

COLLATION OF NUTRIENT CONTENTS OF AUSTRALIAN FEEDSTUFFS

T.F. Leche
 Division of Animal Production, C.S.I.R.O.,
 Ian Clunies Ross Animal Research Laboratory,
 P.O. Box 239, Blacktown, 2148.

ABSTRACT

The recent history of feedstuff collation overseas and in Australia is described. In particular, the development and the functions of the Australian Feeds Information Centre are reported.

Work on classifying and tabulating data collected for Australian feedstuffs is discussed, as are ways of overcoming some current limitations of the data. Priorities for future activity of the Centre are outlined.

HISTORY

In 1809 Thaer produced the first recorded tables of feedstuff composition from his analysis of hays for two characteristics - acid and alkali solubility. Since then feedstuffs analysis has expanded to the point that today over 200 characteristics of a feedstuff may be determined. Growth in this field has been aided by the proliferation of analytical techniques and apparatus and by our greater understanding of nutritional physiology.

Simultaneously, the collation of these analytical results has attracted much interest. Nutritionists wanting to store, retrieve and manipulate these data have found the computer useful. The greatest impetus seems to have arisen in America about 25 years ago, but other countries - notably West Germany - have also been active.

The work in America resulted in a number of publications, shown in chronological order in Table 1. Probably the most significant of these

TABLE 1. Chronology of selected publications on feedstuffs collation in the United States between 1956 and 1971.

Year	Authorizing Body	Brief Title or Reference	Comments
1956	USA-NRC	Bulletin 449	For concentrate by-products
1958	USA-NRC	Bulletin 585	For grains and forages
1959	USA-NRC	Bulletin 659	Abridged version of 449 and 659
1963	Harris	J. Anim. Sci. 22: 535-547	System of naming feedstuffs
1964	USA-NRC	Bulletin 1232	Revision of Bulletin 659
1968	Utah S.U.	Bulletin 479	International Feed Nomenclature
1969	USA-NRC	Bulletin 1684	Revision of Bulletin 1232
1971	USA-NRC	Atlas of Data for U.S. & Canada	Nutritional data for 6000 feeds

were the two which dealt with systematic naming of feedstuffs (Harris 1963; Harris, Asplund and Crampton 1968). The resulting system of nomenclature has since been adopted internationally.

Australia's participation in the field of feedstuff data collation began in 1966. The Animal Production Committee (APC) of the Standing Committee on Agriculture (SCA) recommended that the Department of Primary Industry (DPI) be invited to prepare a draft system of classifying Australian feedstuffs. After hearing recommendations from Expert Panels and from the APC, the SCA expressed the views in mid-1969 that,

- (a) a feed classification system, based on the International Feed Nomenclature, should be established.
- (b) standard methods of analysis be defined.
- (c) a Committee be convened to report on standard methods of analysis and the adequacy of laboratory staff and facilities.
- (d) a national collating centre be established in the DPI.

The Australian Feeds Collating Centre was duly established within the DPI in 1969.

In America meanwhile, a survey of tropical livestock production and feed composition in the Latin American tropics was started in 1969. Called the Feed Composition Project, it was based at the University of Florida and led by Professor Christiansen, in collaboration with Professor Harris of Utah State University. He was asked to advise the DPI on the mechanics of establishing a feeds information centre in Australia. His report was presented in 1971.

In the same year, the Food and Agriculture Organization (FAO) commissioned a consultant to report on,

- (a) present world activity in collecting and retrieving data on chemical and nutritional characteristics of feeds.
- (b) availability of information on the use of feeds for various classes of animals, and on special properties (e.g. toxicity) of feeds.
- (c) the effects of processing on feeds.
- (d) on whether the FAO should set up its own feed collating system or act as coordinator for existing centres of activity in the field.

The consultant (Alderman 1971) recommended that FAO form a Feeds Information Centre in Rome to assist with coordination of feeds collation work around the world. For this purpose, an International Network of Feed Information Centres (INFIC) was established under the aegis of FAO in 1971. A major aim of INFIC was to standardize terminology, techniques and vocabulary so that data could be exchanged among centres easily and accurately.

Australia joined INFIC and has attended each annual meeting since 1973. The participating organizations and their areas of geographic responsibility are given in Table 2.

TABLE 2. Organizations participating in the International Network of Feed Information Centres, and their geographic responsibilities.

Institution	Parent Country and City
Australian Feeds Information Centre ₆	Australia; Sydney
Canadian Department of Agriculture ₅	Canada; Ottawa
Documentation Centre, University of Stuttgart-Hohenheim 1,2	Federal Republic of Germany; Stuttgart
International Feedstuffs Institute 3,4,5,6	United States of America; Logan, Utah
International Livestock Centre for Africa ₁	Ethiopia; Addis Ababa
l'Institut d'élevage et de médecine vétérinaire des pays tropicaux ₁	France; Maisons-Alfort
Tropical Products Institute _{1,4}	United Kingdom; London
Instituto Interamericano de Ciencias Agrícolas ₃	Costa Rica; San José
Food and Agriculture Organization _{1,4}	United Nations; Rome

Subscripts indicate geographic responsibilities additional to those for the parent country: (1) Africa, (2) Europe, (3) Latin America, (4) Near East, (5) North America, (6) Oceania and south-east Asia.

The Feeds Collating Centre began collecting data from Australian laboratories in 1970 and by May, 1974, more than 4000 standard source forms had been received. Coding of information on the forms began in early 1973 and programming for computer processing was started by the Bureau of Agricultural Economics.

Unfortunately, a staffing shortage in the DPI impeded processing of the source forms. The APC sought ways to expedite the work, but efforts to maintain the Feeds Collating Centre in the DPI were abandoned eventually late in 1974.

The then Division of Animal Physiology was asked to assume responsibility for the work and the project was transferred to CSIRO near the end of 1975. The SCA approved the transfer on condition that various functions of the Centre should continue:

- (a) to provide a uniform feed nomenclature which can be easily identified with common names in Australia.

- (b) to establish a data bank and retrieval system for information about feedstuffs.
- (c) to publish and distribute feed composition tables.
- (d) to be able to exchange information on feeds as part of an International Network of Feed Information Centres.
- (e) to promote improved methods of expressing chemical and biological analyses of feedstuffs and standardized methods of analyses.
- (f) to correlate feed composition data with nutrient requirements of animals so feed efficiency can be increased.
- (g) to develop a system adaptable for use in linear programming of animal diets and in the manufacture of feedstuffs.

With the limited staff available priority has had to be given to the most pressing of these functions - the first three.

The new Division of Animal Production felt these duties would complement the work of the industry liaison office being set up for its research programme on the Strategic Nutrition of Livestock. In this way, information about feeds, as well as about feeding, could be provided for the livestock industries. The Australian Feeds Information Centre was therefore created, with responsibility for feeds data collation in addition to general industry liaison.

Howarth (1976) has described the processing of data from the transfer until July, 1976. Briefly, the source forms were checked, coded, punched on to cards and submitted to the computer for storage. A number of programmes was written to effect this data storage. By the end of 1976, all useful source forms had been included in the database. Additional programmes to retrieve and manipulate the data for tabulation are being prepared now.

COLLECTION OF THE DATA

Laboratories around Australia submitted analytical results on standard source forms. Table 3 shows the distribution of these forms with respect to the type of organization..

Fewer than 200 of the 4400 source forms now in the database were collected after this work passed to CSIRO. Further submissions are most welcome but we are unable with present staff to solicit them by visiting laboratories.

CLASSIFICATION OF THE DATA

The International Feed Nomenclature (Harris et al. 1968) classifies feeds by names with up to six components:

TABLE 3. Data submitted to the Australian Feeds Information Centre by various organizations.

Type of Organization	% of Contributing Laboratories	% of Forms Submitted
State Departments of Agriculture	45.2	52.3
Stockfeed Makers and Commercial Organizations	23.8	27.6
CSIRO	16.7	18.1
Universities and Colleges	14.3	2.1

(a) Original material (plant, animal or other); and where possible the scientific name, including genus, species, cultivar, variety, breed, strain, kind; and common name.

(b) Specific part of the original material.

(c) Processes undergone by the specific part before being fed.

(d) Stage of maturity (of plants).

(e) Cutting or crop.

(f) Grade.

For the present, the terms cutting (or crop) and grade have been ignored in our sorting because this information was inapplicable or unavailable in most cases.

American publications using this system list feeds in order of common names with the scientific name shown at the start of each group. We have preferred to sort and list the Australian data on the less ambiguous scientific name. Cross-references with common names should enable users to find feeds easily.

Each unique feedstuff is assigned an International Feed Reference Number of 6 digits. The first places the feed into one of 8 classes of feeds (e.g. silage, energy feed). The remaining five are assigned arbitrarily by the International Feedstuff Institute in Utah, in the interests of uniformity throughout the INFIC network. These numbers, which facilitate retrieval and sorting by computer, have not yet been assigned to most Australian feeds but this does not hinder our present work.

The International Feed Nomenclature describes feeds qualitatively with considerable precision. Each combination of the six name components specifies a different feedstuff and this results in 1400 feedstuffs for the Australian data. For example, the many combinations of variety, processing and stage of maturity create 76 feedstuffs for the common oat and 40 for Rhodes grass.

DISTRIBUTION OF THE DATA

Table 4 shows how the 4400 source forms have been distributed among the 1400 feedstuffs. It is apparent that no statistical calculations can be made for the majority (76%) of these feedstuffs in the present circumstances, because they lack sufficient source forms. This obstacle could be overcome if more data were available, especially in selected feedstuffs. However, the Nomenclature differentiates between feedstuffs to a greater degree than required for many purposes. Some compromise between specificity of classification and adequacy of replication would alleviate this problem. For example, the system distinguishes between samples of Grasslands Manawa ryegrass which were fan air-dried either with or without heat. Pooling the data for these feedstuffs will not sacrifice appreciable information, particularly for chemical constituents, in many situations.

Most samples have not been completely analysed, even for the major nutrients. Therefore, the number of values per nutrient within a feedstuff will be somewhat less than indicated in Table 4. Aggregation of data for feedstuffs of similar chemical and nutritional value appears unavoidable until more data are obtained.

A cursory view of the feedstuffs in the current list reveals that about 55% would be eaten by ruminants only. A further 43% could be eaten by ruminants or non-ruminants. This distribution is surprising in view of the minimal use of formulated diets for ruminants in this country.

TABLE 4. The distribution of data source forms over the feedstuffs.

Number of Source Forms/Feedstuff	Number of Feedstuffs in each Class	Cumulative %
1	808	59.6
2	224	76.2
3	92	83.0
4	74	88.4
5	38	91.2
6-10	64	95.9
11-50	49	99.7
51-100	5	99.9
> 100	1	100.0

PRESENTATION OF DATA

Various expert panels and other specialists have agreed that,

- (a) there should be a clear distinction between determined and derived values (e.g. digestible energy and total digestible nutrients, respectively), to the extent that they should appear in separate tables.
- (b) the number of observations and the coefficient of variation should appear with mean values.

The choice of format is between the block style of the Atlas of Nutritional Data (Crampton and Harris 1971) and the more conventional array

or matrix. The array is less economic of space if values for many nutrients are not available.

The data could be presented in one or more of the following forms :

- (a) bound book
- (b) looseleaf book
- (c) wall chart
- (d) microfilm or microfiche
- (e) computer printout

CSIRONET equipment can produce microfilm or photographic negatives from output displayed on a video screen. Printing type can then be set from negatives, quickly and accurately. It is appealing to use the computer for presenting the data, in addition to storing them.

THE FUTURE

The first goal is to produce a draft copy of the tables, of determined data only, for circulation to selected representatives of research, extension, industry and education. Guided by their comments and criticisms about format, style and so on, a first edition of tables will be prepared for general distribution.

Following that, consideration will be given to the other functions listed for the Australian Feeds Information Centre. Policies would be formulated with the advice of the APC Expert Panel on Australian Feedstuffs, which has representatives from all State Departments of Agriculture, and from research groups in CSIRO and Universities. Opinions will be sought from a technical committee of the Australian Stockfeed Manufacturers' Association and from primary producers.

The most immediate need is collection of more data and this would probably be best accomplished by visits to laboratories from Centre staff.

Promotion of standard methods of analyses would receive high priority among our activities. Routine distribution of standard samples of feedstuffs to laboratories, for analysis by recommended methods, has been suggested by INFIC as a means of monitoring analytical accuracy.

The Centre should also be able to provide information about specific matters not answered satisfactorily by the tables of feedstuffs composition.

A request for additional staff and funds to enable the Centre to undertake these extra roles has been submitted.

ACKNOWLEDGEMENTS

I am grateful to Ms K. Keniry and Mr G. Groenendyk for data processing, and to Dr N. Graham for helpful criticism. The Australian Pig Industry funded this work in part.

REFERENCES

- Alderman, G. (1971). Proposals for the establishment of a feeds information system for the Food and Agriculture Organization. Rome, F.A.O. FAO-AGA/MISC/71/28.
- Crampton, E.W. and Harris, L.E. (1964). Joint United States-Canadian Tables of Feed Composition. Natl. Acadm. Sci., Natl. Res. Council Pub. 1232.
- Crampton, E.W. and Harris, L.E. (1969). United States-Canadian tables of feed composition. Natl. Acad. Sci., Natl. Res. Council Pub. 1684. Second Revision.
- Harris, L.E. (1963). A system for naming and describing feedstuffs, energy terminology and the use of such information in calculating diets. J. Anim. Sci. 22: 535-547.
- Harris, L.E., Asplund, J.M. and Crampton, E.W. (1968). An International Feed Nomenclature and methods for summarizing and using feed data to calculate diets. Logan, Utah Agricultural Station. Bulletin 479, 391 p.
- Howarth, B.R. (1976). The Australian Feeds Information Centre: A progress report. Australian Poultry and Stockfeed Conference, Melbourne.
- Miller, D.F., Bechtel, H.E., Beeson, K.C., Boucher, R.V., Harris, L.E., Huffman, C.F., Lucas, H.L., Morrison, F.B., Nelson, E.M. and Schneider, B.H. (1956). Composition of concentrate by-product feeding stuffs. Natl. Acad. Sci., Natl. Res. Council Pub. 449.
- Miller, D.F., Bechtel, H.E., Beeson, K.C., Harris, L.E., Huffman, C.F., Lucas, H.L., Morrison, F.B., Nelson, E.M. and Schneider, B.H. (1958). Composition of cereal grains and forages. Natl. Acad. Sci., Natl. Res. Council Publ. 585.
- National Academy of Sciences (1971). Atlas of Nutritional Data on United States and Canadian Feeds, prepared by E.W. Crampton and L.E. Harris. Washington, D.C. 772 p.
- National Research Council Joint United States-Canadian table of feed composition (1959). Natl. Acad. Sci., Natl. Res. Council, Pub. 659.
- Thaer, A. (1809). Grundsätze der rationelle Landwirtschaft. Vol. 1. Sec. 275. Die Realschulbuchhandlung, Berlin. (Cited by Harris et al. 1968).