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International feed nomenclature

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Summary

Because of the confusion associated with the naming of feedstuffs throughout the United States and Canada, the United States National Academy of Science Committee on Animal Nutrition recognised the need for a systematic feed nomenclature. This would describe feed accurately, be adaptable for coding of feed names and data on electronic computers, be adaptable for retrieving data for specific tabulations, and be useful internationally.

To meet these objectives, a new system was devised which makes it possible to know the contents and other characteristics of a feed from its name. This system is known as the 'International Feed Nomenclature.'

A complete 'International Feed Name' consists of nine component terms, and to the extent that information is available, it gives a quantitative description of the feed.

Feeds have also been categorised into eight different classes. This is done according to the origin of the feed product.

An 'International Reference Number' is assigned to each feed. The first digit of this number is the class of feed and the remaining digits are assigned consecutively. The reference number is used to identify the feed in the computer for calculating diets. It is also used for summarisation of the data and for printing feed composition tables, which may be printed directly from the computer.

Through this project, an international network of feed information centres has been developed. At the present time, cooperating centres are located in Australia, Canada, Germany, the United States, and FAO (Rome). The International Feedstuffs Institute at Utah State University correlates the technical phases of the work while FAO handles the non-technical phase.

Résumé

La nomenclature internationale des pâtures

A cause de la confusion associée avec les dénominations des pâtures d'un bout à l'autre des Etats-Unis et du Canada, le Comité de l'Académie Nationale des Sciences des Etats-Unis pour la nutrition des animaux, a reconnu le besoin d'une nomenclature systematique des pâtures. Celle-ci décrira avec précision, sera adaptable pour coder les noms des pâtures et les données dans des ordinateurs, sera adaptable pour recouvrer ces données pour des classifications spécifiques et sera utile internationalement.

Pour satisfaire ces objectifs, on a imaginé un nouveau système qui rend possible de savoir en partant de son nom, les contenus et les autres caractéristiques d'une pâture. Ce système est connu comme la 'Nomenclature Internationale des Pâtures'

Une Dénomination Internationale complète des Pâtures consiste en neuf termes composants et jusqu'à la limite où l'information est disponible, elle donne une description quantitative de la pâture

Les pâtures ont été aussi catégorisées dans huit classes différentes. Ceci est fait selon l'origine du produit alimentaire.

Un 'Numéro International de Référence' est assigné à chaque pâture. Le premier chiffre de ce numéro représente la catégorie de la pâture et les chiffres restants sont assignés consécutivement. Le numéro de référence est utilisé pour identifier la pâture dans l'ordinateur pour calculer les diètes. Il est aussi utilisé pour résumer les données et pour imprimer les tables de composition des pâtures, qui peuvent être imprimées directement de l'ordinateur.

Avec ce projet, on a développé un réseau international de centres d'information des pâtures. A présent des centres coopérants se trouvent en Australia, au Canada, en Allemagne, aux Etats-Unis et à FAO (Rome). L'Institut International des Pâtures de l'Université d'Etat de Utah met en corrélation les phases techniques du travail tandis que la FAO exécute les phases non-techniques.

Nomenclatura internacional de piensos

A causa de la confusión asociada con la denominación de piensos a través de los Estados Unidos y Canadá, el Comité de la Academia Nacional de Ciencias de los Estados Unidos sobre Nutrición Animal reconoció la necesidad de una nomenclatura sistemática de piensos. Esta describiría el pienso exactamente, sería adaptable para la codificación de los nombres de los piensos y datos en computadores electrónicos, sería adaptable para la recuperación de datos por tabulaciones específicas, y sería útil internacionalmente.

Para cumplir estos objetivos, se ideó un nuevo sistema que hace posible conocer los contenidos y otras características de un pienso por el nombre que tiene. Este sistema es conocido como la "Nomenclatura Internacional de Piensos".

Un "Nombre de Pienso Internacional" completo consta de nueve términos componentes, y hasta el punto en que se puede disponer de información, da una descripción cuantitativa del pienso.

También se han clasificado los piensos en ocho categorías diferentes. Esto se hace de acuerdo con el origen del tipo de pienso.

Se asigna un "Número de Referencia Internacional" a cada pienso. El primer dígito de este número es la clase de pienso y los dígitos restantes se asignan consecutivamente. El número de referencia se usa para identificar el pienso en el computador para calcular las dietas. Se usa también para resumir los datos y para imprimir tablas de composición de los piensos, que pueden ser impresas directamente por el computador.

Mediante este proyecto, se ha desarrollado una red internacional de centros de información sobre los piensos. Actualmente, existen centros que cooperan en Australia, Canadá, Alemania, los Estados Unidos y la FAO (Roma). El Instituto Internacional de Piensos en la Universidad del Estado de Utah correlaciona las fases técnicas del trabajo mientras que la FAO se ocupa de la fase no técnica.

Introduction

Data on feed analyses and animal trials with feeds started more than one hundred years ago. Since the beginning of our century, there has been a tradition of compiling feed composition tables as Kellner (1905) did in Germany and Henry (1898) did in the USA.

Research that is effectively determining the nutrient requirements of animals on the one hand and the concomitantly increasing need for more accurate information about composition and nutritive values of feeds, requires specialised methods of processing large amounts of data.

It seems to be more than mere accident that in the home countries of the afore-mentioned pioneers in compiling of feed composition tables, Germany and USA, two separate centres of feed data documentation were built up. The German documentation began in 1949 (Haendler, 1963; Haendler and Jager, 1971) and the documentation in Utah (USA) began in 1952 (Harris, *et al.* 1968).

International network of feed information centres (INFIC)

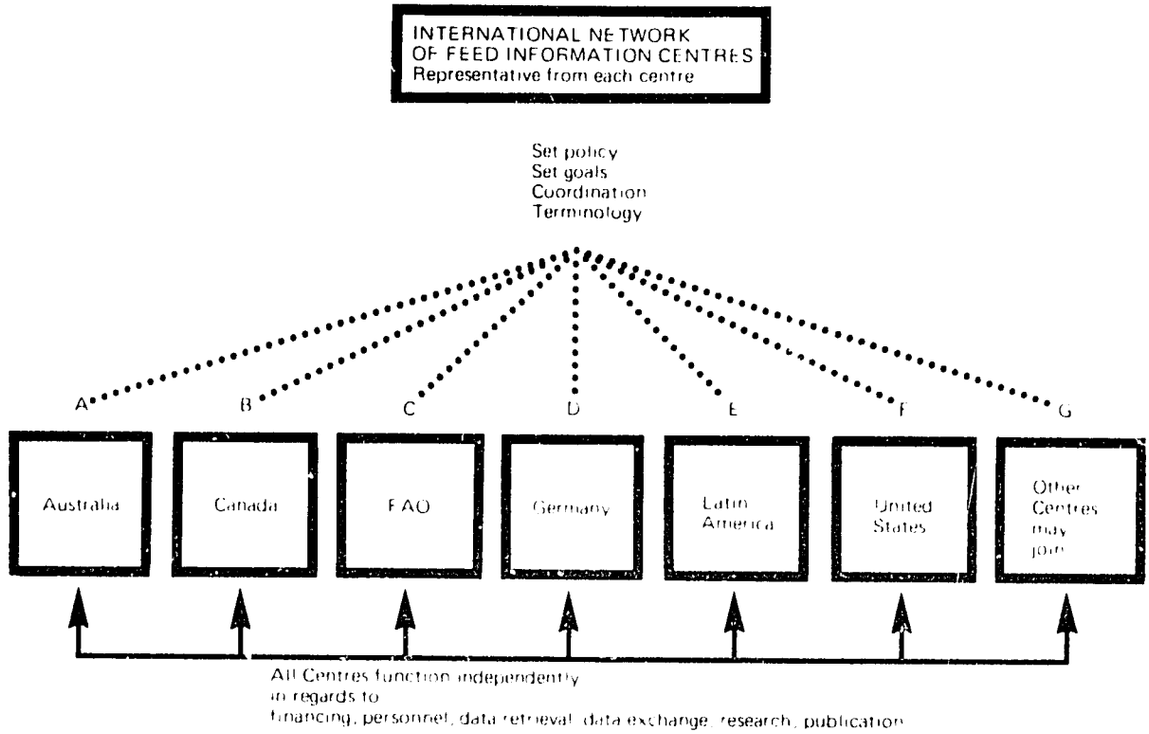
Although there was some contact between Utah and Hohenheim for several years, it was not possible to combine or adapt the two systems to each other. Personnel at the Utah centre contacted the FAO concerning the need for world co-operation. The FAO in turn sent a consultant to visit various centres compiling data on feed composition (Alderman, 1971). This resulted in two informal meetings which were held at FAO headquarters in Rome in 1971 and 1972 (Harris and Christiansen, 1972, Haendler and Harris, 1973).

Representatives attended these meetings from the Australian Feeds Information Centre, Canberra, Australia; the Canada Feed Information Centre, Ottawa, Canada; the Dokumentationsstelle der Universität Hohenheim, Stuttgart-Hohenheim, Federal Republic of Germany; the Florida Feeds Information Centre, US-AID for Latin America, Gainesville, Florida, USA; the FAO Feed Information Centre, Rome, Italy; and the Agency for International Development (AID), Washington, DC, USA. It was decided by this group that an 'International Network of Feed Information Centres' (INFIC) should be established (Figure 1). It should be noted that others may join.

In 1973, another informal meeting of the INFIC group was held in Hohenheim, Germany, to finalise the organisation. Some of the most important decisions reached during these meetings were:

(1) To adopt the 'International Nomenclature' for naming feeds (Harris *et al.* 1968).
(2) To combine the best parts of the Utah and Hohenheim classifications and coding systems into an International system (this should be completed in 1974).
(3) To develop 'International Definitions' of nutrition terms.
(4) To adopt an 'International Record Keeping System' for recording feed composition data (Harris, 1970) which needs to be enlarged to record other substances including those with negative effects such as pesticides, mycotoxins and others.

Figure 1
Organisation of the international network of feed information centres

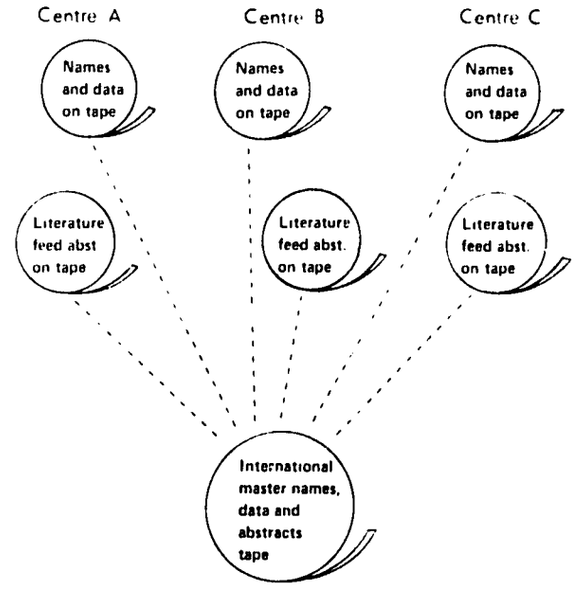


(5) To adopt summarising procedures so data from all centres can be dovetailed by a computer.
(6) To exchange data.
(7) To work co-operatively with the USA Agency for International Development and similar European institutions.
(8) To work with the International Union of Nutritional Scientists (UINS) to standardise terminology and methods for analysing feed samples.

It was suggested that different centres be responsible for various regions of the world. With the help of the FAO the two data processing centres, Hohenheim and Utah, would extend their activities to the developing countries. Hohenheim would be responsible for the Near East including the African countries bordering the Mediterranean. The Federal Agency for Economic Co-operation would support laboratory work in these countries, and data would be sent to Hohenheim. Utah would receive data through the FAO from the other African countries, while data from Australia, New Zealand, and the Southwest Pacific would be summarised at Canberra. Canada would collect data and send it to Utah.

Utah would collect data from the USA and Latin America. (The Animal Science Department at the University of Florida has been collecting data from Latin America but this responsibility will be transferred to Utah on July 1, 1974). The Hohenheim Centre would furthermore extract data from literature as it did at present and would intensify its activity in European countries. The International Feedingstuffs Institute at Logan, Utah would dovetail data from all centres, make a master tape, and send copies of the tape to all centres (Figure 2). The system of combining data is illustrated in the '*Atlas of Nutritional Data on United States and Canadian Feeds*', National Academy of Sciences (1971) and the '*Latin American Tables of Feed Composition*' prepared by McDowell *et al.* (1974a; 1974b).

Figure 2
International feed names and data and abstracts of feed literature will be dove-tailed at the Utah International Feedstuffs Institute into a master tape which will be sent periodically to each centre



Eventually, the 'International Data Bank' will also contain summary and literature feed abstracts (Figure 2), which are presently already available in certain centres. Thus, Hohenheim has been preparing such abstracts regularly since 12 years. The ultimate use of such data will be in conjunction with animal nutrient

requirements to calculate diets and feed mixtures manually or with a computer. Among such centres Hohenheim (Scholtyssek *et al.* 1963) had the first experience in calculating diets with the method of linear programming in the early sixties.

International feed nomenclature system

With the expansion of food technology pertaining to preparation of human foods and as more human food by-products as well as offals suitable for animal feeding are processed, the problems of feed nomenclature assume major proportions for applied nutritionists. Non-forage diets of many domestic animals no longer primarily consist of unaltered farm-produced grains. Feed production has been increasingly separated from animal production; and even when entire grains are used in diets, they often go through commercial channels where cleaning, grading, blending, and possibly grinding, pelleting, or extruding have resulted in products nutritionally unlike the crop originally harvested. These changes have increased diets values and animal efficiencies. But they have also complicated the problem of feed names. Feed control officials of both the USA and Canada therefore approved names for the feeds regulated by feed legislation in their countries and described the processes involved and permitted in their manufacture. Such names, however, are usually common or trade names, and do not convey nutritionally useful information, except by coincidence or implication. As a means of correcting the numerous inconsistencies practiced by various organizational workers who are naming feeds, a new international system was proposed by Harris, (1963) and Harris *et al.* (1968). This is known as the 'International Feed Nomenclature System'.

More than 18,000 feeds have been given 'International Names'. More than 20% of the 'common names' proved to be duplicate names for the same product found in different areas of the world. This unnecessary duplication had been complicating feed identification. This nomenclature system is now in widespread use in North and South America and its principles have been adopted by INFIC. It has been designed to minimise feed identification problems by assigning descriptive names to feedstuffs, and it offers a system with the potential for international standardisation.

The international feed names give, to the extent that information is available or applicable, a quantitative description of the product. A complete name consists of nine component terms:

(1) Scientific name (genus and species)
(2) Origin (or parent material)
(3) Common species, variety, or kind
(4) Part actually eaten
(5) Process(es) and treatment(s) to which the original material or part eaten has been subjected before being fed to the animal.
(6) Stage of maturity (applicable primarily to forages)
(7) Cutting or crop (applicable primarily to forages)
(8) Grade, quality designations, and guarantees
(9) Classification (according to nutritional characteristics).

The different feeds have been assigned to eight classes each of which has been designated at the end of the international name by a number within parentheses. This number forms the last term of the name of a feed, and is also the first digit of its six-digit international reference number.

The numbers and classes they designate are:

1. Dry forages and roughages: subdivided into hay (both legume and non-legume), straw, fodder (aerial part with ears, with husks or with heads), stover (aerial part without ears, without husks or without heads) and other products with more than 18% fibre, hulls and shells.

   This class includes all forages and roughages, cut and cured. Forages or roughages are low in net energy per unit weight, usually because of their high fibre content, though sometimes because the water content is high. According to the nomenclature, products that in the dry state contain more than 18% crude fibre are classified as forages and roughages. Thus, in addition to forages, such products as oat hulls, peanut hulls, and cotton seed hulls are classified as roughages and are included in this group.
2. Pasture, range plants and forages fed green: included in this group are all forage feeds not cut (pasture), all feeds cut and fed green, and feeds cured on the stem, such as dormant range plants. The term 'fresh' is used as a process term for most of these feeds although they may be dry and matured when consumed.
3. Silages: subdivided into maize, legume and grass.
4. Energy feeds: subdivided into cereal grains low in cellulose, cereal grains high in cellulose, cereal milling by-products low in cellulose, cereal milling by-products high in cellulose, fruits, nuts and roots. Products with less than 20% protein and less than 18% crude fibre are classified as energy feeds.
5. Protein supplements: subdivided into those of animal, avian, marine, milk and plant origin. Products which contain 20% or more protein.
6. Mineral supplements.
7. Vitamin supplements
8. Additives: antibiotics, colouring materials, flavouring, hormones, medicants.

The guidelines for classification are approximate and there is some overlapping. Each class used in this system has certain properties that are considered in balancing diets.

Description of components of international feed names

Scientific names

The orderly classification of plants and animals according to their presumed natural relationships forms a basic biological discipline. In the nomenclature, the scientific name(s) consists of the genus and species.

Origin

The origin indicates the parent material from which the feed originates (ie, plant, animal or mineral). For most plants, this source is designated by the common name such as 'timothy' or 'wheat'. Whenever such a name is not the only one used, cross references are used so it will be recognised internationally. An example of this is 'alfalfa'. In some countries this plant is known as 'lucerne'. In view of this, 'alfalfa' is used as the international origin, but there is a cross reference: 'lucerne see alfalfa'.

For non-plant feeds, the name of the animal or bird is used as the origin term, such as 'cattle', 'crab', 'chicken', 'horse', 'sheep', 'turkey', or 'whale'. 'Fish' is used as the origin term of all fishes and the species, or variety, follows, ie, 'fish, cod'; or 'fish, salmon'. When the specific origin is unknown, the words 'animal', 'fish', or 'poultry' are employed as origins.

Proposing any of the common names of a feedstuff as an international standard does not imply that its other common names are not as good, but merely means that one name must be selected in order to minimise confusion.

Common species, variety, or kind

If the nutritive value of a feed has been influenced by the species or kind of product comprising it, this description is included. Examples would be 'cattle, holstein', 'fish, salmon', 'maize, dent yellow', or 'copper sulfate'. When species or varietal information is lacking, the species term is omitted.

Part actually eaten

The third component of a feed name is the actual part of the parent material consumed. To the layman, the edible parts of plants or animals are usually considered to be the obvious structures as leaves, stems, seeds, milk, or bone. But today food technologists are fractionating natural foods and reconstituting their parts into new 'processed' foods. For example, many modern cereals are blends of parts of numerous cereals with or without added synthetic or purified minerals, vitamins, amino acids, antioxidants, and flavours. This extensive processing of plant seeds and manufacturing of new products provides innumerable by-products that find use as feeds for animals, as do the by-products from the preparation of table meats and fish.

The parts of the feed names have been defined (Harris *et al.* 1968; National Academy of Sciences, 1971). Examples of various parts and their definitions are as follows:

Bran: the pericarp of cereal grains. There is also a feed known as pineapple bran, but as the definition of 'bran' does not fit this feed the name was changed to pineapple cannery residue. However, pineapple bran is carried as another name.

Cob: the fibrous inner portion of the ear of maize from which the kernals have been removed.

Germ: the embryo found in seeds and frequently separated from the starch endosperm during milling.

Gluten: the tough, viscid, nitrogenous substance that remains after the flour or wheat or other grain have been washed to remove the starch.

Husks: leaves enveloping an ear of maize; the outer coverings of kernels or seeds, especially when dry and membranous.

Process and treatments

A feed may be modified by a food technologist or a feed manufacturer by a variety of processes, some of which may greatly alter the feeding value of the products treated (National Academy of Sciences, 1973). While heat may damage some components, such as the amino acids and vitamins, it may make other nutrients more available, such as the carbohydrate in potatoes or beans.

Mink may suffer from thiamine deficiency and die when fed certain types of raw fish that contain the enzyme thiaminase. This enzyme destroys the thiamine present in a mixed ration. Since thiaminase is heat labile, cooking the causative fish before mixing the remaining diet ingredients is a satisfactory means of avoiding this problem.

Grinding may change the completeness of digestion of cellulose and protein, while grinding or pelleting of forages alters the proportions between the volatile fatty acids produced by rumen microflora of milking cows and hence affects the relation between the fat and non-fat solids in the milk produced. For this reason, pelleted forages are not recommended for dairy cows.

It is important, then, that persons who feed animals be aware of the processes to which a given feed has been subjected. Examples of representative processes are listed and defined below:

(1) Condensed: reduced to denser form by removal of moisture.
(2) Cracked: particle size reduced by a combined breaking and crushing action.
(3) Dehydrated: having been freed of moisture content by thermal means.
(4) Dry-rendered: residues of animal tissues cooked in open steam-jacketed vessels until the water has evaporated. Fat is removed by draining and pressing the solid residue.

Stages of maturity

The stage of maturity may be unimportant or inapplicable to many feeds, but is probably the most important factor in determining the nutritive value of a forage. Alfalfa is a good example of this. If it matures beyond the one-tenth bloom stage, its lignin content increases markedly and this lowers its digestibility and the voluntary intake of the harvested hay. Table 1 lists the terms used in the international feed names to denote stages of maturity.

TABLE 1. *Stage of maturity terms used in international feed names*

Blooming plants	*Non-blooming plants*[a]
Germinated	1 to 14 days' growth
Early vegetative	15 to 28 days' growth
Late vegetative	29 to 42 days' growth
Early bloom	etc.
Midbloom	
Full bloom	
Late bloom	
Milk stage	
Dough stage	
Mature	
Post ripe	
Stem cured	
Regrowth early vegetative	
Regrowth late vegetative	

[a] These classes are for species that remain vegetative for long periods and apply primarily to plants that grow in the tropics. When the name of a feed is developed, the age class forms part of the name (eg. Pangolagrass, aerial part fresh 150 to 28 days' growth). For plants growing longer than 14 days, the interval is increased by increments of 14 days.

Cutting or crop

The cutting refers to the sequence during a specific growing season, designated as cut 1, cut 2, cut 3, etc. This pertains largely to the hays.

Grade or quality designation

This information is useful in describing the nutritional value of the feed as well as the limits set by law for control purposes. The maximum and minimum quantities of various constituents in the international feed name will have to be established by the countries or international agencies dealing with the particular specifications permissible. Standards for feedstuffs processed and fed within the territorial boundaries of a country should be established by officials of that country. Where feedstuffs are being exported to foreign markets, quality standards may be established by an international agency or by specifications established by the importing nation.

TABLE 2. *Variability in composition in relation to description of a feed*

Name of feed and nutrient	*Protein dry basis %*	*Coefficient of variation %*
Alfalfa, hay, sun cured		
Protein	18.2	16
Calcium	1.32	42
Alfalfa, hay, sun cured, cut 2		
Protein	18.4	11
Calcium	1.25	36
Alfalfa, hay, sun cured, early bloom, cut 2		
Protein	17.6	4
Calcium	1.27	20

Using the 'component' system, it is possible to describe and essentially reproduce a feed ingredient. The exactness of a given name depends upon the accuracy and the amount of information available. A feed described in detail is a much more consistent entity as far as the coefficient of variability is concerned than is one for which less information is presented (Table 2).

A high consistency in description is only possible if the component terms are unambiguous and if the vocabulary is free from synonyms. This is why at Hohenheim a team supported by a grant from the

TABLE 3. *International feed names broken down into components*

Component		*Name components*		
Description number		*Example 1*	*Example 2*	*Example 3*
International names				
Genus	025	*Medicago*	*Bos*	*Linum*
Species	030	*sativa*	*spp*	*usitatissimum*
Origin	155	Alfalfa	Cattle	Flax
Part	215	aerial part	whey	seeds
Process	245	dehydrated ground pelleted	condensed	mechanical extracted ground
Maturity	275	early bloom		
Cutting	300	cut 2		
Grade	325		min solids declared	max 10% fibre
Class		forage 1	energy feed 4	protein supplement 5
Official and other names for the feeds above				
AAFCO	425		Condensed whey	Linseed meal, mechanical extracted
CFA	430			Linseed meal
Other	435	Lucerne dehydrated, ground, pelleted, early bloom cut 2	whey, condensed	Linseed oil meal, expeller extracted
Other	440		whey, evaporated	Linseed oil meal, hydraulic extracted
Other	445		whey, semisolid	Linseed oil meal, old process
International feed reference no.		1 07 733	4 01 180	5 02 045

Institute fur Dokumentationswesen, Frankfurt, is working to revise and complete (and translate into German and French) a vocabulary for describing feedstuffs. This work is benefiting from long experience with the use of the Hohenheim classification system and the intense study of documentation languages. The results of this work were submitted to a committee established at the INFIC meeting in Hohenheim in September 1973, in order to arrive at a controlled vocabulary for international use.

The international system of naming may be illustrated by three examples (Table 3). In normal linear form, these international names are written as follows.

1. Alfalfa, aerial part, dehydrated ground pelleted, early bloom, cut 2, 1.
   Lucerne
   International feed reference number (IFR)
   1 01 733
2. Cattle, whey, condensed, minimum solids declared, 4.
   condensed whey (AAFCO)
   whey, condensed
   whey, evaporated
   whey, semisolid
   IFR 4 01 180
3. Flaxseeds, mechanical extracted ground, maximum 10% fibre, 5.
   linseed meal, mechanical extracted (AAFCO)
   linseed meal (CFA)
   linseed oil meal, expeller extracted
   linseed oil meal, old process
   IFR 5 02 045

The six-digit IFR number listed after each name may be used as the 'numerical name' of a feed when using an electronic computer to calculate diets to obtain maximum profit. Note the first digit of the reference number is its class designation.

In the linear form, each component is in a certain order without commas so the component terms may be recognized. This order follows a logical sequence. The examples illustrate the principle that the full international name of a feed consists of all the nine components minus only those inapplicable to the feed. At the present time, over 15,000 international feed names are on magnetic tape in accordance with the component system.

American Association of Feed Control Officials (1974) names are designated by 'AAFCO' and Canada Feed Act (1967) names by 'CFA'. Their official names cannot usually be used as international names because individual names are either incomplete or do not begin with the 'origin' or parent material. For example, if the scientific name *Bos spp.* is to be included in a table of feed composition data, then the term 'whey' must be preceded by 'cattle' since whey in this instance comes from cattle milk. The AAFCO name begins with 'condensed' and does not show origin.

Official names from other countries will be added as they become known. For Europe the official names will be determined and defined by the competent authority of the European Communities, a draft of which has been in existance for several years.

Figure 3

Composition of Latin American feeds

NAME OR NUTRIENT	UNIT	AS FED	DRY	CV	NO
AVENA SATIVA, OATS					
AVENA SATIVA, GRAIN, (4)					
REF NO 4-03-309					
DRY MATTER	%	88.0	100.0	7	23
ORGANIC MATTER	%	85.0	95.6		
ASH	%	3.9	4.4	90	35
SHEEP DIG COEF	%	27.	27.		
CRUDE FIBER	%	12.6	14.2	31	38
HORSES DIG COEF	%	44.	44.		1
SHEEP DIG COEF	%	32.	32.		1
SWINE DIG COEF	%	14.	14.		1
ETHER EXTRACT	%	4.7	5.3	28	39
HORSES DIG COEF	%	80.	80.		1
SHEEP DIG COEF	%	80.	80.		1
SWINE DIG COEF	%	79.	79.		2
NITROGEN FREE EXTRACT	%	57.8	65.0	8	27
HORSES DIG COEF	%	79.	79.		1
SHEEP DIG COEF	%	78.	78.		1
SWINE DIG COEF	%	76.	76.		2
PROTEIN	%	9.9	11.2	23	51
HORSES DIG COEF	%	79.	79.		1
SHEEP DIG COEF	%	78.	78.		1
SWINE DIG COEF	%	81.	81.		2
CATTLE DIG PROT	% *	5.6	6.3		
GOATS DIG PROT	% *	6.6	7.5		
HORSES DIG PROT	%	7.8	8.8		
SHEEP DIG PROT	%	7.7	8.7		
SWINE DIG PROT	%	8.0	9.0		
ENERGY GE	KCAL/KG	4079.	4584.		1
CATTLE DE	MCAL/KG *	2.69	3.03		
SHEEP DE	MCAL/KG *	2.88	3.24		
SWINE DE	KCAL/KG *	2735.	3077.		
CATTLE ME	MCAL/KG *	2.21	2.48		
CHICKENS ME-N	KCAL/KG	1262.	1420.		2
SHEEP ME	MCAL/KG *	2.34	2.65		
SWINE ME	KCAL/KG *	2564.	2884.		
CATTLE ME-M	MCAL/KG *	1.34	1.51		
CATTLE ME-MAIN	MCAL/KG *	0.83	0.94		
CATTLE ME-LACTATION	MCAL/KG *	(1.47)	(1.65)		
CHICKENS PRODUCTIVE	KCAL/KG	1651.	1858.		1
CATTLE	TDN % *	61.0	68.6		
HORSES	TDN %	67.5	75.9		1
SHEEP	TDN %	65.3	73.4		1
SWINE	TDN %	62.0	69.8		2
CALCIUM	%	(0.20)	(0.23)	98	14
CHLORINE	%	(0.10)	(0.11)		1
COBALT	MG/KG	(0.026)	(0.029)		1
IODINE	MG/KG	0.064	0.072		1
IRON	%	0.005	0.005	15	10
PHOSPHORUS	%	0.27	0.30	21	14
POTASSIUM	%	(0.42)	(0.47)		2
SODIUM	%	(0.06)	(0.07)		1
SULPHUR	%	0.20	0.23		1
ASCORBIC ACID	MG/KG	(3.2)	(3.6)	25	10
BIOTIN	MG/KG	(0.28)	(0.32)		1
CHOLINE	MG/KG	(945.)	(1063.)		2
FOLIC ACID	MG/KG	0.22	0.24		1
NIACIN	MG/KG	(16.7)	(18.7)	28	10
PANTOTHENIC ACID	MG/KG	13.1	14.8	3	5
RIBOFLAVIN	MG/KG	1.3	1.5	11	10
THIAMINE	MG/KG	(2.5)	(2.8)	10	10
ARGININE	%	(0.64)	(0.72)	30	4
CYSTINE	%	(0.17)	(0.19)		3
GLYCINE	%	(0.49)	(0.55)		1
HISTIDINE	%	(0.16)	(0.18)		3
ISOLEUCINE	%	(0.58)	(0.65)		2
LEUCINE	%	(0.86)	(0.96)		2
LYSINE	%	(0.37)	(0.42)	36	4
METHIONINE	%	(0.17)	(0.19)		3
PHENYLALANINE	%	(0.60)	(0.66)		2
THREONINE	%	(0.39)	(0.44)		2
TRYPTOPHAN	%	(0.14)	(0.16)	21	5
TYROSINE	%	(0.73)	(0.82)		2
VALINE	%	0.65	0.73		2

Atlas computer format is useful for recording a large amount of data about a feed (about 450 entities are being recorded). Data are from Latin America. A feed there is known by its scientific name—hence this is listed as 'origin'. The common name is shown after the scientific name. 'CV' is the coefficient of variation and 'NO' is the number of analyses. A '*' indicates the values were estimated using a formula; parentheses indicate the values were taken from US data, which makes a more complete table. (Taken from McDowell et al., 1974a).

International record system

An 'International Record System' to provide a unified method for recording laboratory analytical data on an 'international source form' has been developed (Harris, 1970). This allows for direct transfer of data to an electronic computer system and the addition of data to a master file on cards or tape. Data are summarised by and master copies for tables of feed composition can be made directly from the computer. Tables are photographed and printed by the offset method (Figures 3 and 4) which makes it possible to publish a feed composition table in about four weeks (National Academy of Sciences, 1970, National Academy of Sciences, 1971, McDowell *et al.*, 1974b)

Figure 4

Tablas de composiciónde America Latina

Línea No.	Especie genérica nombre común / Nombre Internacional del alimento / Otro nombre	Alimento Internacional Referencia No	Materia seca	En base a tal como ofrecido y en base seca: Ceniza	Fibra cruda	Extracto Etéreo	Proteína	ED Bovinos	ED Ovinos	ED Suinos	EM_n Pollos
			%	%	%	%	%	Mcal/kg	Mcal/kg	kcal/kg	kcal/kg
01	ZARZA DEL CAMPECHE										
02	-SEE LEUCAENA LEUCOCEPHALA, PARTE										
03	AEREA, FRESCO, (2)										
04	ZEA MAYS, MAIZ										
05	-OLOTES, MOL, (1)	1-02-782	87.6	4.2	31.5	2.7	2.9	2.19*	1.99*	-	-
06			100.0	4.8	36.0	3.0	3.3	2.50*	2.21*	-	-
07											
08	-PARTE AERFA, CURADO AL SOL (C-S), (1)	1-02-775	82.8	6.4	23.3	1.4	7.9	2.01*	2.09	-	-
09			100.0	7.7	28.2	1.7	9.5	2.43*	2.52	-	-
10											
11	-PARTE AERFA, DESH, (1)	1-02-768	94.9	6.4	32.1	2.1	6.9	2.28*	2.21*	-	-
12			100.0	6.7	33.9	2.2	7.3	2.40*	2.33*	-	-
13											
14	-PARTE AERFA SIN MAZORCAS Y SIN TUZA,	1-13-325	88.2	9.7	32.0	1.7	4.8	1.89*	1.87*	-	-
15	PICADO DESH Y MOL, (1)		100.0	11.0	36.3	1.9	5.5	2.14*	2.13*	-	-
16											
17	-PARTE AERFA, FRESCO, (2)	2-02-806	28.2	2.4	7.8	0.8	2.0	0.79*	0.76*	-	-
18			100.0	8.7	27.8	2.8	7.3	2.81*	2.68*	-	-
19											
20	-PARTE AERFA, FRESCO, PROXIMO A LA	2-02-803	-	-	-	-	-	-	-	-	-
21	MADUREZ, (2)		100.0	8.1	29.2	1.6	8.8	2.61*	2.66*	-	-
22											
23	-PARTE AERFA, FRESCO, MITAD DE FLORACION, (2)	2-13-763	-	-	-	-	-	-	-	-	-
24			100.0	10.7	23.5	0.9	9.8	2.79*	2.75*	-	-
25											
26	-PARTE AERFA, FRESCO PICADO, (2)	2-10-357	22.3	1.8	6.6	0.4	1.6	0.57*	0.59*	-	-
27			100.0	7.9	29.6	2.0	7.0	2.57*	2.64*	-	-
28											
29	-TALLOS, FRESCO, (2)	2-02-814	18.2	0.9	6.2	0.3	0.6	0.41*	0.46*	-	-
30			100.0	5.1	33.9	1.7	3.3	2.23*	2.54*	-	-
31											
32	-PARTE AERFA, ENSILADO, (3)	3-02-822	27.5	2.2	7.6	0.9	2.3	0.80*	0.80*	-	-
33			100.0	8.1	27.8	3.3	8.5	2.90*	2.90*	-	-
34											
35	-PARTE AERFA, ENSILADO, ESTADO DE LECHE, (3)	3-02-818	23.4	1.6	7.2	0.6	1.5	0.64	0.63*	-	-
36			100.0	7.0	30.9	2.5	6.2	2.75	2.68*	-	-
37											
38	-PARTE AERFA, ENSILADO, PROXIMO A LA	3-02-819	25.5	1.3	7.4	0.8	2.6	0.69	0.74*	-	-
39	MADUREZ, (3)		100.0	5.2	28.9	3.2	10.0	2.68	2.91*	-	-
40											
41	-PARTE AERFA, ENSILADO EN SILO DE	3-02-824	-	-	-	-	-	-	-	-	-
42	TRINCHERA, (3)		100.0	6.4	30.5	6.3	7.3	2.52*	2.75*	-	-
43											
44	-GRANO, (4)	4-02-879	89.1	1.6	2.2	4.6	9.9	3.24*	3.62*	3344.*	-
45			100.0	1.8	2.5	5.2	11.1	3.63*	4.07*	3752.*	-
46											
47	-GRANO, FERTILIZADO, (4)	4-10-359	86.0	1.3	2.1	1.7	8.7	3.10*	3.30*	3293.*	-
48			100.0	1.6	2.5	2.0	10.1	3.60*	3.84*	3831.*	-
49											
50	-GRANO, MOL, (4)	4-10-422	88.8	2.2	2.5	4.0	8.9	3.08*	3.36*	3310.*	-
51			100.0	2.4	2.8	4.5	10.0	3.47*	3.79*	3727.*	-
52											
53	-MAZORCAS, MOL, (4)	4-02-849	86.2	1.9	7.9	3.4	7.3	2.83*	2.98*	3040.*	2810.
54			100.0	2.2	9.2	3.9	8.5	3.28*	3.46*	3528.*	3259.
55											
56	-SUB-PRODUCTO DE LA FABRICACION DE	4-02-887	89.1	5.7	5.0	9.8	16.4	3.71*	3.49*	3492.*	1952.
57	SEMOLA, MN 5% GRASA, (4)		100.0	6.4	5.6	11.0	18.4	4.16*	3.91*	3918.*	2190.
58											
59	-AFRECHO CON GERMEN, MOL, (5)	5-13-529	89.3	4.3	9.4	8.6	14.5	-	3.48*	-	-
60			100.0	4.8	10.5	9.6	16.3	-	3.90*	-	-
61											
62	-GLUTEN CON AFRECHO, MOLINERIA HUMEDA	5-02-903	90.4	5.7	9.3	2.7	24.6	3.28*	3.31*	3395.*	1688.
63	Y DESH, (5)		100.0	6.3	10.3	2.9	27.3	3.63*	3.66*	3758.*	1868.
64											
65	-GLUTEN, MOLINERIA HUMEDA Y DESH, (5)	5-02-900	87.6	6.5	5.3	5.9	40.8	3.13*	3.40*	-	2427.
66			100.0	7.4	6.1	6.7	46.6	3.58*	3.88*	-	2772.
67											
68	-GRANOS DE DESTILERIA CON SOLUBLES,	5-02-843	92.6	4.7	9.1	9.7	27.2	3.15*	3.02*	-	2479.
69	DESH, MN 75% SOLIDOS ORIGINALES, (5)		100.0	5.1	9.8	10.5	29.4	3.40*	3.26*	-	2677.
70											
71	-SOLUBLES DE DESTILERIA, DESH, (5)	5-02-844	92.2	7.7	5.0	8.0	27.2	3.27*	3.46*	3332.*	2928.
72			100.0	8.3	5.4	8.7	29.5	3.55*	3.75*	3614.*	3176.
73	ZEA MAYS, MAIZ, AMARILLO										
74	-GRANO, (4)	4-07-911	88.2	1.5	2.3	4.2	9.0	3.16*	3.37*	3307.*	-
75			100.0	1.7	2.6	4.8	10.2	3.58*	3.82*	3748.*	-
76	ZEA MAYS, MAIZ, BLANCO										
77	-GRANO, (4)	4-09-907	88.3	1.5	2.9	4.1	9.4	3.17*	3.35*	3314.*	-
78			100.0	1.7	3.2	4.7	10.7	3.59*	3.80*	3752.*	-
79	ZEA MAYS, MAIZ, OPACO 2										
80	-TALLOS, FRESCO, PROXIMO A LA MADUREZ, (2)	2-13-506	-	-	-	-	-	-	-	-	-
81			100.0	7.1	35.8	0.5	5.7	-	2.40*	-	-
82											
83	-GRANO, (4)	4-11-445	86.3	1.7	2.5	4.4	9.7	3.11*	3.28*	3235.*	-
84			100.0	2.0	2.9	5.1	11.2	3.61*	3.80*	3748.*	-
85	ZEA MAYS, INDENTATA, MAIZ, AMARILLO DENTADO										
86	-INDENTATA AMARILLO DENTADO, GRANO, (4)	4-02-935	87.0	1.5	2.9	3.5	8.8	3.08*	3.30*	3489.*	3329.
87			100.0	1.7	3.3	4.0	10.1	3.54*	3.80*	4008.*	3825.
88	ZEA MAYS, INDENTATA, MAIZ, BLANCO DENTADO										
89	-INDENTATA BLANCO DENTADO, GRANO, (4)	4-02-928	87.5	-	-	-	-	-	-	-	-
90			100.0	-	-	-	-	-	-	-	-
91			-	-	-	-	-	-	-	-	-

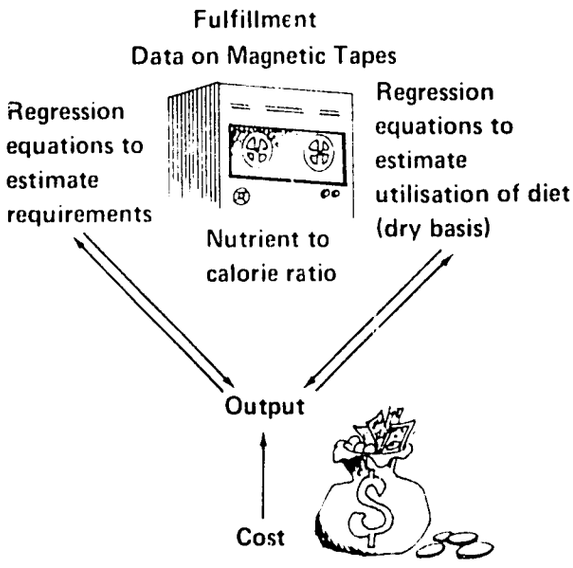
The computer output in long format. This has been used in all the USA National Research Council (1970) nutrient requirement series. It is useful when only a small amount of data is to be reported on each feed. The 'origin' is the scientific name, and the remainder of the names are in Spanish. (Components are translated from English to a different language and fed into the computer, which will then print out the translated names). (McDowell et al., 1974b).

Línea No.	En base a tal como ofrecido y en base seca																		
	NDT Bovinos	NDT Ovinos	NDT Suinos	Calcio	Cobalto	Cobre	Manganeso	Fosforo	Potasio	Zinc	Colina	Niacina	Acido Pantotenico	Pro Vitamina A	Riboflavina	Cistina	Lisina	Metionina	Triptofano
	%	%	%	%	mg/kg	mg/kg	mg/kg	%	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	%	%	%
01																			
02																			
03																			
04																			
05	49.6*	44.2	-	0.26	-	-	-	0.17	0.79	-	-	-	-	-	-	-	-	-	-
06	56.6*	50.5	-	0.30	-	-	-	0.19	0.91	-	-	-	-	-	-	-	-	-	-
07																			
08	45.6*	36.0	-	0.31	-	-	-	0.14	-	-	-	-	-	-	-	-	-	-	-
09	55.1*	43.5	-	0.35	-	-	-	0.17	-	-	-	-	-	-	-	-	-	-	-
10																			
11	51.7*	50.0*	-	1.86	-	-	-	0.14	-	-	-	-	-	-	-	-	-	-	-
12	54.5*	52.8*	-	1.96	-	-	-	0.14	-	-	-	-	-	-	-	-	-	-	-
13																			
14	42.8*	42.5*	-	0.41	-	-	-	0.14	-	-	-	-	-	-	-	-	-	-	-
15	48.5*	48.2*	-	0.47	-	-	-	0.16	-	-	-	-	-	-	-	-	-	-	-
16																			
17	18.0*	17.1*	-	0.11	-	-	-	0.01	-	-	-	-	-	-	-	-	-	-	-
18	63.8*	60.8*	-	0.39	-	-	-	0.04	-	-	-	-	-	-	-	-	-	-	-
19																			
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	59.1*	60.2*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22																			
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	63.2*	62.4*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25																			
26	13.0*	13.4*	-	0.04	-	6.2	11.1	0.03	-	-	-	-	-	-	-	-	-	-	-
27	58.4*	60.0*	-	0.19	-	27.9	49.8	0.13	-	-	-	-	-	-	-	-	-	-	-
28																			
29	9.2*	10.5*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	50.6*	57.6*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31																			
32	16.1	18.1	-	0.16	-	0.5	13.2	0.07	0.32	4.3	-	5.4	-	-	-	-	-	-	-
33	65.8	65.8	-	0.57	-	1.7	48.2	0.24	1.18	15.8	-	19.9	-	-	-	-	-	-	-
34																			
35	16.1	14.2*	-	0.07	-	-	-	0.06	0.37	-	-	-	-	-	-	-	-	-	-
36	69.0	60.9*	-	0.28	-	-	-	0.24	1.57	-	-	-	-	-	-	-	-	-	-
37																			
38	17.1	16.8*	-	0.27	-	3.4	8.8	0.44	1.03	5.4	-	-	-	-	-	-	-	-	-
39	67.0	65.9*	-	1.06	-	13.3	34.3	1.71	4.02	21.0	-	-	-	-	-	-	-	-	-
40																			
41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	57.1*	62.5*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43																			
44	73.4*	82.2	75.8*	0.07	-	19.8	58.4	0.33	0.71	30.7	-	27.0	28.2	-	-	0.11	0.27	0.14	0.16
45	82.4*	92.2	85.1*	0.09	-	22.3	65.5	0.37	0.80	34.5	-	30.3	31.6	-	-	0.13	0.30	0.15	0.18
46																			
47	70.3*	75.0*	74.7*	0.32	-	2.8	1.7	0.26	0.22	17.2	-	-	-	-	-	0.17	0.23	0.13	0.40
48	81.8*	87.2*	86.9*	0.02	-	3.3	2.0	0.31	0.25	20.0	-	-	-	-	-	0.20	0.27	0.15	0.47
49																			
50	69.9*	76.2*	75.1*	0.12	-	17.3	7.7	0.36	0.25	24.0	-	18.1	-	-	-	0.25	0.33	0.17	0.11
51	78.7*	85.9*	84.5*	0.13	-	19.5	8.6	0.41	0.28	27.0	-	20.4	-	-	-	0.28	0.38	0.20	0.12
52																			
53	64.2*	67.6	69.0	0.09	0.133	3.0	4.5	0.23	0.46	8.9	398.	17.6	4.4	-	0.9	0.14	0.18	0.14	0.07
54	74.5*	78.4	80.0	0.13	0.154	3.5	5.2	0.26	0.53	10.3	462.	20.4	5.1	-	1.1	0.16	0.21	0.17	0.08
55																			
56	84.2	79.1	79.2*	0.44	0.059	13.2	14.4	1.16	0.45	-	964.	59.6	7.8	-	2.2	0.19	0.45	0.18	0.12
57	94.5	88.7	88.9*	0.49	0.066	14.8	16.1	1.31	0.51	-	1081.	66.9	8.8	-	2.4	0.21	0.51	0.20	0.13
58																			
59	-	79.0*	-	0.84	-	35.7	13.4	0.88	0.97	-	-	-	-	-	-	-	-	-	-
60	-	88.6*	-	0.94	-	40.0	15.0	0.99	1.09	-	-	-	-	-	-	-	-	-	-
61																			
62	74.5	75.1*	77.0	0.33	0.084	45.8	23.1	0.71	0.58	-	1495.	70.0	12.9	-	4.2	0.54	1.02	0.55	0.26
63	82.4	83.1*	85.2	0.37	0.093	50.7	25.6	0.79	0.64	-	1654.	77.5	14.3	-	4.6	0.60	1.13	0.61	0.28
64																			
65	71.1*	77.0*	-	0.29	0.068	27.2	8.6	0.67	0.29	-	890.	42.3	9.5	-	1.6	0.63	0.81	0.92	0.20
66	81.2*	88.0*	-	0.34	0.078	31.1	9.8	0.76	0.34	-	1016.	48.3	10.9	-	1.8	0.71	0.95	1.05	0.23
67																			
68	71.4*	68.5	-	0.17	0.111	56.5	23.9	0.73	0.65	-	2837.	-	-	-	-	0.34	0.75	0.50	0.18
69	77.1*	73.9	-	0.18	0.120	61.1	25.8	0.79	0.70	-	2848.	-	-	-	-	0.37	0.81	0.54	0.20
70																			
71	74.2*	78.5*	75.6	0.31	0.194	82.7	73.7	1.24	1.75	84.3	4798.	-	-	-	-	0.44	0.94	0.55	0.21
72	80.5*	85.1*	82.0	0.34	0.211	89.7	79.9	1.35	1.90	91.4	5203.	-	-	-	-	0.47	1.02	0.60	0.23
73																			
74	71.6*	76.4*	75.0*	0.05	-	53.8	4.4	0.30	0.44	-	-	19.5	-	-	790.4	0.08	0.20	0.14	0.06
75	81.1*	86.6*	85.0*	0.06	-	61.0	5.0	0.34	0.50	-	-	22.1	-	-	895.8	0.09	0.22	0.16	0.07
76																			
77	71.9*	76.1*	75.2*	0.01	-	-	-	0.27	-	-	-	18.6	-	-	450.7	-	0.29	-	-
78	81.4*	86.1*	85.1*	0.02	-	-	-	0.31	-	-	-	21.1	-	-	510.3	-	0.33	-	-
79																			
80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
81	-	54.4*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
82																			
83	70.6*	74.4*	73.4*	0.12	-	-	-	0.27	-	-	-	-	-	-	-	0.18	0.34	0.12	0.06
84	81.8*	86.2*	85.0*	0.14	-	-	-	0.31	-	-	-	-	-	-	-	0.21	0.42	0.13	0.07
85																			
86	69.9*	75.0*	79.1	0.01	-	3.4	4.1	0.25	0.33	10.3	435.	21.3	5.6	-	1.1	0.11	0.20	0.17	0.09
87	80.4*	86.1*	90.9	0.01	-	3.9	4.7	0.28	0.38	11.8	500.	24.4	6.5	-	1.3	0.12	0.23	0.20	0.10
88																			
89	-	-	-	0.04	0.027	2.6	3.9	0.26	-	-	-	6.8	1.8	-	0.6	0.09	0.26	0.09	0.09
90	-	-	-	0.04	0.031	3.0	4.4	0.30	-	-	-	7.8	2.0	-	0.7	0.10	0.30	0.10	0.10
91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Members of the international network of feed information centres (INFIC) plan to publish feed composition tables for given regions or countries. These tables and animal nutrient requirement tables (National Academy of Sciences, 1970; Agricultural Research Council, 1965) are of most use to developing countries or persons without access to a computer or chemical laboratory, since diets, rations, or feed mixtures may be calculated manually using data from the tables.

Figure 5

Requirements of animals should be calculated to fit a group of animals in a given environment. Utilisation of the diet should be calculated by regression equations. Balance the diet using amount of nutrient per 1,000 kcal Metabolisable Energy and regression equations to estimate utilisation of ME. Introduce cost to make up the most profitable diet.



Ultimately, the user's feed will be analyzed for critical nutrients. Other feed analyses and nutrient requirements data will be kept on magnetic tapes or discs in a computer. Using the analysed data, stored feed analyses, and nutrient requirement data, plus equations, a more precise diet, ration, or feed mixture can be calculated by the computer to obtain maximum profit (Harris *et al.* 1972, Harris *et al.* 1974).

A remote terminal may be set up in a farmer's kitchen, for example, or in a feed mill office. The terminal is connected to a telephone, signals are fed into the computer, and the diet or feed mixture is printed by the terminal (Figure 6).

The proposed 'international bank' of chemical and biological feed data will allow rapid provision of answers to a wide range of inquiries on feeds or methods of feeding.

Presently the Hohenheim centre answers questions concerning feedstuffs and feeding, and supplies data on request. In the future it will be possible to obtain data stored in a common data bank from the Documentation centre in Stuttgart-Hohenheim, Germany, or from the International Feedstuffs Institute at Logan, Utah, USA (Figure 2), if desired.

Figure 6

A portable terminal may be plugged into an electrical outlet on a farm or at a feed mill. An operator connects the terminal to the central computer at Utah State University by phone. The operator types in the costs of the feeds and codes to designate to the computer the animal nutrient requirements and feeds to be used. The central computer calculates the animal diet and the portable terminal prints out the most profitable one.

Dr Lorin E. Harris is typing the data on the portable terminal. Leonard C. Kearl is holding a 720 page *Atlas of Nutritional Data on United States and Canadian Feeds*. Scientists from Utah State University and Dr E. W. Crampton of McDonald College in Quebec prepared the atlas for the USA National Academy of Sciences. It is used as a 'bible' in its field.

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