need to establish means of minimizing this. Reliable definition of the type of supplement (energy, protein or non-protein nitrogen, mineral, vitamin) that would improve the performance of grazing animals is dependent on knowledge such as discussed above. Definition of the quantity required must recognize that with a pasture diet its effect is rarely additive. If it makes good a specific nutrient deficiency, herbage intake will be increased. More often it is reduced to an extent that varies with the quantity and quality of herbage available and type of supplement. This substitution effect is included in the 'Fill Unit System' for predicting intake of INRA (1978). There is need for further definition from direct studies of intake and digestion (e.g. Ørskov 1979), and by back-calculation from the observed performance of animals to what was their probable total feed intake and the change in herbage intake effected by supplementation.

GENERAL

There is space only to mention that other topics being studied include major and trace minerals, and water: quantities required, effects of salinity and temperature, and distances between watering points. Feeding systems have a long history; their extension to pastoral production is relatively recent and is both cause and effect of the development of techniques for definition of the nutrition of grazing animals. Systematic definition is hampered by, but will promote work to diminish, the many gaps in present knowledge. The rapid development of programmable calculators and computing facilities is allowing increasing use of these in practical application of a feeding system, but the system must be used with understanding of its bases which must be conceptually and scientifically sound.

FEEDING STANDARDS FOR PIGS

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In the development of uniform feeding standards for pigs, the paucity of Australian data will inevitably result in considerable reliance on overseas standards. The most comprehensive of these form the U.K. Agricultural Research Council's (ARC) recommendations first released in 1967 and now under revision. The final recommendations of the Working Party should take into account the revised ARC report, which is expected in 1981. There are several aspects of Australian pig production not covered by ARC recommendations, and we are concentrating on the collection and collation of data on these.

REQUIREMENTS

It is probable that the application of overseas feeding standards will be affected by the following considerations.

(i) Strain of pig The Australian herd has been virtually closed for some 20 years, although limited importation of new stock may occur shortly. In recent years herd improvement schemes, based on performance selection, have been undertaken by the larger, intensive production units, and may have resulted in the development of strain differences between Australia and elsewhere. It is unlikely, however, that the genetic improvement has been as great as that achieved by national projects in countries such as Denmark and the U.K.

(ii) Boar meat Production and marketing of meat from entire males has been widely adopted in Australia, in contrast to many overseas countries where it is prohibited. Standards for boars have to be developed.

(iii) Marketing of superporkers The gradual adoption of the superporker concept in Australia, which requires the marketing of a carcass of approximately 65 kg dressed weight with a defined depth of back fat, means that specific feeding standards may have to be developed.

(iv) Environmental factors Pigs are produced under a wide range of environmental conditions in Australia, and many production units experience

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heat stress during summer. High temperatures are known to depress feed intake, and feed conversion efficiency may also be adversely affected. The effect of high temperature on carcass quality is not well defined, although reduced feed intake in heavy pigs would be expected to reduce fat deposition.

There is a need to determine the extent to which high ambient temperature and humidity affect performance according to breed, sex, age and feeding level. This will permit nutritional and management practices to be established which minimise the effects on pig performance. So that we can assess the effect of these factors on the applicability of overseas feeding standards in Australia several members of the Intensive Pig Producers Association have kindly agreed to make their production data available to the Sub-Committee.

METHODS OF EXPRESSING NUTRIENT CONTENT OF FEEDSTUFFS

Energy

The Working Party has recommended the adoption of digestible energy (DE) as the unit of energy for pigs. We believe that DE is more suitable than metabolisable energy for the reasons outlined by Farrell (1978). We have been advised that the revised ARC recommendations for pigs will be based on DE.

We are collating the information available on the DE content of Australian feeds. Preliminary indications are that there is little effect of variety or environmental conditions on the energy content of barleys, sorghums or 'wheats (Table 1). Greater variation exists for weather-damaged wheats, wheat by-products and meat-and-bone meals and for these regression equations relating variation in DE to chemical composition will be developed.

TABLE 1 Digestible energy content (MJ/kg) dry matter of Australian feeds

Feed	No. of observations	Digestible energy content Mean	Range
Barley	8	14.3	13.9-14.6
Sorghum	8	16.5	15.7-17.1
Wheat - normal	8	16.2	15.7-16.9
- weather-damaged	8	16.2	15.0-17.2
Wheat by-products - brans	3	13.9	12.7-15.8
- mill runs	2	13.7	13.3-14.1
- pollards	3	15.0	13.8-16.3
Meat-and-bone meals	14	12.1	10.1-15.0

Source: Batterham, unpublished data.

Amino acids

The revised ARC recommendations on amino acid allowances will be based on the system of the maintenance of a balance of amino acids relative to the lysine level, as recommended by Cole (1978). We endorse this approach, but realise that separate recommendations for lysine requirements will have to be made for boars, castrates and gilts in Australia.

There is evidence that free amino acid supplements are incompletely utilized under once daily feeding systems. While the economic implications of this are likely to decline as the Australian industry adopts more liberal feeding standards, there is a need to ensure that measurements of amino acid requirements are conducted under conditions that ensure full utilisation of supplemental free amino acids. Many of the current overseas estimates for amino acid requirements may be over-estimates as a result of inefficient utilization of the test amino acid used to determine the dose response curve.

The adoption of a standard definition of amino acid availability which includes the potential for digestion, absorption and utilisation is strongly recommended (McNab 1979). This definition implies that availability can only be determined by bioassay in situations where the test amino acid is limiting. A suitable procedure is the slope-ratio assay with growing animals (Carpenter 1973). Batterham *et al.* (1979) have applied this method to a number of protein concentrates in the pig, and shown that the availability of lysine is low in some instances (Table 2). This finding has economic implications for the Australian pig industry since lysine is normally the first and major limiting amino acid in diets for growing pigs. Current information on the total and available amino acid content of Australian feeds will be collated.

TABLE 2 Availability of lysine in protein concentrates.

Protein concentrate	Availability of lysine percent
Cottonseed meal	43
Fish meal	89
Meat-and-bone meal	49
Skim-milk powder	85
Soyabean meal	84

Minerals and vitamins

Data on the mineral and vitamin content of Australian feed ingredients will be collated, and the need for the supplementation of diets reviewed.

FEEDING STANDARDS FOR POULTRY

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The Sub-Committee on poultry has adopted many of the recommendations in the publications of the British Agricultural Research Council (ARC 1975) and the National Research Council of the United States (NRC 1977). Areas that have been inadequately covered, or topics that need to be revised or expanded to include special conditions in Australia, will be considered. Some of these are discussed here.

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ENERGY

The metabolisable energy (ME) system currently in use (Farrell 1978a) is endorsed although the potential value of a net energy system should be explored. It is well established that breeds and strains of broiler chickens and laying hens adjust intake according to the energy concentration of their diet and McDonald (1978) has derived a number of equations that predict the daily ME requirements of layers for various genotypes and environments. Dietary formulation should be adjusted to allow adequate intake of essential nutrients when feed consumption is reduced in response to high temperature. This area is being considered in detail.

There is the continuing need to measure the ME of feedstuffs used by the Australian feed industry. Cereal grains, with the exception of wheat (Mollah *et al.* 1979) and those off-grade, appear to have similar ME to those reported in the literature and deviation about the mean value is generally small. On the other hand the wide range of protein concentrates available to the Australian poultry industry and their large variation in quality and composition, indicates a need to provide ME values of these ingredients. Where possible, determined ME values should be related to easily measurable chemical fractions such as ash, fat, protein and fibre so that useful prediction equations can be calculated (Janssen 1976).

It is difficult to recommend a procedure for determining the energy content of poultry feedstuffs but the values generated will then be standard values for Australia. The True Metabolizable Energy (TME) system (Sibbald 1976) is being adopted in some countries. The advantages of this method, based on starving and force-feeding adult cockerels about 30 g of a single ingredient, are that it is rapid and removes much of the variation in the 'apparent' ME of a feedstuff due to endogenous excreta, the amount of which is probably'characteristic of each bird. In a modified method (Sibbald 1977) the mean endogenous excreta of six starved adult cockerels is used to correct the excreta energy of each of the test birds. Thus much of the advantage of the original TME method is lost in that a constant value is now used to correct for what is generally recognised to be a variable. Another equally rapid method of determining ME has been developed (Farrell 1978b); this is still in terms of 'apparent' ME, but because endogenous excreta are inseparable from total excreta and may be characteristic of the bird and of individual feed ingredients, it may be unwarranted to attempt to separate these two components. A rapid method will be favoured by this Committee, when one has been satisfactorily tested.

PROTEINS AND AMINO ACIDS

The Sub-Committee accepts the ARC (1975) recommendations with some qualifications. For example, Guirguis (1977) demonstrated the importance of providing birds with a balanced intake of essential amino acids (EAA) irrespective of the protein level of the diet. Under these circumstances a starter diet of 18% crude protein and a finisher diet of 16% is adequate. Furthermore Guirguis (1978) showed the importance of providing adequate amounts of non-EAA. This requirement, like that of the EAA varied with the age of the chicken. The EAA requirements of the laying hen because of genotypes used in the Australian egg industry, are less certain. With the exception of methionine and cystine, requirements appear to be in general agreement with the ARC (1975) requirements particularly for lysine (McDonald 1979). Little work has been published here on the amino acid requirements of broiler breeder hens, but for commercial layers amino acid allowances should be in g/d rather than as concentration in the feed to account for variation in the feed intake caused by different temperatures. There is the need to determine availability of amino acids in feedstuffs and particularly in protein supplements.

MINERALS

(i) Molybdenum Two conditions that occur sporadically in Australia are femoral degeneration and scabby hip syndrome in broilers (Payne and Bains 1975), and poor hatchability characterised by a high incidence of weak chicks with clubbed down and long ginger hairs (Payne 1977) attributed to molybdenum deficienc (Nell *et al.* 1979; Nell and Annison 1980). These syndromes have not occurred in broiler chicks on diets containing only 0.03 mg molybdenum per kg. Thus requirement appears to be similar to that recommended by the ARC (1975) of 0.02 mg/kg; levels above about 250 mg/kg are toxic.

(ii) Calcium and phosphorus Because of the heavy reliance on meat and meat and bone meal in Australian poultry diets, little attention has been paid to minimum requirements for Ca and P, but rather to the effects of high levels of these minerals on performance. McDonald and Solvyns (1964) observed a depression in weight gain of chicks to four weeks of age on diets containing 1.36 g Ca/MJ ME, although Connor and Neill (1971) found no such effect on diets containing up to 1.29 g Ca. During the latter part of growth, the Ca requirement of pullets is delicately balanced. Karunajeewa (1977a) observed that birds on starter and grower diets containing 1.45 and 1.93% Ca respectively, tended to lay fewer eggs and with thinner shells than pullets reared on diets with lower Ca levels. In contrast, the rate at which pullets retain dietary Ca increases greatly two to three weeks before laying, and it is important therefore to ensure that the dietary concentration of Ca is sufficient to meet these increased requirements. During the laying phase the requirement for Ca is somewhat less for maximum egg output than for maximum shell thickness. The actual requirement will also depend on the content and source of P. Connor and Barram (1972) calculated that optimal egg shell quality is achieved with a Ca:P ratio of 6.3:1. Karunajeewa (1977b) maintained that shell quality is better when hens are fed diets based on plant proteins and containing additional Ca supplements than when based on meat and bone meal. Data from-here and overseas suggest that the ideal layer diet should provide a daily intake of 3.8 g *Ca* and 0.6 g P. However, birds at peak lay may not obtain these amounts when high temperature depresses feed intake.

(iii) Selenium Selenium is sometimes extremely low in grains (0.01 mg/kg, Nell 1976) in certain areas of New South Wales and Queensland; a case could therefore be made for its inclusion as selenite in Australian poultry diets. Analysis of feedstuffs provides a guide only, since availability of feed ingredients varies widely. Bains *et al.* (1975) described muscular dystrophy in broiler breeder hens and a small percentage of chickens hatched from the affected flock showed symptoms characteristic of a Se deficiency. However the Committee has insufficient data at present to recommend Se inclusion in 'poultry diets. .

BIOTIN; ESSENTIAL FATTY ACIDS

The ARC (1975) concluded that biotin was so widely distributed in feeds that a deficiency in commercial diets was unlikely. However, since 1974 a number of reports have indicated that biotin deficiency is a major contributing factor in the development of fatty liver and kidney syndrome (FLKS) in Australia (Payne *et al.* 1974). Although many diets contain reasonable amounts of biotin, much of it is probably not available to the birds (Frigg 1976). Broiler chickens are more susceptible to FLKS than are commercial layer pullets. As a consequence it is recommended that all broiler diets should be supplemented with 0.1 mg biotin/kg irrespective of the biotin content of the ingredients. The ARC recommended a total dietary allowance for broilers of 0.15 mg/kg but in view of the previous discussion, further work on factors that reduce biotin availability in feeds is needed.

Essential fatty acid requirements are normally expressed in terms of linoleic acid; the ARC (1975) indicated a requirement of 10 g/kg of diet for growing birds, and 12 g/kg for laying hens. Typical Australian diets based on wheat, sorghum and meat meal can fail to meet the bird's daily requirement. An increase in egg weight of about 1 g may be expected when the linoleic acid content of the layer diet is supplemented to the requirement level of 12 g/kg (Balnave, pers. comm.). Further increases sometimes can be obtained by higher supplementation. The major importance of this nutrient lies in the maintenance of maximum egg size.

GENERAL

A major requirement in the poultry industry is for procedures to evaluate the biological availability of some nutrients in feedstuffs and particularly the availability of amino acids in protein sources such as meat meals and oil seed meals. Effects of high temperature on the production of broilers and layers are a seasonal problem and means of minimising these effects by dietary manipulation and other means are of high priority. Methods of controlling the feed intake of broiler breeder hens and decision on the amounts of feed they should be offered, before and during the various phases of the laying cycle, are of concern. Finally, the ME system can be viewed as an interim measure; the ultimate aim is to consider feed allowances and requirements of poultry in terms of net energy. .

CONCLUSION & ACKNOWLEDGEMENTS

Progress will be reported to future meetings of the Society, and elsewhere. The four authors thank their colleagues in the APC Working Party and its Sub-Committees for their continuing major contributions to the work they describe. They thank also many people in Australia and overseas for their generous assistance which will be properly acknowledged in the publications on feeding standards. The contribution of Mrs. Judy Bartlett and Mrs. Wendy Hyson in manuscript coordination and preparation is gratefully acknowledged.

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