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International Programs Institute
Utah State University
Logan, Utah 84322
and
Agency For International Development
Washington, DC 20523
[redacted]

ANNUAL REPORT AND WORK PLAN

Utah State University
and
Agency for International Development

Title Increasing Livestock Production Through Improved Nutrition Information 931-11-130-050-73
Leader L.E. Harris, Director, International Feedstuffs Institute
Co-Project Leaders L.C. Kearl and P.V. Fonnesbeck
Contract Period November 15, 1974 to November 15, 1980
Period Covered by Report November 15, 1976 to November 15, 1977
Total AID funding of contract to November 15, 1977 $339,983.00
Total expenditure through previous contract year (to 11/30) $310,732.19
Total expenditures and obligation for current year $130,141.00
Estimate of expenditures for next contract year $125,155.00

Summary

A trip was made to Germany, Italy, Turkey, Syria, and Jordan, May 29-July 4, 1977. Several problems concerning terminology were resolved with the INFIC center in Stuttgart, Germany. Representatives of INFIC at the center in Rome (FAO) were briefed on the current status of INFIC. They requested a continuation of liason between FAO and INFIC. Contacts were made in Turkey and some feed data were received. Continued cooperat between the research institutions and INFIC was assured. Contacts were made in Syria, with Damascus University. The Arab Center for the Stu of Arid Zones and Drylands (ACSAD) (Syria) was approached concerning hosti an INFIC center in Damascus to collect and process feed composition data collected in the Middle East Countries. Personnel at the University of Jordan were contacted and agreed to host an INFIC center provided they could locate funds to administer the program.

A trip was made to Guatemala and Costa Rica, September 22-30, 1977. Dr. Ricardo Bressani and his staff were contacted at the Institute of Nutrition for Central America and Panama (INCAP) Guatemala City, requestir their support in establishing an INFIC center in San Jose. This was obtained. A workshop was held in San Jose, Costa Rica on Feed Compostion and Animal Feeding Systems. Those present accepted the concept for establishing an INFIC center and a proposal to this end was presented to the Instituto Interamericano de Ciencias Agricolas (IICA). They also agreed to request the Latin America Society of Animal Production (ALPA) to appoint feeding systems committees to study the information available and to make feeding recommendations to the livestock and poultry producers in Latin America. At the ALPA meetings held in Cuba, December,1977, a committee was appointed to study the information available and to recommend feeding programs for animals grazing pastures and rangelands.

A trip was made to Germany, Jordan, Egypt, Malaysia and the Philippines October 29-November 22, 1977. In Germany, three INFIC manuscripts were edited and approved for publication by members from four INFIC centers. Changes in the terminology were approved. A workshop was held in Jordan and ACSAD (Damascus, Syria) agreed to act as the INFIC center for 21 Arab countries. Also, the members present agreed to seek support among scientists throughout Middle East countries to organize a Society of Animal and Range Sciences. Contacts were made in Egypt for the exchange

of data between Cairo University and IFI. Scientists in Malaysia and Philippines are very much in favor of establishing an INFIC center in Southeast Asia to process and store feed composition data for that area Details on this will be worked out.

A Middle East Table of Feed Composition was published using data gathered from several Mideast countries.

Major Objectives of Project

1. To promote the use of the International Feed Vocabulary and the INIFC recording system throughout the Free World.
2. To enlarge the International and United States Databank by entering up-to-date chemical and biological feed data into the system.
3. To establish regional INFIC centers to serve developing countrie
4. To publish data collected in regions for use by scientific and government agencies, and the livestock and poultry industries.

Major Accomplishments During the Year

Objective 1

In promoting the aims and goals of INFIC the following papers were presented at the workshop in Amman, Jordan and San Jose, Costa Rica. and at Seminars in Egypt, Malaysia and the Philippi

Organization of Feeding Systems Committees

International Feed Vocabulary

The International Network of Feed Information Centers

Drafts of three manuscripts were prepared during the year regarding the International Network of Feed Information Centers (INFIC). These manuscripts were edited in Germany in cooperation with INFIC members from Germany, France, and England (see Appendix 1 and 2). Galley proofs of these manuscripts have been circulated to the other INFIC centers for their input. It is anticipated that these manuscripts will be published during 1978.

While in Germany, the international feed names and methods for summarizing data were agreed to. By doing this, compatibility between the German and Utah systems was achieved. This International Nomenclature and Recording System will be used to describe and record feed information by INFIC centers in Australia, Canada, Germany, FAO, Middle East, Latin America, Africa, France, England, and the United States. Several years work will be required to achieve this goal.

Objective 2

Data were collected from eight Middle East countries and compiled into a Middle East Table of Feed Composition. The data collected and

added to the files were for 459 feeds. About 3,000 source forms wer added to the databank containing information on feeds used in the United States.

Computer programs were developed for screening data for accuracy and comparing it with existing data in the databank. The method devised for this is to calculate the mean and standard deviation and indicate on a printout all values that are two or more standard deviations from the mean. These values are checked with the original documents to verify the data.

Objective 3

A workshop was held in San Jose, Costa Rica, September 27-29, 1977, for the purpose of establishing an INFIC center at the Instituto Interamerica de Ciencias Agricolas (IICA) in San Jose (see Appendix 3). The center at San Jose will collect and process feed data for 21 Latin American countri Speakers from eight countries participated in the workshop. It was recommended by the personnel from the International Feedstuffs Institute that feeding systems committees be established to make recommendations on feeding systems for domestic animals in Latin America.

The Latin Americans in attendance recommended that a resolution be presented at the Latin American Society of Animal Production meetings in Cuba (Dec. 1977) to the effect that feeding system committees be appointed. These committees would study the feasibility of developing feeding systems for livestock and poultry in Latin America. Feeding systems for grazing animals would receive primary attention. The establishment of an INFIC center at San Jose seems assured.

A workshop was held in Amman, Jordan, November 6-9, 1977, for the purpose of establishing an INFIC center for the Middle East and to initiate action for establishing a Society of Animal and Range Sciences for the Middle East. It was suggested that when the society becomes functional that feeding systems committees for the Middle East be appointed for the different species of domestic animals in their area.

An INFIC center was established at the Arab Center for the Study of Arid Zones and Drylands (ACSAD) in Damascus, Syria, to collect feed data in 21 Arab countries. An Ad Hoc committee was formed to study the feasibility of forming a Society of Animal and Range Science. Dr. Ahmad Faqih at the University of Jordan said he would contact scientists in the Middle East to see if a society of Animal and Range Science could be established (Appendix 4). When a society is formed feeding system committees will be appointed.

Scientists at the University of Pertanian Malaysia, Malaysia, and the Philippine Council for Agriculture and Resources Research (PCARR) and the University of Philippines, Philippines, were visited and informed of the objectives of INFIC. Tentative plans are being made for personnel at PCARR to organize a workshop this summer to bring together individuals from several Southeast Asian countries for the purpose of working out procedures for collecting feed composition data and organizing an INFIC center for Southeast Asia. A plan to organize feeding systems committees will be on the agenda.

Objective 4

A Middle East Table of Feed Composition was published and copies were distributed to several scientists in the Mideast. Suggestions have been received for revising this publication to meet the needs of users in those countries.

Data is on-line for those wishing to use it for calculating diets for maximum profit.

Practical Application

The International Feedstuffs Institute is the World Coordinating Center for INFIC

The International Network of Feed Information Centers (INFIC) was organized under the auspices of the Food and Agricultural Organization (FAO), a branch of the United Nations, located in Rome, Italy. The mission of INFIC is to collect, process, and disseminate information on nutritive values of materials used for livestock and poultry feeds throughout the world. These data must be converted through proper documentation into meaningful information that is available to all potential users. Members are: FAO, Australian Feed Information Centre, Blacktown, Australia; Canadian Department of Agriculture, Ottawa, Canada; Documentation Center at the University of Hohenheim, Stuttgart, Germany; L'Insitut D'Elevage et de Medecine Veternaire des Pays Tropicaux (IEVMT), Maison-Alfort, France; International Livestock Center for Africa (ILCA), Addis Ababa, Ethiopia, Tropical Products Institute (TPI), London, England; The Arab Center for the Study of Arid Regions and Drylands (ACSAD), Damascu Syria; Insituto Interamericano de Ciencias Agricolas (IICA), San Jose, Costa Rica, and the International Feedstuffs Institute, Logan, Utah, USA. Plans are underway to establish a center to serve Southeast Asia.

The International Feedstuffs Institute (IFI) was insturmental in the formation of INFIC. Seeing the need for a system of standardization of feed names and methods for determining the nutritional values of feedstuffs, scientists at IFI pioneered the procedures for documentation of feed composition data by electronic means. Today, a common system for naming feeds, methods for analyzing nutritive values and recording data is used by all INFIC centers. These procedures were developed at IFI(USU). This system is known as the International Nomenclature and Recording System. Data is collected and processed at each center and forwarded to IFI where it is stored in the International Databank. IFI correlates all the technical phases of INFIC.

Publications (See Appendix 5)

Kearl, Leonard C., Lorin E. Harris and Howard Lloyd. Middle East Tables of Feed Composition, Utah Agr. Expt. Sta. Research Report 30. November 1977.

Harris, Lorin E. and Leonard C. Kearl, International feed vocabulary. Proceedings of the workshop University of Costa Rica, San Jose, Costa Rica, September, 1977. Proceedings of the workshop University of Jordan, Amman, Jordan, November, 1977.

Kearl, Leonard C. and Lorin E. Harris. International network of feed information centers. Proceedings of the workshop University of Costa Rica, San Jose, Costa Rica, September, 1977; Proceedings of the workshop University of Jordan, Amman, Jordan, November, 1977.

Harris, Lorin E., H. Haendler R. Riviere, L. Rechaussat, and H. Fonseca; International feed databank system. International Network of Feed Information Centers. Utah State University Press, Logan, Utah, in press.

International Network of Feed Information Centers (a position paper). Utah State University Press, Logan, Utah (in press).

Plan of Work Under Each Objective for 1978

Objective 1

A workshop will be held in the Philippines in 1978. Seminars will be held in several countries. One section of the workshop and the seminars will be devoted to the "International Feed Vocabulary;" methods of collecting feed samples; recording ; coding; and summarizing data on feedstuffs, A position paper will be published on INFIC. An up-to-date report covering feed vocabulary, collecting feed samples; recording feed data; and summarizing feed data will be published. Up-to-date coding procedures will be circulated to all INFIC Centers.

Standardized short feed names will be put in the Association of American Feed Control Officials Handbook. These names will be used in feed composition tables.

Objective 2

Data will be acquired from the Middle East and Southeast Asia and added to the data bank.

Data on missing nutrient values will be solicited from U.S. laboratories and industry.

Objective 3

Work will continue in the Middle East and Latin America to strengthen the effort of the two new regional INFIC centers in achieving their objectives. These will include technical assistance and use of the USU computer facilities.

A workshop will be held in the Philippines. At the workshop Sout Asian scientists will decide where they wish to locate INFIC centers for Southeast Asia.

One graduate student from Latin America and one from the Middle East w be encouraged to attend Utah State University enrolled in an animal science program with emphasis on nutrition, feeds and computer programmin

Objective 4

The Middle East Tables of Feed Composition will be revised and published for distribution throughout the Arab nations. Printouts of all data processed from ACSAD and Southeast Asia will be forwarded to the donar organization for use as they wish. Feed information will be provided to U.S. users upon request.

APPENDIX I

REPORT OF TRIP TO GERMANY, JORDAN, EGYPT, MALAYSIA AND THE PHILIPPINES

October 29, to November 22, 1977

Lorin E. Harris, Leonard C. Kearl

International Feedstuffs Institute
Animal, Dairy and Veterinary Science Department
Utah State University
Logan, Utah

GERMANY

Purpose

A workshop was held in Stuttgart, Germany with INFIC members from the Institut D'Elevage et de Medecine Veterinaire des Pays Tropicaux, Paris; the Documentation Center, Hohenheim University, Stuttgart; the Tropical Products Institute, London and the International Feedstuffs Institute, Utah State University, Logan, Utah, October 30-November 4, 1977.

The purpose of the workshop was to clarify several terms used in the International Feed Vocabulary and to edit three manuscripts to be published by INFIC.

Commentary and Evaluation

Corrections were made to the international terminology making it compatible with the German and Utah systems. Three manuscripts: (a) an INFIC position paper; (b) an International Feed Vocabulary and Methods for Collecting and Summarizing Feed Data; and (c) International Codes, were reviewed in detail and changes and corrections were made as agreed to by those present.

It was a successful workshop with the objectives being accomplished.

JORDAN

Purpose

A workshop was held in Amman, Jordan, present information on feeding systems for several species of animals in the Middle East; to explain the role of INFIC in assisting countries (regions) in establishing a data collection system; to develop a plan for establishing a country and regional Society of Animal and Range Science; to present information on developing a committee system (under the leadership of the Society) to investigate the possibility of establishing recommended feeding systems for the various classes of animals indigenous to the Middle East; to establish a cooperative arrangement with the Arab Center for the Study of Arid Zones and Drylands (ACSAD) for the collection and storage of feed information collected from the Arab countries and to determine if ACSAD would assume the responsibility to act as the INFIC Center in the Middle East

Commentary and Evaluation

The workshop provided a forum for presenting several topics on feeds and livestock and poultry feeding systems used throughout the Middle East countries. General discussions were held giving each person an opportunity to present his experiences and suggestions on improving management of the feed and animal resources of the region.

Preliminary arrangements were made with (ACSAD) Damascus, Syria to function as an INFIC center. Dr. M.F.A. Farid, ACSAD will visit the laboratories of his choice in the twenty-one Arab countries to collect feed composition data. The data will be checked by ACSAD personnel for accur

and correct naming and then forwarded to the International Feedstuffs Institute at Utah State University to be coded and processed. As funds become available, ACSAD will develop computer software and process all data collected in the Arab countries.

An Ad Hoc committee was organized, comprised of members from each country represented (Egypt, Jordan, Iran, and Turkey), to investigate the possibility of forming a Society of Animal and Range Science for the ARAB countries which do not have such a society. Action is being taken on this at the present time. (See Appendix 1).

Upon the formation of an Animal and Range Science Society, Feeding Systems Committees will be appointed to work out feeding systems for the species of domestic animals in the Middle East.

The main objectives of the workshop were accomplished. The viable political situation developing in these countries may have an affect on how rapidly our work will progress in this region. Thirty to fifty people attended each session.

EGYPT

Purpose

Meetings were held with faculty and staff at Cairo University, Giza, Egypt, November 10-12, 1977, to establish a working agreement for the exchange of feed composition data between Cairo University and the International Feedstuffs Institute.

Commentary and Evaluation

Discussions were held to plan ways to collect and exchange feed nformation in accordance with the INFIC system. A seminar was held with en people in attendance.

Officials at Cairo University agreed to transcribe their data to international source forms and forward it to IFI for inclusion in the revised Middle East feed table to be published in 1978.

The mission achieved its objectives and an agreement for the exchange of ideas and information was established.

MALAYSIA

Purpose

Meetings were held with faculty and staff at the University of Pertanian Malaysia and the Ministry of Agriculture, Serdang, Selangor, Malaysia, November 15-17, 1977, to explain the role of INFIC and assess the possibilit of collecting and exchanging feed composition data between those organizations and the International Feedstuffs Institute.

Commentary and Evaluation

This was an exploratory mission to establish liason for the puspose of exchanging feed composition data between the University of Pertanian Malaysia, and IFI. This was accomplished and the Head, Department of Animal Science, Dr. Syed Jalaludin, has organized a committee to start collecting feed data and recording these data on international source forms.

A seminar was held and approximately forty university, Ministry of Agriculture, and agricultural industry people were in attendance. Also, they have initiated plans to hold a workshop in the Spring of 1978, with officials from the Animal Sciences Societies of Southeast Asia present, to discuss the possibility of an area wide collaborative effort in collecting and exchanging feed information. The eagerness of this group to become involved in the feed composition work took us by surprise. We will have to assess the work being done by Dr. Jalaludin and his group in light of the work of the Animal Production and Health Organization of Southeast Asia under

the leadership of Dr. J.C. Madamba, Philippine Council for Agriculture and Resources Research (PCARR). We were most pleased, however. with the enthusia: of the Malaysian scientists to commence work in this area.

PHILIPPINES

Purpose

Meetings were held at the Philippine Council for Agriculture and Resources Research (PCARR), Los Banos, Philippines, and the University of Philippines, College Laguna, Philippines, November 18-22, 1977, to discuss the possibility of the Animal Production and Health Organization for Southeast Asia (APHOSEA) becoming a member of INFIC for collection and processing feed composition from several countries in Southeast Asia.

Commentary and Evaluation

Dr. Joseph C. Madamba, Director of APHOSEA, was very cooperative in agreeing to work toward a common goal of collecting feed data throughout Southeast Asia. There are eleven nations cooperating in agricultural studies in this area (Thailand, Sri Lanka, Nepal, Pakistan, India, Australia, Bangladesh, Philippines, Malaysia, Indonesia and Singapore). Currently APHOSEA is being funded by the governments of the countries involved. Several other Asian countries have petitioned for membership in APHOSEA and eventually, it is anticipated that 21 or 22 nations will become members of this organization.

Private conversations were held with Dr. Joseph C. Madamba, Director, PCARR (also APHOSEA) and Dr. Alfonzo Eusebio, Director of the Animal Science Section, PCARR. Each person was helpful in appreciating the need for cooperation among the countries of Southeast Asia and the need to develo

a uniform system for collecting and reporting feed information. PCARR has published several bulletins, similar to the NRC Nutrient Requirement Series for use in the Philippines. Complimentary copies were provided to IFI. Also, a comprehensive feed composition table published by the Animal Science Department, University of Philippines was presented to IFI.

Dr. Madamba reported he had submitted a proposal to US AID to fund a feed composition project through the Animal Production and Health Organization for Southeast Asia (APHOSEA). Included in this were funds to hold a workshop in mid 1978. He would like to invite three people representing agri-business, government, and science from each of the eleven cooperating members of APHOSEA to participate in this workshop.

The staff and faculty at the University of Philippines scheduled a seminar attended by approximately fifty individuals from the Animal Science Department. L.E. Harris presented information on the International Feed Vocabulary and Feeding Systems Committees. L.C. Kearl presented the role of INFIC in assisting regional areas in establishing feed composition centers.

It is our assessment that the meetings were productive, and the groundwork has been laid for the exchange of information and ideas between IFI and APHOSEA. Eventually, we anticipate a feed composition program will be inaugurated within APHOSEA to collect feed information from all its member countries. At this point in time, however, it is not certain if APHOSEA would assume the responsibilities of being an INFIC center, or if the data would be forwarded to the INFIC center in Australia for processi and storage. Further discussion will be needed with all parties concerned to determine the manner in which each interested group will function. If a workshop can be held the Asian scientists can determine if they wish to have an INFIC center and where it will be located.

Personnel Visited

The attached list gives the names and addresses of those individuals who were contacted. There were many others who attended the workshop and seminars.

GERMANY

H. Haendler
Dokumentationsstelle der
Universitat Hohenheim
7000 Stuttgart-70 (Plieningen)
Paracelsusstrasse 2
Postfach 106
German Federal Republic

J. Jager
Dokumentationsstelle der
Universitat Hohenheim
7000 Stuttgart-70 (Plieningen)
Paracelsusstrasse 2
Postfach 106
German Federal Republic

F. Neese (Mrs.)
Dokumentationsstelle der
Universitat Hohenheim
7000 Stuttgart-70 (Plieningen)
Paracelsusstrasse 2
Postfach 106
German Federal Republic

D. Halliday
Tropical Products Institute
56/62 Gray's Inn Road
London WC1X 8LU
England

R. Riviere
Institute D'Elevage et de Medécine
Veterinaire de Pays Tropicaux
10 Rue Pierre Curie
94700 Maisons-Alfort
France

L. Rechaussa.
Institute D'Elevage et de Medecine
Veterinaire de Pays Tropicaux
10 Rue Pierre Curie
94700 Maisons-Alfort
France

L. Harris
International Feedstuffs Institute
Utah State University
Logan, Utah 84321

L. Kearl
International Feedstuffs Institut
Utah State University
Logan, Utah 84321

D. Friede
Dokumentationsstelle der
Universitat Hohenheim
7000 Stuttgart-70 (Plieningen)
Paracelsusstrasse 2
Postfach 106
German Federal Republic

M. Meir
Dokumentationsstelle der
Universitat Hohenheim
7000 Stuttgart-70 (Plieningen)
Paracelsusstrasse 2
Postfach 106
German Federal Republic

JORDAN

S. Qa[illegible]
Dean, College of Agriculture
University of Jordan
Amman, Jordan

M. Farid
ACSAD
P.O. Box 2440
Damascus, Syria

G.Vogt
Projekt-Manager
Ankara Merkez Yem Analiz Laboratuvari Md. Lugu
Deutsche Techische Hilfe Zifu
Zentralinstitut fun Futtermitteluntersuchung
Yenimahalle/Ankara, Turkey

J. Hyslop
USAID
American Embassy
Amman, Jordan

F. Qushair
USAID
American Embassy
Amman, Jordan

N. Sefidbakht
Animal Science Department
University of Pahlavi
Shiraz, Iran

R. Akyildiz
Head, Animal Science Department
Ankara University
Ankara, Turkey

G. Goddard
Faculty of Agriculture
Poultry Science Department
University of Jordan
Amman, Jordan

L. Harris
International Feedstuffs Institute
Utah State University
Logan, Utah 84321

L. Kearl
International Feedstuffs Institute
Utah State University
Logan, Utah 84321

T. Nassar
Animal Science Department
Faculty of Agriculture
University of Jordan
Amman, Jordan

G. Shaw
Faculty of Agriculture
University of Jordan
Amman, Jordan

R. Thompson
Faculty of Agriculture
University of Jordan
Amman, Jordan

G. Jawharieh
c/o A. Faqih
P.O. Box 13103
University of Jordan
Amman, Jordan

A. Faqih
P.O. Box 13103
University of
Amman, Jordan

S. Haddade
University of Jordan
College of Agriculture
Amman, Jordan

F. Hourani
Faculty of Agriculture
University of Jordan
Amman, Jordan

H. Khalifa
P.O. Box 19082
Amman, Jordan

R. Montee
CARE-JORDAN
P.O. Box 5062
Amman, Jordan

I. Ruhi
P.O. Box 2215
Amman, Jordan

A. Said
Faculty of Agriculture
University of Jordan
Amman, Jordan

H. Sido
Ministry of Agriculture
Amman, Jordan

MALAYSIA

O. Din
Deputy Director
Veterinary Services Division
Ministry of Agriculture
Jalan Swettenham
Kulal Lumpur, Malaysia

S. Heng
I.C.I. (Mal) Sdn. Bkd.
Wisma Daman Sara
Kuala Lumpur, Malaysia

D. Mardi
Petaling Jaya
Kuala Lumpur, Malaysia

D. Muller
c/o IPRC Office
Singapore

T. Seng
Director & General Manager
Jalan Gudang
Bater Tiga
Industrial Estate
Selangor, Malaysia

C. Choo
Factory Manager
Nam Joo Hong Chan Sdn. Bhd. & Feedmill
Factory Lot 4A, Road 215
Petaling, Jaya

M. Dahan
Fakulti Kodek. Vet. & S. Peternakan
Universiti Pertanian Malaysia
Serdang, Selangor, Malaysia

R. I. Hutagalung
Department of Animal Science
Faculty of Veterinary Medicine
and Animal Science
Universiti Pertanian Malaysia
Serdang, Selangor, Malaysia

S. Jalaludin
Associate Professor and Head, Department
of Animal Science, Faculty of Veterinary
Medicine and Animal Science
Universiti Pertanian Malaysia
Serdang, Selangor, Malaysia

S. Siang
Pharmaceuticals Department
ICI (Malaysia) Sdn. Berhad
Wisma Damansara
Jalan Semantan
Kuala Lumpur 23-03
Malaysia

R. Svec
Agricultural Attache
Embassy of the United States of America
11th Floor
AIA Building
Jalan Ampang
Kuala Lumpur, Malaysia

PHILIPPINES

P. Alcontare
UPLP, College, Laguna
Philippines 3720

B. Burgor (Miss)
c/o Philippine Council fc.
Agriculture & Resources Research
Los Banos, Laguna
Philippines

A. Eusebio
Director
Livestock Resources Division
PCARR
Los Banos, Laguna
Philippines

P. Lopez
Department of Animal Science
UPLB-College, Laguna
Philippines

W. McCluskey
Agriculture Advisor, Research Chief
Agricultural Research Dvision of AID
1601 Ramon Magsaysay Center
1680 Roxas Boulevard
Manila, Philippines

E. Tan
PCARR Philippine Council for Agriculture
and Resources Research
Los Banos, Laguna
Philippines

J. Madamba
Director General
Philippine Council for Agricultu
and Resources Research (PCARR)
Los Banos, Laguna, Philippines

L. Castillo
Department of Animal Science
University of Philippines
College Laguna, Philippines

C. Perez
Department of Animal Scienc
University of Philippines
College Laguna, Philippines

E. Coligado
Department of Animal Scienc
University of Philippines
College Laguna, Philippines

E. Rigor
Department of Animal Scienc
University of Philippines
College Laguna, Philippines

V. Arganosa
Department of Animal Scienc
University of Philippines
College Laguna, Philippines

V. Momangan
Department of Animal Science
University of Philippines
College Laguna, Philippines

C. Arboleda
Department of Animal Science
University of Philippines
College Laguna, Philippines

T. Abilay
Department of Animal Science
University of Philippines
College Laguna, Philippines

EGYPT

A. Abou-Raya
Faculty of Agriculture
Cairo University
Cairo, Egypt

M. El-Abbady
Animal Nutrition Department
Faculty of Agriculture
Cairo University
Giza, Egypt
A.R.E.

S. Allam
Cairo University
Department of Animal Nutrition
El-Giza, Egypt

E. Gihad
University of Cairo
Faculty of Agriculture
Department of Animal Nutrition
Giza, Egypt

N. Goher
Department of Animal Production
College of Agriculture
Cairo University
Giza, Egypt

O. El-Hosseing
Faculty of Agriculture
Cairo University
Department of Animal Production
Giza, Egypt

M. El-Kotoury
Animal Nutrition Department
Faculty of Agriculture
Cairo University
Giza, Egypt

A. Mehrez
Faculty of Agriculture
University of Mansoura
El-Mansoura
Egypt

A. El-Sherbiny
Animal Production Research Institute
Dokky
Cairo, Egypt

A. Shalaby
Cairo University
Faculty of Agriculture
Department of Animal Production
Animal Nutrition
Giza, Egypt

I. Soliman
Animal Production Institute
Dokky
Cairo, A.R. Egypt

APPENDIX 2

Report of Trip to Germany, Italy, Turkey, Syria, and Jordan

May 30 to July 4, 1977

Leonard C. Kearl

International Feedstuffs Institut
Animal, Dairy, and Veterinary Sciences Department
Utah State University
Logan, Utah

GERMANY (June 1-5)

Dokumentationsstelle der Universitat Hohenheim, Stuttgart.

Personnel

Mr. F. Jager
Mrs. Neese
Mrs. Mier
Dr. Friede

Discussion

Work was done concerning the name changes needed to make the German and U.S. systems compatible for data exchange by computer. Three INFIC publications were discussed and a time frame for final publication was agreed to.

Recommendations

It was decided to proceed to make the necessary changes in the feed vocabulary and to work toward developing a common short name in English that could be translated and used in both languages (German and English).

ITALY (June 5-8)

The Food and Agricultural Organization (FAO), Rome

Personnel

Dr. Bunnell
Dr. Chenost
Dr. S. A. El Shishtawy

Discussion

Discussions were centered around extension of the feed composition project into the near and Middle East and possible sources of obtaining funds to establish and operate a regional INFIC center in Jordan. Dr. Bunnell and Dr. El Shishtawy each felt the Arab League or one of the organizations sponsored by the Arab League would be the most likely source of funds.

FAO (Dr. Chenost) wishes to maintain liason with INFIC and participate in the activities as time and funds permit.

Recommendations

It is felt that a representative of FAO should participate in INFIC meetings. His input on conditions prevailing throughout the developing countries would be invaluable. Also, he should be kept informed of new developments taking place within INFIC, especially, information concerning on-going projects in the developing countries

TURKEY (June 8-21)

EGE University (Izmir-Bornova)

Personnel

Prof. Dr. Sukru Bulgurlu
Prof. Dr. Fevzi Sevgican
Mr. Bulent Pekerten
Mr. Moh'd Kamel Khaled

Discussion

The role of INFIC and the part IFI plays was explained to the staff. The objectives of publishing a Mid East feed table and establishing a regional center in the area were explained. The Animal Science Department will cooperate in these programs. They are doing some digestion trials with dairy cattle and sheep. The facilities are fair. Data were transcribed from their laboratory records to source forms. These were mailed to IFI from Izmir.

Recommendation

Continued cooperation should be maintained with personnel at EGE University. They are most cooperative in sharing their information and promoting the objectives of INFIC.

Ataturk University (Erzurum)

Personnel

Prof. Dr. Ali Ozdengiz
Doc. Dr. Ahmed Cakir
Mr. Hakki Emsen
Dr. Sumer Hasimoglu
Dr. Ibrahim Manga
Dr. Ayhan Aksoy

Discussion

Discussions were centered around the input of feed composition data into the Mid East databank. A Memorandum of Agreement was entered into whereby they would transcribe data from their labor atory records to INFIC source forms and forward them to IFI Five hundred dollars was paid for this service.

Recommendation

Data from Ataturk University was entered into the Mid East databank. Continued cooperation should be maintained.

Grassland and Animal Husbandry Research Institute (Ankara)

Personnel

Dr. Nazmi Alinoglu
Dr. Ozer Kurt
Mr. Ali Karabulut

Discussion

This was a follow-up to our original discussion of 1975. The need for a center in the Mid East was stressed and support for one located in Jordan was agreed to. Director Alinoglu has excellent research facilities and is carrying on numerous animal and plant projects.

Recommendations

Continued cooperation between IFI and GAHRI should be maintained.

Ankara University (Ankara)

Personnel

Prof. Dr. Remzi Akyildiz

Discussion

An agreement was reached where personnel at Ankara University would transcribe current laboratory records to source forms. Five hundred USD were paid for this service. Also, translation were made from Turkish to English of a feed composition table published by the Animal Science Department, Ankara University

Recommendations

Cooperation should be continued with personnel at Ankara University.

Ministry of Agriculture (Ankara)

Personnel

Dr. Osman Yavuz
Dr. Gunther Vogt

Discussion

Dr. Vogt is a German assigned to Ankara for the purpose of establishing a feed control laboratory. This facility will b equipped for most all types of chemical analysis. The staff will be trained in Germany in the very latest techniques and procedures used in feed evaluations. Dr. Vogt has agreed to provide data to IFI when the facility becomes operational (possible 1978).

Recommendations

Continued cooperation with Dr. Vogt should be maintained.

SYRIA (June 22-25)

Damascus University (Damascus)

Personnel

Dr. Issa Hassan
Dr. Mohamed Ibraham
Dr. Abouzakhem Abdallah
Dr. Ghanem Haddad

Discussion

The role of INFIC and the need for cooperation in the exchange of feed composition data were stressed. The staff agreed to cooperate in anyway they could in order to forward the completion of the objectives and publish tables on feed composition for the Mid East. They agreed to support, by providing data to a regional INFIC center.

Recommendations

Continued correspondence should be maintained with the staff.

Nutrition Section, Animal Science Division, The Arab Center for the Study of Arid Zones and Drylands (ACSAD)

Personnel

Dr. Mohamed F. A. Farid
Dr. Ghanaim

Discussion

The role of INFIC and the need for a regional center in the Mid East was stressed. Dr. Farid reported he was working through ACSAD, to collect feed composition data in 21 Arab countries. The possibility of ACSAD becoming a regional center to serve the Mid East countries was discussed.

Recommendations

ACSAD should be considered as a possible host for the INFIC center in the Mid East. They have access to excellent computer facilities in Damascus or Cairo, Egypt. Dr. Farid thinks this is a possibility. Further discusions should be held on this subject.

General Organization for Feed (Damascus)

Personnel

Mr. Adel Jarmukli
Dr. Ibraham Azar

Discussion

These gentlemen are involved in the formulation of commercial feeds in Syria. Our discussions were concerned with the need for reliable feed composition data to be used in formulating livestock and poultry diets. These men agreed there is a need for additional information on the ingredients they are using in mixing commercial feeds in Syria.

Recommendations

Occasional correspondence should be maintained to ascertain the kinds of information needed by the feed industry.

JORDAN (June 25 - July 1)

University of Jordan (Amman)

Personnel

Dr. Ahmad Faqih
Dr. Subhi Qasem
Mr. George Goddard
Dr. Talal Nassar
Dr. I. A. Dyer

Discussions

The main point of our discussion was to determine ways or securing funds to establish a regional INFIC center at the University of Jordan to collect, process and store data from the Middle East countries

Discussions (cont'd.)

Dr. Dyer suggested that a proposal be prepared and submitted to the Jordan National Planning Council (NPC) for consideratio It was determined to be prudent to delay submission of this proposal until extension of the AID contract with IFI was appr The current AID contract with IFI is due to terminate November 15, 1977. Approval for the Animal Science Department to engag in this project was granted by Dr. Qasem, Dean of the College of Agriculture (UJ).

Feed data to enter into the Mid East databank were furnished to IFI by Dr. Faqih.

Recommendations

Assistance should be provided in helping the University of Jordan in obtaining the necessary funds to carry on the activities of a regional INFIC center.

Agency for International Development

Personnel

Mr. Richard Burke, Ankara, Turkey
Mr. Donald Yeaman, Damascus, Syria
Mr. John Hyslop, Amman, Jordan

Discussion

Each of the above AID representatives were very helpful in providing assistance in making appointments, counseling on important cultural and professional ethics and providing transportation.

Summary

The main objectives of the trip were accomplished. Agreement on technical prob lems was achieved in Hohenheim. Some data was collected and continued support f the project was assured in Turkey. ACSAD (Syria) is engaged in a similar feed collection project throughout 21-22 Arab countries. Dr. M. F. A. Farid is in charge of this program and he agreed to work with IFI in achieving our mutual goals. It was suggested that maybe ACSAD assume the responsibilitie of an INFIC center. They are financed by the Arab League, but their budget does not provide sufficient funds for computer work. For the time being, this would have to be done in Utah. The University of Jordan expressed an interest in hosting an INFIC center. They have no funds, however, and were to submit a proposal to the Jordan National Planning Council in an effort to obtain the necessary financial support. The College of Agriculture (UJ) approved organizing the project as a part of the Animal Science Department.

APPENDIX 3

Report of Trip to Guatemala and Costa Rica

September 22-30, 1977

L. E. Harris and L. C. Kearl

International Feedstuffs Institute
Animal, Dairy and Veterinary Sciences Department
Utah State University
Logan, Utah

GUATEMALA

Purpose

To visit with Dr. Ricardo Bressani, Director, Instituto de Nutricion Centro America y Panama, Guatemala City, Cuatemala concerning mutual interests in animal nutrition studies.

Commentary and Evaluation

Various aspects of international emphasis on protein and carbohydrate utilization in human and animal diets were discussed. Procedures to be used in acquiring chemical and viological values generated in research laboratories throughout Latin America were reviewed. Dr. Bressani agreed to support an INFIC center in San Jose. On-going projects at the Institut de Nutricion Centro America y Panama were visited.

The meetings were fruitful and alternative approaches to many of the problems faced in organizing a feed composition center were brought forth. Dr. Bressani and Dr. M.T. Cabezas were helpful in providing this information to us. Dr. Bressani was unable, because of a prior commitment to attend the workshop in San Jose. Dr. Cabezas, however, was able to take place on the program.

COSTA RICA

Purpose

To attend a workshop in San Jose for the purpose of organizing an INFIC center and appointing Feeding Systems Committees within the framework of the Latin America Society of Animal Production (ALPA).

Commentary and evaluation

Sixteen speakers representing eight countries presented papers at the workshop. The topics covered feeding systems used for dairy cattle, beef cattle, swine and poultry. Also, the INFIC story was presented to those in attendance. During the final day, the Latin Americans discussed the pros and cons on the organization of an INFIC center and appointing feeding systems committees. The decisions were resolved in favor of organizing an INFIC Program contingent upon funding. They worked up a resolution favoring the formation of feeding systems committees to be presented to the Society of Animal Production for Latin America at their bi-annual meetings to be held in Cuba, December, 1977.

A decision to present a proposal to the Instituto Interamerican de Ciencias de Agricolas (IICA) san Jose, Costa Rica to host the INFIC program was made. Plans are going forward at this time and hopefully IICA will render a favorable decision in the near future.

The membership at the ALPA meetings approved a resolution to form a committee to study nutrient requirements of grazing animals and to report their findings.

GUATEMALA

R. Bressani
Institute of Nutrition of
Central America and Panama
Guatemala City, Guatemala

M. Cabezas
Institute of Nutrition of
Central America and Panama
Guatemala City, Guatemala

R. Jarquin
Institute of Nutrition of
Central America and Panama
Guatemala City, Guatemala

COSTA RICA

J. Buitrago
Centro International de Agricultura Tropical
Cali, Colombia

M. Cabezas
Institute of Nutrition of Central A
and Panama
Guatemala City, Guatemala

D. Carlson
University of California
Davis, California

G. Cubillos
Centro Agronomico Tropical de
Investigacion y Ensenanza
Tumiella, Costa Rica

C. Chicco
Centro Nacional de Investigaciones
Agropecuarias
Maracay, Venezuela

H. Fonseca
University of Costa Rica
San Jose, Costa Rica

H. Munoz
Centro Agronomico Tropical de Investigacion
y Eusenanza
Turrialba, Costa Rica

O. Paladines
Centro Internacional de
Agricultura Tripical
Cali, Colombia

V. Quiroga
Instituto Interamericano de Ciencias
Agricolas
San Jose, Costa Rica

M. Ruiz
Centro Agronomico Tropical de Investigacion y Ensenanza
Turrialba, Costa Rica

M. Tapia
Instituto Interamericano de Ciencias Agricolas
La Paz, Bolivia

F. Torres
Instituto Nacional de Tecnologia Agropecuaria
Buenos Aires, Argentina

C. Wernli
Instituto de Investigaciones Agropecuarias
Santiago, Chile

E. Jimenez
Universidad Central de Venezuela
Maracay, Venezuela

N. Raun
Chief, Livestock Division
DS-Agr. USAID
Rosslyn Plaza, 406 C
Washington, D.C. 20523

L. Harris
International Feedstuffs Institute
Utah State University
Logan, Utah, USA 84321

L. Kearl
International Feedstuffs Institute
Utah State University
Logan, Utah USA 84321

M. Genis (Interpreter)
Institute Interamericano de
Ciencias Agricolas
San Jose, Costa Rica

APPENDIX 4

This is a report from Dr. Ahmad Faqih, of the University of Jordan, concerning the progress he is making in organizing a Society of Animal and Range Science.

SUBJECT: The Middle East Society for Animal and Range Science.

I would like to inform you that an an hoc committee was formulated during the last session of the Workshop on Middle East. It was composed of Abou Rayya (Egypt), Sefidbackt (Iran), Akylidiz (Turkey), and Faqih of Jordan as a chairman. The main objective of the committee is to improve animal production and ranges through gathering and dissimination of informatio related to animals, feedstuffs and ranges. This could be brought about by formulating a mother organization for countries in the Middle East. The name of this organization was proposed to be "Middle East Society for Animal and Range Science." One scientist from every Middle Eastern country will serve as a member in the mother organization. The members will meet once every two or three years and exchange scientific knowledge related to animal industry and wealth. It was proposed that the Director of the International Network of Feed Information Centers (INFIC), Professor Harris of Utah State University at present will serve as a permanent member. It was also suggested by Dr. Vogt that another permanent member will be the director of "Dokumentationsstelle der Universitat Hohenheim, Germany

A branch of the mother organization shall be formulated in every country. For example, a Jordanian branch may be called as "Jordanian Society for Animal and Range Science." The executive members of this branch will be elected by the general body of any existing society or association that represents animal agriculture. The national branch of the society for Animal and Range Science should consist of members who have the know-how and are at the front lines of knowledge on livestock and

poultry in so far as their nutrition requirements, feeding systems, healt and disease, management, and evaluation of feedstuffs and ranges.

Finance for the national societies should be sought according to every countries situation. For example, dues from members, contributions from individuals, private feed companies, livestock farmers as well as government subsidies all should be looked at as sources for finance.

This was a brief expose about initiating the "M.E. Society for Anima and Range Science" both at the Middle-Eastern and local levels. Without your support and understanding of the functions and responsibilities of this society, nothing can materialize. After all, every country should work for the improvement and advancement of its animal wealth and ranges.

Looking forward for your reply including any questions and comments.

Ahmad M. Faqih, Acting Head
Department Animal Production and Protection
Faculty of Agriculture
University of Jordan
Amman, Jordan

APPENDIX 5

Publications

Kearl, Leonard C., Lorin E. Harris and Howard Lloyd. Middle East Tables of Feed Composition. Utah Agri. Expt. Sta. Research Report 30. November 1977. (This paper is being revised; copies will be forwarded when it is complete.)

INTERNATIONAL FEED VOCABULARY[1]

Lorin E. Harris and Leonard C. Kea[2]
International Feedstuffs Institute
Utah State University
Logan, Utah

SUMMARY

To overcome the confusion in naming feeds, and International Fe Vocabulary has been devised. Feed names are constructed by combining compenents within six facets: (1) origin, including scientific name (Genus, species, variety), common name (common origin, species, variety) and chemical formula where appropriate; (2) part fed to animals as affectec by process(es); (3) process(es) and treatments(s) to which the origin of part eaten was subjected to prior to being fed to the animal; (4) stage of maturity and development (applicable to forages and animals); (5) cutting (primarily applicable to forages); (6) grade (official grades and guarantees, etc.,). Only sufficient components are used to describe each feed.

In addition, feeds are separated into eight classes: (1) dry forages and roughages, (2) pasture, range plants, or forages fed green (3) silages, (4) energy feeds, (5) protein supplements, (6) mineral supplements, (7) vitamin supplements, and (8) additives. Each class represents a special characteristic peculiar to a given group of feed products.

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[1]A report on Project 079, Journal Series No. 2252. This research was partly financed by the United States Agency for International Developr under contract number AID/TA-C-1159 entitled "Increasing Livestock Production Through Improved Nutrition Information."

[2]Director, International Feedstuffs Institute and Professor, Animal, Dairy, and Veterinary Sciences Department; Associate Director, Interna Feedstuffs Institute and Research Associate, Animal, Dairy, and Veteri Sciences Department, respectively.

A six-digit "International Feed Number" is assigned to each feed. The first digit of this number denotes the class of feed. The remaining digits are assigned consecutively but never duplicated. The reference number is used in computer programs to identify the feed for use in calculating diets, for summarization of the data, for printing feed composition tables and for retrieving on-line data on a specific feed.

The purpose of the International Feed Vocabulary is to promote cooperation among research scientists. teachers,extension workers, feed manufacturers and producers.

Key words: feed vocabulary, feed names, feed numbers, feed class, feed parts, feed process.

INTRODUCTION

The collection of feed analyses data and animal feeding trials began more than one hundred years ago. Since the beginning of this century, there has been a tradition of compiling feed composition tables similar to those of Kellner (1905) in Germany and Henry (1898) in the USA. It would seem to be more than mere coincidence, however, that fifty years later separate centers of feed data documentation were established concurrently in Germany (Haendler, 1963; Haendler and Jager, 1971) and in the United States (Harris, et al., 1968).

Research that is effective in determining the nutrient requirements of animals on the one hand, and establishing the need for more accurate information about composition and nutritive values of feeds on the other, requires specialized methods of processing large amounts of data.

With the expansion of food technology and the use of more fabricated human foods, an increasing number of human food by-products suitable for animal feeding are available. This increases the problems associated

with feed nomenclature. Nonforage diets of many domestic animals no longer consist primarily of unaltered farm-produced grains. Even when entire grains are used in diets, they often go through commercia channels where cleaning, grading, blending, and possibly grinding, pelleting or extruding have resulted in products nutritionally unlike the crop originally harvested. Oftentimes, these changes will have a significant effect up the nutritional value of the product.

RATIONALE FOR NAMING FEEDS

Feed control officials approve names for feeds and describe processes 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 those naming feeds an international system was proposed (Harris, 1963; Harris et al., 1968). This system was modified by a joint working party, Logan-Hohenheim-Maisons-Alfort, and is now known as the International Feed Vocabulary.

The international feed vocabulary is now in wide-spread use in North and South America and its principles have been adopted by INFIC. It has been designed to minimize feed identification problems by assigning descriptive names to feeds and it offers a system with the potential for international standardization. A description of the INFIC international feed vocabulary is outlined below.

A Glossary of definitions of miscellaneous nutrition terms are given by Harris et al. (1968).

INTERNATIONAL FEED VOCABULARY

The International Feed Vocabulary is designed to give a comprehensive and concise name to each feed. A complete name may have as many as six individual components. Each component describes an essential attribu in evaluating a feed. These components are arranged in six facets:

- origin, including scientific name (Genus, species, variety), common name (common origin, species, variety) and chemical formula
- part fed as affected by process(es)
- process(es) and treatment(s) to which the origin of part offered was subjected to prior to being fed to the animal
- stage of naturity and development (applicable to forages and animals).
- cutting (primarily applicable to forages)
- grade (official grades with guarantees, etc.,)

The following is a description of each facet.

Facet 1: Origin

The origin or parent materials is of three types:

- for plants
  - specific
  - nonspecific
- for animals
  - specific
  - nonspecific
- for minerals, chemical products and drugs.

For specific plants and animals, the origin facet is divided into:

scientific name
- genus
- species
- variety or kind

common name (in English, German, French, ...)
- common origin
- species
- variety or kind

For a feed derived from a plant, the common origin is the name of the plant (e.g. Clover, Wheat, Oats).

For a feed derived from a mammal or poultry the common origin is the name of the animal(e.g. Cattle, Horse, Whale, Turkey).

For a feed derived from plants, ammmals, birds, or fishes, common origin is followed by species and variety if the specific origin

is known (e.g. Clover, white; Cattle, Hereford; Chicken, white leghorn; and Fish, cod).

For feeds without a specific origin, common name is only used (e.g. Bread, Animal, Poultry, Fish...).

Minerals, drugs and chemicals are listed according to the nomenclature of the International Union of Pure and Applied Chemistry.

Facet 2: Part offered to the Animal

This component of the feed name consists of the actual part of the parent material given in the diet. In the past, the edible parts of plants and animals were considered to be mostly the obvious-leaves, stems, seeds, meat trimmings, milk or bone. Today, due to the extensive fractionation of plant seeds and the reconstituting of many of the parts into new processed foods, innumerable by-products are available for animal feeding, as are those by-products from the pareparatio of table meats and fish.

For forages, the term aerial parts, has been used to replace forage. Fodders are designated as aerial parts with ears with husks (or heads), and stovers, as aerial parts, without ears without husks (or heads). For range plants, where only a selected portion of the plant is actually eaten, the term browse is used.

Definitions of parts are given by Harris et al(1968). Examples of definitions are:

Bran. The pericarp of cereal grai

Cob. The fibrous inner portion of the ear of corn from whic kernels have been removed.

Germ. The embryo found in seeds and frequently separated from the starchy endosperm during milling.

Facet 3: Process(es) and Treatment(s)

Numerous processes may be used in the preparation of animal feeds. Some of these may affect the feeding value of the products, while heat may damage some nutrients it may make others more available.

Grinding and pelleting usually encourage increased consumption and and increase in the digestibility of the cellulose and protein. Also, such treatments alter the proportions of the lower fatty acids produced by rumen microflora in lactating cows, thus decreasing the quantity of fa in the milk.

It is important, then that a feeder be aware of the processes to which a feed has been subjected. Also, the type of animal and its physiology must be considered relative to these factors. Therefore, origin and part terms will be followed by those distinguishing the different methods of processing, alone or combined (separation of particles by size, reducing particle size, heat processing, binding particles together, chemical treatments, biological treatments, e. g., sun-cured, dehydrated, ensiled,...).

If a feed has not been processed, the term "fresh" is used. The term dehydrated means those feeds artifically dried. "Fan air dried" indicates those hays dried indoors by air convection.

The term, "mechanically extracted" (mech extd) has been used in place of expeller extracted, hydraulic extracted or old process. This new term was adopted by the Association of American Feed Control Officials in 1965 and is defined in their latest handbook (AAFCO, 1977) as follows: Extracted, mechanical. (Process) Having removed fat or oil from materials by heat and mechanical pressure. Similar terms: expelle extracted, hydraulic extracted, "old process."

Definitions of processes are given by Harris et al. (1968). Examples of definitions are:

Dehydrated. Freed of moisture by heat.

Dry rendered. Residues of animal tissues cooked in open steam-jacketed vessels until the water has evaporated; fat removed by draining and pressing the solid residue.

Facet 4: Stage of Maturity or Development

The stage of maturity may not be important or even apply to many feeds such as grain by-products, but for forages it is probably the most important factor influencing their nutritive values. Alfalfa (lucerne) is an example of this. With increasing maturity, the cell wall content increases, resulting in reduced digestibility. Table 1.

The age of animals influences the body composition and their by-products. As animals mature, the fat content usually increases while the water and protein content decrease.

Facet 5: Cutting or Crop

Many forage crops are cut and harvested several times during the growing season. Feeds from each cutting have different nutrient composition and physical properties. The cutting or crop component of the name refers to the sequence of cutting from the first to the last (cut 1, cut 2, etc.). Comparable terms would be first cut, second cut, etc. Maturity terms refer to the stage of growth or regrowth (Table 1), and therefore, must be considered within the cutting or crop.

In tropical and subtropical areas crops may be cut throughout the year, particularly if they are irrigated. The time to start counting cutting for non-irrigated forages would be the first rainy season each calander year.

Since stage of maturity is more important than cutting date, the various cuts for forages are sometimes combined with the stage of maturity when data are summarized for feed composition tables.

Facet 6: Grade or Quality Designations

Commercial feeds and feed ingredients are, in some cases, subject to government grading in certain countries and are sold on a quality description basis. Thus, these grades and quality designations must be included as a definitive component of a fully descriptive feed name. Sometimes a certain attribute such as protein is guaranteed. These quality or content guarantees are listed in the grade component of the name as "more than" (minimum) and "less than" (maximum) of various attributes such as crude fiber, protein, fat, etc. As a guide in establishing the grade components, the terms used by the European Committees, the USA Association of American Feed Control Officials (AAFCO) Handbook (1977), the Canada Feeds Act (1967), and industry were consulted. Hay grades in the USA are being revised (Rohweder et al. 1976).

Classes of Feeds

Feeds are classified into groups that have similar properties to be considered in formulating feed mixtures and diets. These international feed classes are as follows:

Code Class Description

Dry forages and roughages

- Hay
  - Legume
  - Nonlegume
- Straw
- Fodder (aerial part with ears with husks or with heads)
- Other products with more than 18 percent fiber
  - Hulls
  - 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 the high fiber content.

2 Pasture, range plants, and forages fed green

Included in this group are all forage feeds not cut and cured; for example; all feeds cut and fed green, or feeds cured on the stem, such as dormant range plants. The term "fresh" is used as a process term for most of these feeds even though they may be dry and weathered when consumed.

3 Silages

Maize (corn)

Legume

Grass

Forages that preserved by ensiling

4 Energy feeds

Cereal grains

Mill by-products

Fruits

Nuts

Roots

Products with less than 20 percent protein and less than 18 percent crude fiber are classified as energy feeds.

5 Protein supplements

Animal

Avian

Marine

Milk

Plant

Products which contain 20 percent or more of protein (N x 6.25)

Mineral supplements

Vitamin supplements

Additives

Antibiotics

Coloring material

Diluents

Flavors

Hormones

Medicants

Where additional data are obtained, perhaps the digestible energy content or cell wall content should be used to help classify feeds (Fonnesbeck, 1976, Rohweder, 1976).

A special problem occurs with feeds which, on the basis of their composition, meet the criteria for several classifications. Alfalfa, aerial part, dehy ground can be considered a forage on the basis of its fiber content, a protein supplement on the basis of its protein content, or a vitamin supplement because of its carotene content; and indeed, this product is used for all three purposes. Brewers yeast can be considered both a protein and a vitamin supplement. In such circumstances, the regular use of the main body of feeds to which the feed in question belongs is considered. Thus, alfalfas are most usually used as forages for ruminants, so dehydrated alfalfa meal is considered as a forage, and most yeast products are used as vitamin supplements, so brewers yeast is classified as a vitamin supplement.

International Feed Number

The six-digit international feed number (IFN) listed after each name

is used for control purposes to identify each feed for summarization and retrieval of data. This number may also be used as the "numberical name" of a feed when using an electronic computer to calculate diets. Note the first digit of the feed number is its class designation. This number is also listed after each "Legal Feed Definition" in the USA AAFC Handbook (1977).

Example of an International Feed Name

The system of naming may be illustrated by the following example. The first column indicates the name component and the second, its description.

Genus.....Medicago

Species.....sativa

Origin.....Alfalfa

Variety.....ranger

Part.....leaves

Process.....dehydrated pelleted

Stage of maturity.....early bloom

Cutting.....cut 1

Grade.....grade 1

Class.....(1)

The example illustrates the principle that complete international names of a feed consist of all component terms applicable to that feed. When a component is not needed to describe the feed, it is left out. When written in linear form, the name components are separated by commas, but without other punctuation. For consistency, only the first letter of the name, the first letter of proper names, and the first letter of element symbols are capitalized. Thus, the feed identified by the above example when written linearly becomes: (Medicago sativa), Alfalfa, ranger,

leaves, dehydrated pelleted, early bloom, cut 1, grade 1. It is important that each component is in a certain order.

Official Country Names

American Association of Feed Control Officials (AAFCO) (1977) names are designated by "AAFCO" and Canada Feed Act (CFA, 1967) names by "CFA".

These official names cannot be used as international names because they are usually either incomplete or do not begin with the "origin" or parent material.

For example:

AAFCO name-Condensed whey

International Feed Name-Bos spp Cattle, whey, condensed

Official names from other countries will be added as they become known. In Europe the official names are determined and defined by authority of the European Communities.

Short Feed Names

In cases in which the International Feed Name gives more detail than is necessary for use in feed composition tables, short feed names have been substituted, but the essentials of the system have been maintained. It will be noted in Talbe 2, that English short feed names, are given in the first column. The difference between the short names and the international names is that where components are understood they are left out in the short names.

The Journal of Animal Science and the National Academy of Sciences Nutrient Requirement Series are now using the short feed names.

List of International and Short Feed Names

A few international and short feed names are given in Table 2.

The purpose of the International Feed Vocabulary is to promote cooperation among research scientists, teachers, extension workers, feed manufacturers, and producers.

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TABLE 1 Stage of Maturity Terms

Preferred Term	Definition	Comparable Terms
For Plants That Bloom		
Germinated	Stage in which the embryo in a seed resumes growth after a dormant period	Sprouted
Early vegetative	Stage at which the plant is vegetative and before the stems elongate	Fresh new growt florescence emergence, immature, prebud stage, very immature, young
Late bloom	Stage at which stems are beginning to elongate to just before blooming; first bud to first flowers	Before bloom, bud stage, budding plants, heading to in bloom, heads just showing, jointing and boot (grasses), prebloom, preflowering, stems elongated
Early bloom	Stage between initiation of bloom and stage in which 1/10 of the plants are in bloom; some grass heads are in anthesis	Early anthesis, first flower, headed out, in head, up to 1/10 bloom
Mid-bloom	Stage in which 1/10 to 2/3 of the plants are in bloom; most grass heads are in anthesis	Bloom, flowering, flowering plants, half bloom in bloom, mid anthesis
Full-bloom	Stage in which 2/3 or more of the plants are in bloom	3/4 to full bloom, late anthesis
Late bloom	Stage in which blossoms begin to dry and fall and seeds begin to form	15 days after silking, before milk, in bloom to early pod, late to past anthesis
Milk stage	Stage in which seeds are well formed but soft and immature	After anthesis, early seed, fruiting, in tassel, late bloom to early seed, past bloom, pod stage post anthesis, post bloom, seed developing, seed forming, soft, soft immature
Dough stage	Stage in which the seeds are of dough-like consistency	Dough stage, nearly mature, seeds, dough, seeds well developed, soft dent
Mature	Stage in which plants are normally harvested for seed	Dent, dough to glazing, fruiting, fruiting plants, in seed, kernels ripe, ripe seed
Post ripe	Stage that follows maturity; seeds are ripe and plants have been cast and weathering has taken place (applies mostly to range plants)	Late seed, over ripe, very mature
Stem cured	Stage in which plants are cured on the stem; seeds have been cast and weathering has taken place (applies mostly to range plants)	Dormant, mature and weathered, seeds cast
Regrowth early vegetative	Stage in which regrowth occurs without flowering activity; vegetative crop aftermath; regrowth in stubble (applies primarily to fall regrowth in temperate climates); early dry season regrowth	Vegetative recovery growth
For Plants That Bloom Intermittently[a]		
1 to 14 days growth	A specified length of time after plants have started to grow.	2 week's growth
15 to 28 days' growth	A specified length of time after plants have started to grow.	4 weeks' growth
29 to 42 days' growth	A specified length of time after plants have started to grow	6 weeks' growth
43 to 56 days' growth	A specified length of time after plants have started to grow.	8 weeks' growth
57 to 70 days' growth	A specified length of time after plants have started to grow.	10 weeks' growth

[a]These classes are for species that remain vegetative for long periods and apply primarily to the tropics. When the name of a feed is developed, the age classes form part of the name (e.g., Alfalfa, aerial part, 15 to 28 days' growth). For plants growing longer than 70 days, the interval is increased by increments of 14 days.

TABLE 2 Short, International, American Association of Feed Control Officials (AAFCO), Canada Feed Act (CFA) and Other Feed Names

International feed number	Common origin. *Scientific name* Short feed name	Common origin. *Scientific name.* International feed name American Feed Control (AAFCO) Canada Feed Act (CFA) Other feed names
	ALFALFA. *Medicago sativa*	ALFALFA. *Medicago sativa*
1-00-078	-hay, sun-cured	-aerial part, sun-cured
1-00-050	-hay, sun-cured, early vegetative	-aerial part, sun-cured, early vegetative
1-00-054	-hay, sun-cured, late vegetative	-aerial part, sun-cured, late vegetative
1-00-059	-hay, sun-cured, early bloom	-aerial part, sun-cured, early bloom
1-00-063	-hay, sun-cured, midbloom	-aerial part, sun-cured, midbloom
1-00-068	-hay, sun-cured, full bloom	-aerial part, sun-cured, full bloom
1-20-681	-hay, sun-cured, late bloom	-aerial part, sun-cured, late bloom
1-20-841	-hay, sun-cured, milk stage, grade 4	-aerial part, sun-cured, milk stage, grade 4
1-00-023	-meal dehy, 17% protein	-aerial part, dehy ground 15 to 17% protein
1-00-024	-meal dehy, 20% protein	-aerial part, dehy ground 17 to 20% protein
3-00-212	-silage	-aerial part, ensiled
3-00-221	-wilted silage	-aerial part, wilted ensiled
	BANANA. *Musa spp*	BANANA. *Musa spp*
4-00-485	-fruit, fresh	-fruit, fresh
4-26-157	-fruit without peelings, dehy	-fruit without peelings, dehy
	CATTLE.	CATTLE. *Bos taurus*
5-01-166	-livers, fresh	-livers, fresh
5-01-175	-milk, skimmed dehy	-milk, skimmed dehy
4-01-182	-whey, dehy	-whey, dehy
	FISH.	FISH.
5-01-977	-meal mech extd	-whole or cuttings, boiled mech extd ground
5-26-185	-whole, fresh	-whole, fresh
	FISH, ANCHOVY. *Engraulis ringen*	FISH, ANCHOVY. *Engraulis ringen*
5-01-985	-meal mech extd	-whole or cuttings, boiled mech extd ground
	SOYBEAN. *Glycine max*	SOYBEAN. *Glycine max*
5-04-600	-seeds, meal mech extd	-seeds without oil, mech extd ground
5-20-637	-seeds, meal solv extd, 44% protein	-seeds without oil, solv extd ground, 44% protein
5-04-612	-seeds without hulls, meal solv extd	-seeds without hulls without oil, solv extd ground
	WHEAT. *Triticum aestivum*	WHEAT. *Triticum aestivum*
4-05-190	-bran	-bran, dry milled
5-05-221	-gluten	-gluten
1-05-175	-straw	-straw
4-26-205	-grain, soft red spring	-grain

THE INTERNATIONAL NETWORK OF FEED INFORMATION CENTERS[1]

Leonard C. Kearl and Lorin E. Harris[2]

International Feedstuffs Institute
Utah State University
Logan, Utah

Summary

The aim of INFIC is to combine (by using the computer) world data on the composition and nutritive value of products that are or may be used as feeds, and to provide abstracts of, and references to, other information about feeds. As an essential prerequisite for successful exchanges between existing data stores and for organizing future input to a common data base, agreement has been established on a miltilingual international feed vocabulary, on information coding, data structure and computer programming. Efforts are being made to establish regional centers in developing countries where feed composition information can be collected, documented and retrieved.

The output of the common data base may take many forms depending on the needs of users which can include conventional feed composition tables, replies to specific inquiries, or on-line data. The output of the system is also immediately applicable in computer programming operations that formulate most-profitable diets.

INFIC can uniquely service advisers in developing countries; it also incorporates services of proven value for the technically advanced countries.

To become fully successful, INFIC requires the collaboration of all laboratories that produce or hold information on feeds, particularly in developing countries, and continued support from funding agencies.

Key Words: network, feed centers, feed data banks, feed nomenclature, feed vocabulary, feed abstracts.

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[2]Associate Director, International Feedstuffs Institute and Research Associate, Animal, Dairy, and Veterinary Sciences Department; Director, International Feedstuffs Institute and Professor, Animal, Dairy, and Veterinary Sciences Department, respectively.

Introduction

The degree of development achieved by a country largely depends upon the extent and utilization of its resources. Relatively little can be done to increase supplies of natural resources, but there are innumerable ways to improve their utilization. The natural and cultivated forage that can be utilized by wild and domestic livestock is a most important factor in the production of animal products, but this resource is often mismanaged. Primary attention must be given to assisting national and regional organizations to achieve efficient use of their resources.

Developed countries with large scale systems of animal production have recorded and stored much data on the composition of feeds and the nutrient requirements of the more important species of domestic animals. Also, computer software has been developed which identifies alternative ways of using these materials in formulation of animal diets.

Developing countries, however, lack basic data on the chemical, physical and biological values of their feeds. Cereal grains and other products suitable for human foods are generally not available for use in animal diets in developing countries. Instead, forages and by-products from the production of human foods are the primary feeds, and these require individualized analyses.

Because environmental factors affect the chemical and physical properties of plant species, applications of nutritional principles have to take into account the conditions prevailing in a given region. These factors point to an urgent need to generate data through applied nutrition research in all countries.

The utilization value of feeds in terms of their economic value and the nutritional requirements of animals must be precisely known before profitable animal diets can be formulated. A major problem in present feed evaluation is the scarcity of reliable data. A world data bank should contain nutritional information about all feeds used in formulating animal diets. In addition, that information should express feed energy values in terms compatible with those describing the energy requirements of animals.

Efficient and effective data exchange among countries and regions requires an international feed vocabulary to accurately describe materials used as animal feeds, and standard methods for chemical and biological analyses of feeds. These requisites must be fulfilled before data can be processed and entered into data banks that can service all countries.

Background

In the early nineteenth century scientists were able to begin classifying feeds according to their chemical composition. The earliest recorded feed tables are those of Thaer (1809) who classified hays according to their content of acid and alkali soluble material. Later, Boussingault (1843) published a table of "hay equivalents" that compared feeds on the basis of their nitrogen content.

Wolff (1874) and Lehmann (1899) expressed feed values in terms of digestible nutrients. These concepts took into consideration differences between feeds in nutrient losses during digestion. This work was expanded by Kellner (1905) in Germany and Armsby (1903) in the United States who, working independently, observed and catagorized differences between feeds in the amount of energy lost during metabolism.

The work of Wolff was expanded in the United States by Atwater (1874). His methods were modified by Henry and Morrison (1910) and became known as the total digestible nutrient (TDN) system. The concepts of digestible, metabolizable and net energy were the outgrowth of work by Armsby (1903) and Kellner (1905).

The TDN and calorie system approaches to defining the nutritive value of feedstuffs have continued up to the present time. Feed composition tables were published in the United States in Morrison's "Feed and Feeding" until the 22nd edition which appeared in 1956. The introduction of digestible nutrients by species of animals first appeared in Schnieder's "Feeds of the World" (Schnieder 1947).

In 1952, the United States National Academy of Sciences recognized the need for a review of feed composition information. This resulted in two publications, one on the composition of concentrates (NRC 1956) and one on the composition of forages and grains (NRC 1958).

Within recent years comprehensive tables of feed composition have been published (NAS 1971; McDowell 1974; Göhl 1975; and ARC 1976).

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 the United States, two separate centers of feed data documentation were built up. The German documentation began in 1949 (Haendler, 1963: Haendler and Jager, 1971); and the United States documentation began in 1952 (Harris et al. 1968).

Although there was some contact between the centers for several years, it was not possible to combine or adapt the two systems to each other. Personnel at the Utah (United States) center contacted FAO concerning the need for world cooperation. FAO, in turn, sent a consultant to visit various centers that were compiling data on feed composition (Alderman, 1971). This resulted in two informal meetings at FAO headquarter in Rome in 1971 and 1972 (Harris and Christiansen, 1972; Haendler and Harris, 1973). These meetings generated the organization of the International Network of Feed Information Centers (INFIC). At the regular annual meetings since that time, discussions have centered around policy matters and strengthening and expanding the organization. Currently, there are nine active INFIC centers (Figure 1). Centers are being established in the Middle and Far East.

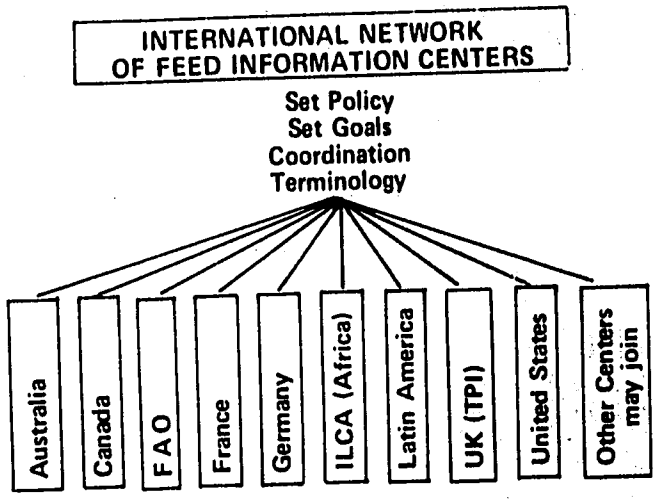

FIGURE 1 Organization of the International Network of Feed Information Centers

The Aims of INFIC

The aims of INFIC may be summarized as follows:

- To acquire and disseminate reliable information on feed composition throughout the world paying particular attention to the needs of less developed countries.
- To provide a vehicle for the exchange of information between existing centers concerned with the documentation of feeds.
- To assist in the establishment of new centers fo the collection and documentation of informatio on feed composition in the different regions of the world, particularly those which are less developed.

To liaise closely with scientific organizations defining and standardizing the chemical and biological entities of feeds.

To improve communication between those responsible for animal production and those engaged in research on animal nutrition.

Membership in INFIC

INFIC is open to all organizations concerned with feed information. Each INFIC center functions independently with regards to financing, personnel, data retrieval, data exchange, research, and publication.

Current membership is:

Food and Agricultural Organization of the United Nations (FAO) Rome, Italy.

The Australian Feeds Information Center, Sydney, Australia.

The Canadian Department of Agriculture, Ottawa, Canada.

The Documentation Center, Hohenheim University, Stuttgart, Federal Republic of Germany.

The International Feedstuffs Institute, (IFI) Utah State University, Logan, Utah.

The International Livestock Center for Africa (ILCA), Addis Ababa, Ethiopia.

The Latin American Program for Feeds and Feeding Systems, San Jose, Costa Rica.

The L'Institut d'Elevage et de Medecine Veterinaire des Pays Tropicaux (IEMVT), Maisons-Alfort, France.

The Tropical Products Institute (TPI), London, United Kingdon

Centers are in the process of being established in the Middle East and Far East (in cooperation with the International Feedstuffs Institute, Logan, Utah, USA, and the Tropical Products Institute, London, United Kingdom).

Geographic Responsibilities

INFIC representatives are responsible for acquiring feed information from the following geographical areas:

(a) Africa: The Documentation Center, Hohenheim University, Stuttgart, Federal Republic of Germany, in cooperation with FAO; The International Livestock Center for Africa, Addis Ababa, Ethiopia; and The L'Institut d'Elevage et de Medecine Veterinaire des Pays Tropicaux Maisons-Alfort, France.

(b) Europe: The Documentation Center, Hohenheim University, Stuttgart, Federal Republic of Germany.

(c) Latin America: The Latin American Program for Feeds and Feeding Systems, San Jose, Costa Rica; and the International Feedstuffs Institute, Utah State University, Logan, Utah, USA.

(d) North America: The International Feedstuffs Institute, Utah State University, Logan, Utah, USA; and The Canadian Department of Agriculture, Ottawa, Canada.

(e) Oceania and Southeast Asia: The Australian Feeds Information Center, Sydney, Australia.

An International System for Naming and Describing Feeds

In recording feedstuffs data from different parts of the world and processing them for use in a common databank, a standardized, unambiguous identification system is essential. This must include: (a) a vocabulary consisting of elements (descriptors) that do not overlap, and (b) regulations for the use of these descriptors in naming feeds. A new international system was proposed by Harris (1963) and Harris, et al. (1968) in order to over come inconsistencies in naming feeds. This system was modified by a joint working party - Logan - Hohenheim - Maisons Alfort, and is now known as the international feed vocabulary. This vocabulary is in English, French, German and Spanish, and has been adopted by INFIC. The vocabulary is divided into logical categories (or facets) as explained below. A feed name is established by combining descriptors of different facets and a translation by computer is possible--for example, from English into French names. The terms used in the vocabulary might not always correspond to those in common use in a given country. In these instances adjustments are made to convert the international feed names into short names. The international feed vocabulary is in widespread use and minimizes feed identification difficulties by assigning descriptive names to feeds.

The International Feed Vocabulary is designed to give a comprehensive and concise name to each feed. A complete name may have individual components. Each component describes an essential attribute in evaluating a particular feed. These components are arranged in six facets.

origin including scientific name (genus, species, variety) common name (genus, species, variety) and eventually chemical formula

part fed to animals and as affected by process(es)

process(es) and treatment(s) to which the origin of part eaten was subjected to prior to being fed to the animal

stage of maturity and development (applicable to forages and animals)

cutting (primarily applicable to forages)

grade (official grades with guarantees, etc.)

... sufficient components are used to describe each fee unequivocally.

Feeds have been assigned to eight classes. Further subdivision of up to nine groups, if needed, is envisaged for developing regression equations to predict missing values. The eight main classes are:

1 Dry forages and roughages (more than 18% crude fiber)

2 Pasture, range plants and forages fed green.

3 Silages.

4 Energy feeds (products with less than 20 percent protein and less than 18 percent crude fiber).

5 Protein supplements (products which contain 20 percent or more protein).

6 Mineral supplements.

7 Vitamin supplements.

8 Additives (antibiotics, coloring material, flavoring, hormones medicants).

Since the descriptive feed names are not practicable for data processing, a consecutive order 5-digit identification number (International Feed Number) is assigned to each name. The code for the feed class is inserted in front of this number (as outlined above, making a 6-digit numb in all (see Table 1). Two examples of naming feeds ar given in the table. Thus, the international names for the two feeds are:

No. 1: *Zea mays indentata.* Maize, dent, aerial part, ensiled, dough stage.

No. 2: *Gossypium spp.* Cotton, seeds without oil, solv extd, less than 36 percent protein.

TABLE 1 Examples of International Feed Names

Name Components	Feed No. 1	Feed No. 2
Genus (of original material)	*Zea*	*Gossypium*
Species	*mays*	*spp.*
Variety or kind	*indentata*	....
Common name	Maize	Cotton
Common variety	dent	....
Part eaten	aerial part	seeds without oil
Process(es) and treatment(s) to which product has been subjected	ensiled	solv extd ground
Stage of maturity	dough stage	
Cutting or crop		
Grade (or quality designation)		less than 36 percent protein
Class	(3)	(5)
International feed number	3-02-912	5-01-632

All feed names are listed in the INFIC International Name File. Any new name not previously composed is added to this file.

The Collection and Recording of Feed Data

A document known as the "International Source Form" is used to record the information about a feed (Harris 1970). On this form, in use in many laboratories throughout the world, the following information is included: identification of the sample, information on the geographical area in which the feed originated, the reference source, published or unpublished, and pertinent information about factors which may influence the nutritional characteristics of the product. The form also has space for describing the animal and procedures used in digestion and balance trials. Chemical and biological values that have been determined on the feed sample can be recorded on the form.

These forms are available to all INFIC institutions and are printed in five different languages.

Data on feeds are requested by INFIC centers in the following ways:

- from chemical and biological analyses of feed samples contracted by the INFIC Center
- from cooperating feed analysis laboratories and research institutions which are forwarded by mail or obtained by personal contact
- from a literature search
- from publications containing feed information that are forwarded to the centers

After the data are put on the source form they are coded (Knight et al. 1966 and Harris et al. 1968). For example, all information concerning the area (count region, state, province), the sources of reference and the feed description are coded and punched into one card. Data pertaining to soil condition, fertilizer applied, etc., are recorded on a second card. Information about metabolic studies is recorded on a third card and a fourth card is used to record the chemical and biological data. Additional cards are used for environmental and other information. The system thus provides flexibility and can be expanded.

Benefits to the User

The information stored in the combined data bank of INFIC will be of particular value to those involved in research and education, planning and development, the feed industry and practical animal production. Eventually the total output will provide ready access to:

- all relevant values for chemical, physical and biological data of existing and potential feeds;
- information on factors which affect the nutritional value of feeds (e.g., age of plant, soil, fertilization, and method of processing);
- information relevant to the incorporation of feeds into diets and rations (e.g., physiological restrictions of the animal, intake levels, efficiency of utilization, and toxicity levels).

Information retrieval may be accomplished in various ways depending on the user's needs and facilities. Access to information would be given by feed tables and specific printouts when direct use of computer or via a remote terminal, is impracticable for a user. Abstracts of information pertaining to specific questions can be selectively withdrawn by some centers.

The system also permits analysis of factors affecting composition and nutritional value of feeds (e.g., environment and technology of processing), provided the sample analysed has been sufficiently described (for example, as requested on the International Source Form distributed to the cooperating laboratories). Data may also be suitable for developing regression equations. The importance of giving consideration to the experimental conditions under which data were obtained and of distinguishing between actually determined and derived values is well recognized. Especially important is the efficient use that can be made of the information stored in the databank by connecting it with computerized programs for the formulation of diets for maximum profit.

Cooperation Required to Support INFIC's Objectives

It is obvious that the potential quantity and quality of output from a data bank depends on its input. To draw information across fields of specialization, countri and languages requires close cooperation among instituti all over the world. Certainly, there are a number of limitations to achieving the aim of an optimal coverage in the documentation of world data. Particular assistan is sought by INFIC from:

- feed analyses laboratories and collecting organizations, in particular those serving developing countries, who could make their results available to the central data bank;
- leading workers in the field of feed analyses and energy metabolism, who could recommend the most economic determinations to employ and appropriate systems to use in expressing energy values;
- research workers and users who could support the international standardization of terminology in organizing future data input into a common data base.

Representatives from the participating countries have expressed interest in the work of INFIC and pledged continued support for it. The United States agency for International Development (US AID) has made an essential contribution through its Florida project, which had 69 laboratories in 23 Latin American countries cooperating in producing, collecting and forwarding analysis results to the Project Center. Using these data, comprehensive feed composition tables have been published in Spanish, Portuguese and English. US AID is providing financial support for the participation of the Utah Center in INFIC and some funds to start the Latin America Program in San Jose, Costa Rica. The Government of the Federal Republic of Germany is supporting work toward INFIC's objectives undertaken by the Hohenheim Center in cooperation with FAO and the International Livestock Center for Africa.

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ORGANIZATION OF FEEDING SYSTEMS COMMITTEES[1]

Lorin E. Harris and Leonard C. Kearl[2]
International Feedstuffs Institute
Utah State University
Logan, Utah

Summary

Information concerning feed compositi...
requirements) of domestic animals within a geopolitical region should be brought together into one data source. Problem areas should be defined and research initiated to generate the missing information.

The Society of Animal Science or the Society of Animal and Range Science should receive the support of the scientists within a region. This support should include the expenditure of time and effort to accomplish the aims and goals of the society. When no formally organized Society exists, action should be taken to generate support needed among the scientific community to organize such a Society for a country or a group of countries.

The Society should appoint a main correlating committee. One member of this committee should be the Director of the International Network of Feed Information Centers for that region. The main committee should appoint Feeding System Subcommittees to study the problems associated with

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[2]Director, International Feedstuffs Institute and Professor, Animal, Dairy, and Veterinary Sciences Department; Associate Director, International Feedstuffs Institute and Research Associate, Animal, Dairy, and Veterinary Sciences Department, respectively.

specific animal management programs. The Subcommittees should publish and recommend feeding systems for the farmer. Information needed should be called to the attention of the main committee. They in turn should recommend how and where to obtain the missing data. When applicable, computer software should be developed to assist in making management decisions.

Introduction

Developed countries with large scale systems of animal production have recorded and stored large amounts of data on feed composition (National Research Council 1977; Agricultural Research Council 1965). Nutrient requirements of the most important species of domestic animals have been compiled (Agricultural Research Council 1976; Göhl 1975; National Academy of Science-National Research Council 1972). The publications on nutrient requirements usually also contain some feed composition data for the given species of animal. Computer software has been developed that uses feed composition data, nutrient requirements and costs to work out the most profitable diets. These publications, however, do not usually bring the information together to meet the needs of animals being fed for production under different conditions. Therefore, steps should be taken to develop feeding systems for animals in different regions.

Developing countries lack the data base to support the programs above, but steps are being taken to accumulate the information available into a data bank as proposed by the International Network of Feed Information Centers (INFIC). (See Kearl and Harris, 1977, in this publication). The purpose of this paper is to suggest ways to organize "Feeding Systems Committees" for developing countries.

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Many developing countries or regions have a Society of Animal Science a Society of Range Science, however, if such societies are not organized,

suggested that a Society of Animal and Range Science be organized. In most areas the problems of animal production and range are interrelated so a combined society is justified.

Societies usually have their beginning in a modest way. A few dedicated individuals form a committee to investigate the procedures necessary to establish such an organization. Members of the committee contact animal and range scientists in a given country or group of countries. For example, there is a Latin American Society of Animal Production (ALPA). This Society is open to scientists throughout all of Latin America.

The society is a medium through which scientists in various aspects of animal production and range management are brought together at regular intervals (yearly or every two years) to discuss and act upon subjects of common interest.

In some countries the National Academy of Science performs the functions suggested above. The essential thing, however, is to start an action program of bringing material together that can be used by the farm advisor and the farmer. One of the functions of the society could be to implement "Feeding Systems Committees."

Feeding System Committees

If there is an active Society, its Board of Directors could appoint committees. To be effective there should be a Main Feeding Systems Committee and Subcommittees for feeding systems of various species of animals.

Main Committee

The main committee should consist of about nine members. Three to serve one year, three to serve two years and three to serve three years. In this way the leadership is passed around. The Director of the INFIC center (See paper

in this publication by Kearl and Harris, 1977) should be a permanent member of the main committee. If there are several countries going together to fo a Society, they could be divided into regions and members could be elected from each region.

The functions of the main committee would be as follows:

- be advisory to the INFIC Center
- set goals and advise sub-committees
- review publications of the INFIC center
- review publications of the sub-committees
- make recommendations on how needed information could be obtained.

Feeding System Sub-committees

The function of the sub-committees is to bring together the known information as it relates to feeding systems for a given species of animal within a certain area. Essentially the committee takes into account:

- biological input-output relations (requirements)
- feed composition
    - combinations and limitations
- economic aspects
    - items which can be translated to dollars such as hours of labor

From this information, feeding systems are devised for different classes of animals. These committess should compile data available and write a publication as soon as possible. The sub-committee also compiles information which is lacking such as data on feed composition and input-output data. Perhaps nutrient requirements need to be modified. For example, animals in the tropics usually need more vitamin A than those in temperate regions. Th information is given to the Main Committee for action.

When the committee has finished its report, another committee is appointed to begin to work on a revised report. Each committee would consist of abou

four to six scientists. The new committee would usually retain one of these individuals with new members. This would provide for the rotating of members. A sub-committee should be appointed for each species of animal in the area covered by the Society. If the environment is greatly different such as tropical and temperate as it is in Latin America, then it may be advisable to have a committee for each environment. Committees could be organized for:

- beef cattle
- dairy cattle
- sheep
- swine
- water buffalo
- poultry
- horses
- camels
- cameloids (Latin America)
- Fish
  - cold water
  - warm wate
- and other animals where appropriate

Finances for Committees

Finances are always a problem. Committee members usually attend the Society meeting. It is suggested that committee meetings could be held for two days before or after the Society meeting. The expense would then only be the per diem for two days. Usually the scientists institution could take care of this.

The manuscript could be broken down into sections and each member of the committee could write a section. The chairman of the committee could correlate the sections and his institution could type it. The main committee could review it and have it published in cooperation with INFIC.

The above methods would permit the committees to begin to function without much financial aid. When the work of the committees became recognized, perhaps finances could be obtained from funding agencies.

Input-Output Relations

The type of diet to be recommended will depend upon the class of animals to be fed such as fattening cattle, maintaining breeding stock, feeding draft animals, laying hens or lactating cows. In this connection, it should also be recognized that approximately two-thirds of the cost of producing livestock are feed costs. Furthermore, livestock diets can vary greatly in their efficiency and nutritional adequacy. Also, diets of equal nutritive value can have wide differences in their per unit cost. Therefore, if livestock or poultry men operate to maximize profits, it is essential that emphasis be given to feeding systems. A large amount of time and effort by animal scientists throughout the world have been devoted to acquiring information and developing a better understanding of the principles of animal nutrition. Attention should now be given to applying these principles toward the practical and profitable feeding of farm animals. Only with a knowledge of these principles and an understanding of their application to practical animal feeding can maximum efficiency in animal programs be attained.

The basic information for a feeding system includes various inputs of nutrients in relation to the output of products such as meat, milk, eggs, fiber, work and waste products.

Dudly and Parks (1966) information on various inputs of energy and outputs of gain for broilers illustrates the kind of information needed before a profitable feeding system can be devised. (Figure1).

The upper curve gives the g/bird gain when diets containing 3,000 to 3,800 kcal/kg of MEn was fed. The lower curve gives the feed costs in bird gain equivalent (g) at the various levels of MEn. The profit or dotted line is the difference between the bird gain and bird gain equivalent. It will be noted that the least-cost diet contained approximately 3,000 kcal/kg MI and the diet producing the maximum bird gain contained approximately 3800 kcal/kg MEn. The most profitable diet, however contained an intermediate

amount of MEn, approximately 3600 kcal/kg. This illustrates the need to consider the amount of products produced with the intake of various levels and ratios of nutrients.

An Example Feeding System

G. E. Stoddard collected information for a feeding system for dairy cows (unpublished data[2]). The purpose of the trial was to determine how much grain should be fed to dairy cows in the Intermountain region of the United States, USA, when Alfalfa, hay, sun-cured, early bloom was fed ad Libitum. Cows producing an average of 6250 kg of milk and 250 kg of fat were fed over a 305 day lactation period. Four levels of grain 0.25, 0.375, 0.50 and 0.625 kg per kg of milk produced over 9.06 kg per cow per day were fed. Hay was fed ad libitum. Milk production over the entire lactation was greatest at the 0.50 kg level of grain feeding. If the amount of hay and grain needed to produce a certain amount of milk can be determined, this information can be used to develop an equation to predict the feed requirements of the animal in relation to the amount of product (milk) produced.

Multiple regression equations were computed from the average milk production (305 day lactation, 4% FCM), hay consumption and grain consumption for the four grain feeding levels. Three cubic equations were generated from the data:

$$\text{Milk production (kg)} = 9723 - 34228X + 95680X^2 - 77568X^3$$

$$\text{Grain intake (kg)} = 2168 - 14924X + 50144X^2 - 39336X^3$$

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[3] G. E. Stoddard, Animal, Dairy, and Veterinary Science Department, Utah State University, Logan, Utah.

Hay intake (kg) = $2156 + 26673X - 68640X^2 + 49323X^3$

The independent variable (X) in each equation was level of grain feeding (0.25, 0.375, etc. . .).

Returns above feed cost were calculated for various levels of feeding grain and at various prices for milk, grain and hay:

Returns above feed cost = (milk in kg x milk price) - (grain in kg x grain price) - (hay in kg x hay price)

The equation for predicting milk production, grain intake and hay intake were substituted into the equation for estimating:

$$\text{Returns above feed cost} = (9723 - 34228X + 95680X^2 - 77568X^3)\ \text{price of milk} - (2168 - 14924X + 50144X^2 - 39336X^3)\ \text{price of grain} - (2156 + 26673X - 68640X^2 + 49323X^3)\ \text{price of hay}$$

With any given set of prices, returns above feed cost can be calculated for any level of grain feeding. A table of profit estimates for any range of prices can be generated. An example of returns above feed cost was computed for each of the four levels of grain feeding over a range of prices (Table 1)

Using current feed prices the most economical diet consistent with maximum returns above feed cost can be formulated for feeding dairy cows for this region. New diets can be formulated whenever ingredient prices change enough to warrant making necessary changes.

It is suggested that data could be gathered for typical diets fed at different levels in various regions to animals with different physiological functions so that regression equations could be developed to predict returns above feed cost. If the diets were analyzed for various constitutents, such as *in vitro* dry matter digestibility, cell walls and protein, it may be possible to predict the amount of product produced from the chemical analyses of the diet.

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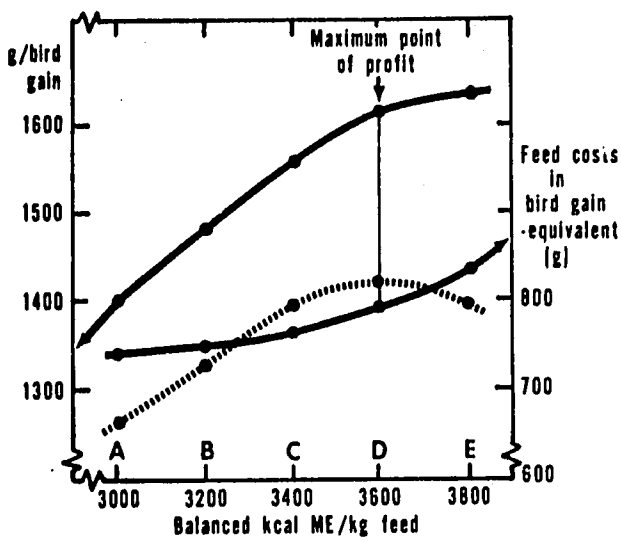

FIGURE 1 Selection of the optimum nutrient density in broiler feeding (adapted from Dudley and Park, 1966). The dotted curve is the profit line, and this is the difference between the g/bird gain and the feed costs in bird gain (g) equivalent.

Table 1 Returns Above Feed Cost Estimated At Various Prices For Milk, Grain and Hay For Various Levels Of Feeding Grain Over A 305 Day Lactation

Price			Returns above feeds cost for grain levels (kg/kg milk			
Milk	Grain	Hay	0.25	0.375	0.50	0.62
$/kg	$/kg	$/kg	$	$	$	$
0.100	0.05	0.025	413	422	458	442
0.100	0.05	0.030	387	396	436	421
0.100	0.05	0.035	360	371	413	401
0.100	0.06	0.025	404	407	436	415
0.100	0.06	0.030	377	381	413	394
0.100	0.06	0.035	351	355	391	374
0.100	0.07	0.025	394	391	413	388
0.100	0.07	0.030	368	366	391	368
0.100	0.07	0.035	341	340	368	347
0.125	0.05	0.025	562	578	629	611
0.125	0.05	0.030	535	552	607	590
0.125	0.05	0.035	509	527	584	570
0.125	0.06	0.025	552	563	607	584
0.125	0.06	0.030	526	537	584	564
0.125	0.06	0.035	499	512	562	543
0.125	0.07	0.025	543	548	584	557
0.125	0.07	0.030	516	522	562	537
0.125	0.07	0.035	490	497	539	516
0.150	0.05	0.025	710	734	800	780
0.150	0.05	0.030	684	708	778	760
0.150	0.05	0.035	657	683	755	739
0.150	0.06	0.025	701	719	778	753
0.150	0.06	0.030	674	694	755	733
0.150	0.06	0.035	648	668	732	713
0.150	0.07	0.025	691	704	755	726
0.150	0.07	0.030	665	678	732	706
0.150	0.07	0.035	638	653	710	686