

PERSPECTIVES OF ANIMAL NUTRITION RESEARCH IN AUSTRALIA

by A.R. EGAN *

Summary: A survey was made of 565 papers published in scientific journals by Australian research workers over the period 1971-76, and of reports of CSIRO Divisions, Departments of Agriculture, and other research Institutions. From this, new directions and current advances in research in animal nutrition in Australia are analysed.

Drawing inspiration from the general analysis of the nutritional research effort in the U.K. as made by a joint ARC/MRC Committee reporting in 1974, an attempt is made to examine the areas in which animal nutrition research in Australia has its strength and weaknesses, and to relate these to patterns of research activity in other countries. In particular, attention is given to evidence that animal nutrition research in Australia needs to become or, in some instances, is becoming more integrative in adopting and applying the diverse techniques of the physiologist, the biochemist, the clinician, the epidemiologist, the behavioural scientist, the statistician and the mathematician.

INTRODUCTION

The primary objectives of this paper are to describe the scope and to identify the focal points of current research in animal nutrition in Australia. To do this would be a sterile descriptive exercise were excursions not made into some comparisons, projections, predictions and criticisms. In this way a fuller perspective view may be created of the aims which guide the research, the bodies which sponsor or direct research, and the more personal factors which lead individual research workers to adopt particular approaches to their enquiries. Consequently, this paper presents firstly, a statistical summary of recently published papers, subdividing these into a variety of categories; secondly, an analysis of the dominant areas of research, attempting to offer reasons for their popularity, and reasons for lack of effort in, or avoidance of, other areas; and thirdly an examination of the strength and weaknesses of the research drawing parallels to the recommendations, predictions and comments made in an excellent analysis of Food and Nutrition Research in the United Kingdom, published by the ARC/MRC Joint Committee in 1974.

Thus it is hoped to develop answers to some of the following questions.

1. What research in animal nutrition is being pursued?
2. Can foci and vectors of research growth be identified?
3. How well does research cover the field of animal nutrition in both breadth and depth?
4. How much research effort is directed expressly to local problems?
5. How far does the international research effort contribute to solution of nutritional problems in Australian animal industry?
6. How far does the Australian research effort contribute to the international field?

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7. What relationships are there between the developments, or the needs for development, in animal nutrition and human nutrition?

SURVEY OF THE SOURCES OF INFORMATION

In research for this paper a range of sources have been studied covering the period 1970-76. This included 13 internationally recognised scientific journals, proceedings of conferences of 8 societies receiving communications on aspects of animal nutrition, and annual reports of CSIRO Divisions, Departments of Agriculture, Universities and other research Institutions. A list of the sources is given in place of a bibliography.

Generally, nutrition research appears to be directed either towards the study of a particular nutrient and the way in which variation in its supply affects a process in the animal, or towards the study of a process or a problem of poor animal performance, and an assessment of the role of nutritional environment in this. These two attitudes lead to a diversity in research activity which is important, and the publications have been classified on both types of basis.

In the analysis of the subject matter area dealt with in 565 scientific publications (Tables 1 and 2), no comparison is made to the parallel distribution of papers from research workers in other countries. However, it will be clear that research overseas is often concentrating in the same or closely related specific areas.

TABLE 1. Numbers of scientific papers published by Australian nutritional research workers (1970-76) divided into major emphasis areas classified according to the dominant function or process studied

Function of Primary concern	Non Ruminant	Ruminant		Totals
		Penned	Grazing	
Behaviour	4	7	12	23
Digestive Physiology	14	74	7	95
Metabolism	17	53	8	78
Growth	32	57	46	135
Body Composition	13	24	9	46
Reproduction	11	27	24	62
Lactation	0	9	12	21
Wool	-	14	14	28
Clinical/Diagnostic	0	18	9	27
Technique/Method	7	17	8	32
Modelling	0	12	6	18
Totals	98	312	155	565

Areas of greatest intensity of publication have been ruminant nutrition, particularly in digestive physiology and quantitative intermediary metabolism. Studies on growth, with increasing emphasis on body composition, have shown a renewed interest expressed in both ruminants and non-ruminants. Much of the work has centred on energy and protein utilization, but the digestion and metabolism of minerals and the effects of minerals in reproduction received considerable support. Areas of

research yielding few contributions were the effects of nutrition on lactation, the behavioural aspects of nutrition, and studies on vitamins (other than vitamin B₁₂/Cobalt). There was some evidence of a strengthening of publication in the areas of diagnosis and clinical tests for nutritional disorders, and increasing reference to detection of sub-clinical or "marginal" nutritional disorders. Particularly in ruminants, attempts to express quantitatively the dynamics of nutritional effects through models of growth or of digestive and metabolic processes are steadily increasing.

TABLE 2. Numbers of scientific papers published by Australian nutritional research workers (1970-76), divided into major emphasis areas classified according to the nutrient or class of nutrients studied

Nutrient Class of Major Concern	Non Ruminant	Ruminant		Totals	
		Penned	Grazing		
"Feed"/Energy	37	108	72	217	
Fibre	4	25	2	31	
Protein, Amino Acid, N	38	92	44	174	
Minerals	10	60	31	101	
Vitamins	4	14	6	24	
Interactions	5	13	0	18	
	Totals	98	312	155	565

Specific papers on methodology and techniques in research, together with the description of techniques and approaches to measurement as detailed in other papers, provided a clear picture of the extent to which technical limitation, particularly in studies on grazing ruminant nutrition, directs research away from particular areas repeatedly identified as "needing more work".

Of course, the numbers of papers reflects both the intensity of research effort, and the literary creativity of individual authors. Some heavily subscribed areas contain numerous papers by one group of authors on one subject, and may poorly reflect the effort and expenditure in that area of research. By contrast, some papers published in apparently "under-subscribed" categories can be predicted to be classical "seed" papers which will lead to a whole new avenue of developments. Often the objectives and the relevance or context of individual published contributions are seen only when the reports of the various research institutions are read through.

AREAS OF STEADY CONTINUING EFFORT

In many cases the ongoing research activities arise from needs of animal industries, and have strong support in Departments of Agriculture. Only a limited proportion of these studies reaches publication in scientific journals, and reports are often restricted to internal reports or extension bulletins. Such areas include:

- (1) Evaluation of efficiency of use of conventional feedstuffs for survival, growth, reproduction or lactation.
- (2) Evaluation of alternative feed components in rations

- (2) (cont.) particularly for intensive production. Unconventional feedstuffs such as poultry litter for ruminants draws increasing attention.
- (3) Techniques in quality control in feed processing.
- (4) Feedstuffs and strategies of their use in supplementary feeding in field conditions.

While these studies contribute in practical terms to nutrition of animals in housed conditions and in the field, they have also been the commencing point for more detailed studies of processes in feed preparation and in animal use of nutrients. Thus biochemical, physiological and clinical studies have developed in these areas and constitute a large bulk of the papers published, even though these may individually appear to relate poorly to the more immediate needs of animal industries.

AREAS POORLY COVERED IN RESEARCH PUBLICATION

While occasional papers or reports refer to studies in the following areas, they are, by and large, somewhat neglected fields in the overall Australian nutrition research pattern:

- (1) Effects of nutrition on behaviour patterns.
- (2) Specific diagnostic aids in detecting nutritional problems, (though these are increasingly referred to in Department of Agriculture Reports). Blood metabolites, enzymes and urine components are commencing to be more commonly measured in nutrition studies and may lead to adoption of some useful diagnostic criteria.
- (3) Nutrition and lactation (local studies are often unpublished or published in Proceedings of Australian Society of Animal Production as short papers).
- (4) Minerals and vitamins in quantitative metabolism.
- (5) Interaction among nutrients and with diseases of non-nutritional origin.
- (6) Comparative nutrition (e.g. sheep vs cattle or vs. other species) at the quantitative metabolism level.

There is clear evidence that more emphasis is being placed upon integrated studies on the amounts of nutrients ingested, and the quantitative estimation of their rates and avenues of metabolism in various physiological states. However, there is also a strong tendency in many publications, to extrapolate in quantitative terms, from experience with one species in one particular environment to the same species in another environment or to another species. In absence of other information, these extrapolations are excused as allowing some discussion and permitting hypotheses to be raised. The tendency, however, clearly indicates the lack of either direct evidence relevant to the effects of altered environment, or any knowledge of appropriate "corrections" which might be necessary when extrapolating information in these ways. The recognition of the existence of a class of variable known as "interactions" between various factors in the environment is well established, but the amount of effort directed to study of interaction is very small.

AREAS OF GROWING INTEREST SINCE 1970

The strongest developments in published research have most clearly been in terms of studies on:

- (1) Post-ruminal digestion, optimising of rumen function and measurement of yields of nutrients and of their absorption and metabolism. These studies have now been brought into use in support of applied studies in Departments of Agriculture, and are no longer the province solely of those working in those institutions with a less direct commitment to immediate solution of practical animal nutrition problems. The difficulties of extending such measurements to the grazing animal are well recognized and techniques are drawing attention from an increasing number of research workers.
- (2) Field mineral nutrition, particularly with respect to selenium, copper and Cu/Mo/S interactions, is receiving attention, with strong recourse to studies on blood and tissue concentrations obtained either by biopsy or at slaughter in animals receiving and not receiving supplements. The philosophy extends to the search for adequate diagnostic criteria for recommending supplementation in cases of sub-clinical marginal or seasonal insufficiencies in nutrient minerals. The difficulties are great and, I consider, the rate of progress will be slow.
- (3) Reproductive performance and the response of male and female to supplemental mineral or protein. These studies have developed an extra dimension in measurement of ovulation rates and of hormone levels in blood as criteria of response to the nutritional emendments.

PARALLELS WITH THE ARC/MRC REPORT, 1974

The Australian animal nutritional research effort reflects and in a number of areas, leads international changes in research emphasis. In parallel with observations of the ARC/MRC Committee, far more emphasis is being placed on integrated studies involving the use or the adaptation of the techniques of behavioural scientists, physiologists, biochemists, clinicians and to some extent epidemiologists. While tests of hypotheses which relate to the occurrence or non-occurrence of a process (i.e. qualitative aspects) continue, the quantitative measurement of rates of processes and the extent of changes which occur with altered nutritional environment are now clearly a respectable part of the research effort once more. This seems to align with the ARC/MRC statement that "nutrition research will be concerned increasingly with finding the optimum relative proportions of different dietary constituents and less concerned with identifying and describing the signs of deficiencies of (for example) particular vitamins or amino acids".

An area of inadequacy in common with those defined by the ARC/MRC report is in the study of nutrition factors in the complex of health problems. This is "more subtle and difficult to grasp than is under-nutrition or malnutrition as a cause of a specific disease". In intensive animal production systems, concentration is on avoidance of disease through immunization and strict hygiene measures. Even so, sub-

clinical and mild debilitating states may arise, and some dietary circumstances may be a predisposing factor. This area is poorly studied and has received very little attention in grazing animals.

In animals, part of the producer's, or of the nutritionist's, inability to recognize and deal with subclinical nutritional disorders, or with disease states subtended by nutritional conditions, is due to the lack of definition of the productive potential of animals. If we consider that the aims of animal production research are rapid growth, high reproductive performance, high lactation rate, and wool growth, we part company with aims in human nutrition; we share an interest in the control of body composition and the avoidance of diseases due to nutrient inadequacies or excesses. We also share a common problem - the need for clarification of the concept of "normalcy" as it applies to response to nutritional inputs, and the need for some criteria for judging departures from this state of "normalcy". The common approach is that there is a definitive cut-off point between the normal and the abnormal state. However there is an emerging desire to devise methods for monitoring nutritional states of animals, so that without appearance of frank disease states, departures from the optimal nutritional conditions can be detected, and their adverse production effects avoided. This desire is expressed in many reports and in conclusions of discussions in published scientific papers. This is particularly difficult in grazing conditions, and few, if any, nutritional research workers have dedicated their undivided attention to this field. As one example of a problem shared between human nutrition and animal nutrition, it is quite clear that the classical methods of evaluation of protein requirements by N-balance and growth responses leave much to be desired. Though they have provided a very useful baseline, they are insensitive, time consuming, and sometimes inappropriate. Protein requirements need to be measured in respect to other functions such as reproductive performance, body composition, aging, disease susceptibility, and return to "normalcy" after periods of undernutrition or protein malnutrition. New criteria and new, rapid assessment methods are needed so that, to give an example, strategies for discontinuous feeding of protein supplements or for variations in feeding patterns can be harnessed to provide for optimal use of expensive resources.

In common with studies in human nutrition, those interpreting and applying research results have been preoccupied with "models" of deficiencies of single nutrients. Studies on interactions between two or more nutrients or classes of nutrients have contributed greatly to the volume of publications in nutritional journals in U.S. and U.K., but much less so in Australia. That Australian research workers are attuned to the possibility of multi-factor interactions when a nutritional problem is encountered is far better reflected in Reports of Departments of Agriculture than in the research publications. To a certain extent, this situation may call for a short-term reversion from the quantitative to the descriptive and qualitative areas of nutritional research. At this level it is probable that much of the information required can be derived from international journals. The somewhat pragmatic approach of Australian nutritionists seems to be that if there are two or more equally tenable hypotheses, one is wisest to choose the simplest. However, in largely avoiding this area of nutrient interactions, as it appears we may be, we need to ensure that our research does not lack an important dimension. The two general concepts which guide research might be paraphrased for nutritional research as follows:

- (i) Research must provide insight into the causes of existing and recognized nutritional problems, and aid in recognizing and defining nutritional problems as yet unrecognized,
- and (ii) Research must provide principles and models which free our imagination from preconceived constraints, limitations and biases, and lay the ground for renewed approaches to refractory problems.

The use of multi-disciplinary approaches to nutritional research is very important in these regards, as this begets new techniques and introduces new alternatives in solution of nutritional problems. That much of the Australian work on ruminant nutrition is now being subjected to mathematical treatment in the so-called "modelling" phase of research and development provides a measure of the confidence of nutritionists that much information which now exists will, when integrated, yield practical alternatives in feeding, particularly, the sheep. It will also yield signposts to areas of inadequate or incorrect information. Such mathematical treatment of data reflects a pattern concurrently being established in other countries, and allows for an integration of research results at the levels of the individual organism and of the system in which the animals, including humans, find themselves.

CONCLUSIONS

New developments, not sudden, but evolving with the branching and recombination of interests in research groups, are seen to involve particularly new applications of the concepts and techniques of physiology, biochemistry, and mathematics in nutritional research. When these are matched by corresponding recombinations with concepts and techniques of behavioural scientists, clinicians and epidemiologists, strengths in animal nutrition research will enable greater contributions in fields as yet poorly developed, such as:

- (i) recognition and correction of nutritional disorders due to multi-factor interactions;
- (ii) recognition and correction of marginal, subclinical or "symptomless" patterns of nutritional disorder possibly underlying low productivity and affecting susceptibility to disease;
- (iii) substitution of unconventional materials (involving problems of toxicity, pollution, unbalance of nutrients) in animal diets whether compounded and fed to housed animals, or supplied as supplements to grazing animals;
- (iv) manipulation of nutrition to preserve production potential in animals during periods of managed "undernutrition" or in recovery from unavoidable nutritional stresses.

REFERENCES

ARC/MRC (1974) - "Food and Nutrition Research - Report of the ARC/MRC Committee" HMSO, London.

Sources:

In research for this paper the following journals, proceedings and reports were covered for the period 1970-76.

Australian Journal of Agricultural Research
Australian Journal of Biological Science
Australian Journal of Experimental Agriculture and Animal
Husbandry
Australian Journal of Experimental Biology and Medical Science
Animal Behaviour
Animal Production
British Journal of Nutrition
Journal of Reproduction and Fertility
Journal of Agricultural Science (Cambridge)
Journal of Nutrition
Journal of Science and Food Agriculture
New Zealand Journal of Agricultural Research
Nutrition Abstracts and Reviews

Proceedings:

Australian Society of Animal Production
Australian Biochemical Society
Australian Physiological Society
IVth International Ruminant Symposium
111rd World Conference of Animal Production
New Zealand Society of Animal Production
Stock Feed Manufacturers Conference Perth (1973),
Adelaide (1975)
Australasian Poultry Science Convention Auckland (1972)
Hobart (1974)
International Nutrition Congress

Reports of Departments of Agriculture, CSIRO Divisions, Universities
and Research Institutes.