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REPORT

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CONSULTANCY ON

BIODEGRADABLE ANIMAL WASTES FOR

LIVESTOCK FEED

FEBRUARY 15 - MARCH 10, 1987

Agricultural Research Project (386-0470)

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CONSULTANCY REPORT
ON
WORK COMPLETED DURING PERIOD OF 16 FEBRUARY TO MARCH 4, 1987 CONCERNING PROJECT SPONSORED BY THE INDIAN COUNCIL OF AGRICULTURAL RESEARCH

PROJECT NO. 386-0470
Agricultural Research Umbrella
Subproject 5
CONVERSION OF BIODEGRADABLE ANIMAL WASTES FOR LIVESTOCK FEED

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I. INTRODUCTION

The Team, consisting of J.P. Fontenot and A.D. Tillman, assembled in Delhi on February 16, 1987 for the purposes of attending a workshop on subproject 5 (Conversion of Biodegradable Wastes for Animal Feed) that was held at Krishi Bhavan on February 20, 1987 and interacting with scientists from each participating institution who presented project proposals at the workshop. While in Delhi the Team was able to visit with each group about the details of experimentation and other factors. After the workshop, the Team was able to visit with the senior scientists and staff members at the following institutions:

- National Dairy Research Institute, Karnal
- Haryana Agricultural University, Hissar
- Bombay Veterinary College, Bombay
- Kerala Agricultural College, Trichur

Because of security reasons, the Team was unable to travel to the Punjab Agricultural College. However, key scientists from that institution met the Team in Delhi for intensive discussions on the project.

Since the Team members had the same objectives, interests and motivations, it was decided to make this a joint report.

For convenience it is divided into the following sections:

I. Introduction

II. Summary

III. Activities of the Team

IV. The Workshop

V. Recommendations

It is our hope that this report will be useful to our Indian colleagues in carrying out this important Research and Development project.

II. SUMMARY OF THE CONSULTANCY REPORT

In keeping with overall objectives of the project (see Annexe A, Sections A and B) the Team made general and specific recommendations:

A. General Recommendations

1. All research activities should be guided by the mission of the project. Basic research requiring use of very expensive techniques and equipment should only be used to solve problems that block progress of the research.

2. Indian scientists are encouraged to continue their extensive coverage of world literatures in the specialized areas.

3. One toxicology laboratory (at NDRI) should be equipped and charged with the responsibility of serving all institutions in studies and for training.

4. Annual workshops should be held in a central place for reviewing results and for planning.

5. ICAR should maintain an active coordinating role of the subproject.

6. A Management Team, under ICAR, should be appointed and charged with the responsibilities of making recommendations on:

a. Overseas training;

b. Equipment needs of each laboratory;

c. Other pressing problems as these may arise.

7. Provisions should be for making effective use of the excellent library facilities found at several institutes and universities.

B. Specific recommendations

Specific recommendationswere made on the research objectives at each of the cooperating institutions for Microbiology and Animal Nutrition (see V-B), Training (see V-C) and Technology transfer (see V-D).

III. ACTIVITIES AND VISITS OF THE TEAM

The Team visited the institutions that are involved in the present project for the purpose of meeting key personnel for discussions on the project and other persons that are directly involved in it:

A. National Dairy Research Institute (Karnal)

As NDRI will provide the toxicological service for all institutions, the Team planned to meet the senior toxicologist. Unfortunately, family illness called him away. Profitable discussions were held with leaders of the Indo-Netherland project which concerned the improvement of crop wastes by fermentation. The results indicate that the problem of high dry matter losses resulting from fermentations must be solved before these processes can have practical applications. Research in mineral nutrition that bear on the present project are also underway.

The library and training facilities at NDRI are excellent and should be made available to scientists and trainees at the universities.

B. Haryana Agricultural University (Hissar)

The Team met with the scientists at HAU that will concentrate efforts on large animal waste products. It has one of the most difficult research assignments of the institutions as most of the faecal wastes from ruminants is of low nutritional value. However, HAU has an excellent staff, good facilities, a good library and some recent experiences in feeding animal wastes. The involvement of a senior microbiologist, either from HAU or outside of the university, could be helpful in their research.

C. Punjab Agricultural University (Ludhiana)

Because of security problems the team was unable to visit PAU. However, there were intensive discussions with key personnel from PAU on their experimental design and on the problems of using poultry wastes as feed. As the staff members have already had extensive experiences in this area, PAU is ready to move on in their research and development challenges.

D. Bombay Veterinary College (Bombay)

The faculty members have the competence and motivation to accomplish the objectives of the research concerning utilization of slaughter house by products. Large amounts of wastes are available from slaughter houses in the Bombay area. For example 85 tons of rumen contents are available from one plant. Limited amount of blood is available and the serum left after separating the hemoglobin for plant microbiological purposes is available. The plans for the research were discussed, and recommendations are given in section V.

E. Kerala Agricultural University

The visit to the Cochin area was arranged by the Faculty of Agriculture, Kerala Agricultural University, Trichur. There is a wealth of expertise outside of KAU in the Cochin area and these persons are interested in cooperating on the project. Faculty from the Fisheries College of Kerala Agricultural University and staff members from the Central Institute of Fisheries Technology are also competent and are interested in cooperating in the project. Large amounts of wastes such as prawn processing waste, fish processing waste, trash fish and squills are available. These wastes are either used as manure (processing wastes) or dumped in the harbour (trash fish). Although there are a number of processors in the area, these are located in a sufficiently concentrated area to facilitate easy collection of large amounts of these wastes.

IV. WORKSHOP

A workshop involving personnel in the five institutions involved in the present project was convened at Krishi Bhavan on 20 February, 1987, in which the project outlines on each project were discussed (see Annexe A - Sections A and B). Discussions were excellent in keeping with the excellent scientific and intellectual competence of Indian scientists.

There were both general and specific recommendations, and these will be discussed in more detail in Section V.

V. RECOMMENDATIONS

A. General

1. All research activities should be guided by the general mission of the project. Basic approaches will be required to obtain answers to the research-revealed major obstacles toward practical application of the research. These obstacles by all and any means, must be characterized and removed as quickly and as efficiently as possible.

2. In general Indian scientists do keep up on applicable world literature. It is recommended that they intensify their efforts as pertains the present project, as this would permit them to benefit by errors made elsewhere and move faster in their missions.

3. Ideally every laboratory would have a toxicology department. Due to budgetary limitations, only one unit is established, and at NDRI. It is recommended that all laboratories be in continuous contact with the NDRI unit for guidance in sample preparation and other details necessary to insure safety of their fermentation feed sources.

4. It is recommended that annual workshops be a requirement of the present project All institutions should report on their results and future plans, thereby permitting group discussions and planning.

5. It is recommended that ICAR maintain an active coordinating role in the present project.

6. It is recommended that the Management Team, in close cooperation with ICAR and individual laboratories, be responsible for making decisions on equipment needed as well as on as overseas training requirements (specific suggestions by the consulting team are presented in V).

7. It is recommended that the excellent library facilities at NDRI and other ICAR institutes be made available to all the institutions involved in the present project. Librarians at these specialized institutes should be provided with funds for making photocopies of specific papers that are requested by the participating scientists. It might be feasible to establish a literature search program for the project.

B. Specific Recommendations (Research)

1. Microbiology

In workshop discussions, a major question concerned the "role of microbiologist" in the present experiment. It is recommended that the microbiologist be intimately involved in experimemntal design and in carrying out of all experiments involving fermentations that are used for the following purposes:

a. Improvement of animal wastes for feed stuffs by microbial degradation;

b. protein synthesis by fermentation;

c. preservation of preformed animal protein in aquatic and animal tissue wastes by ensiling or other means.

In addition, the microbiologist must take the lead in screening waste products and the products resulting from fermentation for pathogenic micro-organisms. At the very minimum, the following should be considered:

- Coliform bacteria
- Samonella, typhmurium
- Clostridium botulimum
- Fasciola gigantica cysts
- Strongyle nematodes

The microbiologist should work with the Animal Nutritionist in design, execution and interpretation of results in all nutrition/feeding experiments.

2. Animal Nutrition

Generally, the consultants agree with the planned research presented at the workshop for the different locations (Annexe A - Sections A and B). Thus, only additional recommendations and/or recommended modifications wlll be presented by locations.

a. Bombay Veterinary College

It is possible that substantial amounts of valuable nutrients will be lost during mechanical squeezing of the rumen contents prior to drying. Thus, the contents should be analyzed before and after squeezing in order to quantify this loss. Since dairy farmers in Bombay feed some concentrate, it is suggested that the scientists explore the idea of mixing of dry absorbent material such as rice bran prior to drying. Drying, especially mechanical drying, should include economic studies.

In the existing studies, it is suggested that the following be evaluated:

1. Variable dry matter levels, probably by varying the proportions of waste and straw;

2. Adding different levels of molasses;

3. Bacteria innoculants to enhance fermentation;

4. Urea treatment to improve fiber digestion and crude protein content;

5. Blood and blood by-product (serum);

6. Preservatives for rumen contents before ensiling.

Data to be collected should include chemical composition of ingredients and ensiled mixtures, in vitro digestion, in vivo digestibility, growth and meat production in ruminants and possibly poultry.

b. Haryana Agricultural University

Research is to be conducted with cattle excretory waste, including faeces and urine. Initially, faeces and urine are to be analyzed when collected, separately and combined. The waste will be ensiled with straw. Initially, ensiling will be in small silos such as double polyethylene bags supported by cardboard or plastic containers (2 kg total material/silo). Later, the feasibility of using straw for bedding and ensiling the straw and collected waste, should be explored.

Variables to study should include frequency of waste collection (1, 2, 3 and 4 times/week); proportions of wastes to straw; ensiling with urea; and use of lignolytic fungi.

Data to be collected should be chemical analyses, ensiling characteristics, in vitro digestion, in vivo digestibility, growth trials, and trials with milk producing animals.

c. Punjab Agricultural University

Research will be conducted in processing and feeding poultry little. Variables to study should include deep stacking mixtures with different moisture levels. Also, it is suggested that research be conducted on ensiling poultry little with green paddy straw or other green forages.

In addition to the data to be collected as outlined in Annexe A - Section B, it is suggested that pH and lactic acid be measured in the deep-stacked and ensiled mixtures.

d. Kerala Agricultural University

It is recommended that the proposed research outlined at the workshop (Annexe A - Section B) be followed. In addition the following recommendation are made:

1. Analysis of fresh and ensiled materials for trimethylamine , since this substance has a very offensive odor.

2. Major emphasis be placed on ensiling seafood wastes with straw and molasses for use as ruminant feed.

3. Feeding trials should be conducted with ruminants.

4. Ensiling parameters (pH and lactic acid) should be measured.

5. Taste panel tests with milk and meat from animal fed waste silages for detection of passable offensive flavors or odours.

C. Training

1. Suggested Locations to be Visited by Management Team:

a. Virginia Polytechnic Institute and State University, Blacksburg, VA.

Professor J.P. Fontenot, Animal Science
Ensiling poultry litter, caged layer waste, swine waste, cattle waste, seafood waste and slaughter house waste; deep stacking and composting poultry litter. Feeding ensiled and deep stacked waste. Test for potential pathogenes.

Professor Tracy Wilkins, Anaerobic Microbiology
Anaerobic microbiology methods, metabolism, pure cultures.

Professor Rod Young, Biochemistry and Nutrition
Residues of pesticides and other harmful chemicals.

Professor John Gerken, Animal Science Extension
Visit farms feeding poultry litter and plant processing poultry litter for sale as feed.

b. Coastal Plains Experiment Station U.S.D.A. and University of Georgia, Tifton, Georgia.

Dr. Larry Newton
Ensiling of swine and cattle waste, solid separation in waste, feeding ensiled waste.

c. Auburn University, Auburn, Alabama

Dr. Tom McCaskey, Animal Science
Microbiology, especially testing for potential pathogens and treatment for destruction of pathogens.

Dr. B.G. Ruffin, Animal Sciences Extension
Visit farms feeding poultry litter.

d. Mississippi State University, Starkville, Mississippi.

Dr. James Minyard, State Chemist
Regulatory aspects of feeding animal waste produces for residue in waste.

e. Purdue University, Lafayette, Indiana

Dr. Alan Sutton, Animal Science
Ensiling of swine waste and feeding ensiled waste.

f. Food and Drug Administration, Washington, D.C.

Dr. Sidney Green, Toxicological research
Methodology in toxicology.

Mr. Jack C. Taylor
Regulatory aspects of feeding animal waste products.

g. U.S. Department of Agriculture, Agricultural Research Service, Washington, D.C.

Dr. Lewis Smith, Animal Science
Review of past research concerning feeding animal wastes.

Dr. Leonard Slyter, Animal Science
Microbiology, especially cellulose degrading bacteria.

h. University of Illinois, Urbana, Illinois

Dr. M.P. Bryant, Animal Science
Microbiology, especially isolation of pure cultures.

i. Washington State University, Pullman, Washington

Dr. J. Males, Animal Science
Ensiling fish silage and crop residues and feeding of silage.

j. Pioneer Microbial, Des Moines, Iowa

Dr. Jerry Berger, Microbiologist
Bacterial inoculants to improve quality of silage.

k. California Department of Agriculture, Sacramento, California

Mr. James Heimer, Feed Control Official
Regulatory aspects and potential hazards of feeding animal wastes, residues in feeds.

l. University of California, Davis, California

Dr. Dennis Shieh, Environmental Toxicologist
Methods for detecting toxins in natural materials.

2. Recommended Training for Scientists working on project

It is recommended that training in the United States be oriented toward the research to be conducted at the particular location. It is suggested that some scientists obtain certain specialized training at other locations in India where the expertize is available.

Suggested training by location is as follows:

a. National Dairy Research Institute

1) Toxicologist (1)*

b. Bombay Veterinary College

1) Microbiology

i. Fermentation and protein systhesis (1)
ii. Detection and destruction of pathogens (1).

2) Methods for ensiling slaughter house waste (1).

3) Procedures for designing feeding trials to evaluate ensiled slaughter house waste and development of feeding programs to use the processed waste (1).

c. Haryana Agricultural University

1) Research methods for processing cattle or swine waste (1).

2) Microbiology, especially regarding detection and destruction of potential pathogens (1).

3) Experimental methods for evaluating ensiled waste and development of feeding systems (1).

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* Number in ( ) is number of trainees.

d. Kerala Agricultural University

1) Methods of processing and ensiling seafood wastes (1).

2) Microbiology of seafood wastes including pathogen detection and destruction (1).

3) Research procedures for evaluating feeding value of ensiled seafood waste and to study the effect of feeding the waste on flavor in meat and milk (1).

4) Toxicology for determining possible toxins in seafood waste (1).

e. Punjab Agricultural University

1) Methods for processing poultry litter to be used as feed (1).

2) Microbiology concerning detection and destruction of pathogens (1).

3) Procedures for evaluating nutritional value of processed poultry litter (1).

4) Procedures for developing systems for feeding processed poultry litter (1).

D. Technology Transfer

The most difficult part of the project concerns the preparation of a technology packet that farmers can use to increase the production of animal products at favorable returns on his investments. It is recommended:

1. The research and development scientists should keep in mind the needs of small subsistence farmers and of the industry as they design and execute projects.

2. Extensive feeding trials should be conducted to determine the economic value of new products that are developed in this project.

3. The leaders of ICAR and the universities should strive for closer cooperation with the institutions and personnel involved in extension of animal production and animal health procedures to the farmers and the industry for effectively using the technology developed in this project. They must be aware of first - limiting constraints in the transfering technology for animal production as well as being innovative in developing methodolgy. It is recommended that the animal scientists in this project take a closer look at the T&V system that has been so effectively used by the plant scientist in spreading the Green Revolution in India; it could serve as an extension model for animal science.

4. Successful technology transfer in all areas must involve the talents of many disciplines. Animal scientists in the present project must be prepared to work closely with all disciplines in "selling" the new technology to the farmers.

ANNEXE A - SECTION A

ICAR working paper for Workshop
on
20th February, 1987

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CONVERSION OF BIODEGRADABLE ANIMAL WASTES FOR LIVESTOCK FEED

I. SUMMARY

The proposed five-year project focuses on the development of biotechnology for the conversion of wastes of animal origin to animal feeds using a wide array of micro-organisms - algae, bacteria and fungi. Five Indian institutions, now active in research and development on animal feed participating in the subproject with coordination of the Indian Council of Agricultural Research, will conduct the research. All will concentrate on the following main objectives:

A. To screen micro-organisms that have potential to convert animal waste to animal feed.

B. To evaluate the nutritional value of the fermented feeds for farm animals and to determine means and economics of including these new feeds into practical livestock rations.

C. To transfer the viable technology of processing feeds from farm/animal wastes to village and industry.

II. SUBPROJECT DEFINITION

Conversion of biodegradable animal wastes for livestock feed will focus on bioconversion of certain farm/animal wastes by wide array of micro-organisms - algae, bacteria and fungi alone or combined with physical or chemical processes so that these can be suitably incorporated in livestock and poultry rations. Appropriate research is needed to develop methods for microbial conversions of waste materials from animal origin. The utilization of such converted feeds offer an important approach for improving the livestock feeding for maintenance and production of farm animals.

Specific processing techniques based on the bioconversion techniques will be developed for utilization of unconventional feeds for utilization in villages. The identification, development and testing of processing technologies cover the treatment of wastes, their evaluation and utilization. The use of such materials in animal feeds will help small farmers, landless laborers and organized farms to minimise cost of animal rations and raise production.

An appropriate research program will include the establishment of a pilot scheme for testing at village level on development process and extension of the methodology in selected villages or animal populations. The operational part shall be taken up by all the centers of the subproject.

III. STRATEGY - COMPONENT ACTIVITIES

I. ICAR Coordinating Unit

II. Toxicological studies on animal feeds obtained from biodegradation of wastes - National Dairy Research Institute (NDRI), Karnal.

III. Biodegradation of wastes from slaughter house into animal feeds - Bombay Veterinary College (BVC), Bombay.

IV. Biodegradation of wastes from large animals into animal feeds - Haryana Agricultural University (HAU), Hissar.

V. Biodegradation of wastes from aquatic animal industries into animal feeds - Kerala Agricultural University (KAU), Trichur.

VI. Biodegradation of wastes from poultry into animal feeds - Punjab Agricultural University (PAU), Ludhiana.

The Indian Council of Agricultural Research (ICAR) in collaboration with USAID New Delhi will coordinate the work of Indian and U.S. scientists in research, consultation and training. The subproject work shall be carried out at five centers viz. (1) National Dairy Research Institute (NDRI), Karnal, (2) Bombay Veterinary College, (BVC), Bombay; (3) Haryana Agricultural University (HAU), Hissar; (4) Kerala Agricultural University (KAU), Trichur and (5) Punjab Agricultural University (PAU), Ludhiana. The scientific staff, technical staff, laboratories, equipments and infrastructure shall be made available for this project. Some analytical equipment, small scale processing equipments, etc. is needed. A number of the present scientific staff have been involved in the studies on biodegradation. Short term training is needed to train scientists in specific areas of Animal Nutrition, Microbiology and Toxicology that is offered by appropriate research institutes or universities in the United States.

V. PLAN OF WORK

Component Objectives

The various components that are involved in this five-year subproject will be guided by the three overall or longtime objectives as follows:

1. To screen micro-organisms which have the potential to convert animal wastes to Single Cell Protein (SCP) or convert these to useful animal feeds.

2. To evaluate the nutritive value of animal wastes and/or their products as animal feeds and to determine means and economics of including these new feeds into practical livestock rations.

3. To transfer the viable technology to farmers or to an industry/agency which serves farmers.

COMPONENT II: Toxicological Studies on Biodegraded Waste Feeds - National Dairy Research Institute (NDRI), Karnal

The National Dairy Research Institute established in 1923, has three regional stations at Bangalore, Bombay and Kalyani (West Bengal), to meet the research requirements of respective regions of the country. NDRI has eight research divisions dealing with various aspects of animal sciences and dairy technology. A large animal farm is attached to the Institute. Further an undergraduate college in Dairy Science as well as post-graduate education facilities in different disciplines of dairy science including production form part of the Institute. Indo-Netherland project on "Bioconversion of Lignocellulose in Crop Residues in India" is progressing at NDRI Southern Regional Station at Bangalore, and at main campus Karnal in the Division of Dairy Cattle Nutrition and Physiology, and division of Microbiology.

The microbiologists here have already screened a number of micro-organisms that have potential to degrade lignocellulose bonds and are now in the process of producing pure cultures of some of these in quantities needed for further specialized research. The animal nutritionists have tested and have underway physical, chemical and microbiological researches on altering the lignocellulose for improved crop residue utilization by ruminants. Recently, coordinating unit of the all India Coordinated Research Project on Utilization of Agricultural By-products has shifted to this institute. This unit, in addition to coordination work of the project, shall provide central facilities to identify the toxic/incriminating factors present in agro-industrial and non-conventional materials to study their chemical nature and effect of treatment for detoxification on small and large animals. In this project NDRI shall provide special chemical and toxicological analyses that cannot be done at other institutions. NDRI will serve as the central toxicological laboratory for the subproject. In order to equip the laboratories better, equipment and additional training is required to strengthen the overall subproject.

Objectives

1. Provide in-country training for designated scientists in India.

2. Provide special chemical analysis for the other four cooperating institutions.

3. Provide a toxicological laboratory for testing for any toxic compounds and antimetabolities that may be found in fermented products.

COMPONENT III: Treatment of Wastes from Slaughterhouse - Bombay Veterinary College (BVC)

BVC is the second oldest veterinary college in India, and its facilities at Parel are old and in need of modernization. Undergraduate college in Veterinary and Animal Husbandary will be at the new site. While some of the post-graduate training will be done at the old site, this sub-project will be, located at the new site. BVC will need many inputs in equipments and training.

In the municipal slaughterhouse during 1983-84 fiscal year they slaughtered respectively, in millions, about 2.47, and 1.08 and 0.43 buffalo/cattle, sheep/goats, and pigs. They work six days per week, and slaughter about 7,000 buffalo/cattle and 1,600 sheep/goat each day. This is owned by the Bombay Municipal Corporation and it conducts custom slaughtering for livestock owners who do not collect the rumen contents or blood. Therefore, these products can be collected and utilized by the slaughter house. Some of the blood is used for making blood meal while some is wasted. The rumen and intestinal contents, on the other hand, are wasted and are washed away through the sewage disposal system. In addition, there is a bit of offal and various animal organs available to the slaughterhouse and only dry rendering plants. Carcass processing is done elsewhere by the livestock owners. However, it appears that the amount of meat scraps and bone available for livestock feed are quite limited in Bombay and elsewhere.

Since Bombay is in the center of a large livestock industry and has the largest slaughter house in South East Asia, it is proposed that Bombay Veterinary College take a lead position in research designed to convert slaughter house wastes into animal feeds. The institution requires to have investment in equipment and training in order to qualify for assuming a leading position in that research.

This institution will focus its efforts on slaughter house products which for the most part are rumen and intestinal contents and blood, especially since the quantities of offal, meat scraps and bones are small and are already finding excellent use as livestock feeds.

A. Objectives

1. To provide facilities for the complete analysis and characterization of intestinal contents and slaughter house affluent. Also, toxic factors, if present, will be described.

2. To utilize rumen and intestinal contents of animals by:

- drying for concentration
- centrifugation for concentration
- production of greater quantities of SCP by fermentation
- silage-making involving further fermentation of crop residue

3. To utilize blood by:

- drying for making blood meal to be fed to non-ruminants or to be used for growing micro-organisms.

4. To screen intestinal contents for micro-organisms that can convert waste products to SCP or other livestock feeds.

5. Development of fermentation technology, if feasible, to produce protein (SCP) from intestinal contents.

6. To evaluate the nutritive value of slaughterhouse wastes and/or their products on animal feeds and to determine means and economics of including these new feeds into practical livestock rations.

7. To transfer the viable technology, if any, to farmers as

COMPONENT V: Biodegradation of Wastes From Fish and Other Aquatic Animal Wastes Kerala Agricultural University (KAU) Trichur:

At KAU, laboratories have already obtained good analysis of most of the feeds found in the Kerala state. It is an active group that is already participating in All India Coordinated Research Project on Utilization of Agricultural By-products for evolving Economic Livestock Rations. The Microbiology Department, will be an active participant in the proposed subproject. Microbiology at KAU is an active group, but they need additional equipment in order to make a significant contribution to the subproject.

KAU shall concentrate their efforts to convert fish wastes, including trash fish and other aquatic organisms to livestock feed. This conclusion derives from the fact that the entire coastline (600 km) of Kerala and its backwaters contain many fish and thus there is commercial fishing. The waste products resulting from the fishing industry, if treated properly, will have a potential for adding to the feed resources of Kerala specially and India generally. Included are fish wastes (intestines, scales, heads and others), trash fish, snails, shell fish, crabs and others. Insoluble protein containing wastes such as shells and scales may be biodegraded to provide protein for SCP production.

A. Objectives

1. To provide facilities for the complete analysis and characterization of aquatic organism wastes and trash fish by microbiological, chemical or physical methods.

2. To increase or preserve the nutritive value of aquatic organism wastes and trash fish by microbiological, chemical or physical treatments.

3. To screen micro-organisms that are capable of converting certain aquatic wastes to protein sources.

4. To screen micro-organisms that are capable of converting trash fish to livestock feed.

5. To test the nutritive value of aquatic waste and their by-products and determine means and economics of including these new feeds into practical livestock rations.

6. To transfer viable biotechnology obtained from the above research to the farmers.

B. Personnel

Scientist in-charge:

KAU has good support in the animal nutrition department from all India Coordinated Research Project on Utilization of Agricultural By-products for Evolving Economic Livestock Rations. Microbiology department will be an active participant in the proposed subproject. The senior scientists at KAU, who are experienced in experimental design and data analysis will design the specific experiments under the broad outline of objectives presented.

COMPONENT VI: Biodegradation of Poultry Wastes- Punjab Agricultural University (PAU), Ludhiana

The Animal Nutrition group in the Department of Animal Sciences of the Punjab Agricultural University has already done work on the microbiological treatments of straws in the All India Coordinated Research Project on Utilization of Agricultural By-products for Evolving Economic Rations for Livestock. The Center also has done some work on the improvement in the chemical composition of various other feed stuffs by microbiological processess. The university has adequate facilities in Animal Nutrition and Microbiology laboratories.

In the subproject PAU shall focus their studies on poultry wastes (feces, feathers, and other by-products) in order to convert these to livestock feeds.

A. Objectives:

1. To provide facilities for the complete analysis of poultry wastes.

2. To increase and measure the nutritive value of poultry wastes for livestock feed.

3. To screen micro-organisms that are capable of converting poultry wastes to SCP or other feeds for animals.

4. To develop fermentation techniques for the production of animal feeds for poultry wastes.

5. To evaluate the nutritive value of poultry wastes bio-converted product and determine means and economics of including these new feeds in to practical livestock rations.

6. To transfer viable bio-technology obtained from the above research to the farmers.

B. Personnel

Scientist In-Charge:

The research involves two major specializations, Animal Nutrition and Microbiology. The senior personnel at this university who are experienced in experimental design data analysis, will design the specific experiments within this framework. The center of the All India Coordinated Research Project on Utilization of Agricultural By-products and Industrial Waste Materials for Evolving Economic Rations for Livestock, located at this university shall be responsible for the technical program of the project at PAU.

ANNEXE A - SECTION B

Outline of Proposed work by:

1. Bombay Veterinary College, Bombay
2. Haryana Agricultural College, Hissar
3. Kerala Agricultural College, Trichur
4. Punjab Agricultural College, Ludhiana

DEPARTMENT OF ANIMAL NUTRITION.

BOMBAY VETERINARY COLLEGE, KONKAN AGR.UNIVERSITY.

INDO-USAID PROJECT ON BIODEGRADATION OF ANIMAL WASTES:

Location of the Scheme: DEPARTMENT OF ANIMAL NUTRITION.
BOMBAY VETERINARY COLLEGE.
PAREL: BOMBAY: 400 012.

Project Officer: Dr.P.M.PUNTAMBEKAR.
B.V.Sc.&A.H.;M.Sc.(Agri);Ph.D.
PROFESSOR OF ANIMAL NUTRITION.
BOMBAY VETERINARY COLLEGE.
PAREL: BOMBAY: 400 012.

Joint Project Officer: Dr.V.L.PARANJAPE.
M.V.Sc.; Ph.D.
PROFESSOR OF MICROBIOLOGY,
BOMBAY VETERINARY COLLEGE.
PAREL: BOMBAY: 400 012.

INDO-USAID PROJECT ON BIODEGRADATION OF ANIMAL WASTES. (SLAUGHTER HOUSE BY-PRODUCTS).

The animal wastes is quantitatively a good source for the feeding of the livestock. However, before using, it needs certain processing so that maximum utilisation of the same can be achieved. It may also be stated that except for certain isolated cases not much work has been undertaken in our country for the same. The Animal Wastes mainly consists of the animal excreta and if the same has to be used the same has to be used after drying which is a laborious and time consuming and costly process. Most of the studies in this direction have been concentrated to the sun-drying and its utilisation. In addition, the health hazards of this aspect (utilisation) has also to be looked into before their utilisation. From this point of view, the microbiological aspects are to be looked after.

The other and most important aspect and the non-traditional source would be the utilisation of the slaughter house by-products. Quantitatively, the most important source would be RUMEN DIGESTA/INGESTA, followed by BLOOD MEAL and MEAT AND OFFAL MEALS. In organised slaughter houses large quantities of rumen digesta/ingesta are available in large quantities and the same is not only not utilised but also the disposal of the same is a problem. Hence, utilisation of the rumen ingesta/digesta is an important aspect for this type of study. The pilot studies have revealed that the rumen digesta has about 80-85 percent of moisture and is therefore bulky and also because of the high moisture content can not be utilised readily and as such. Almost no work has been carried out on the utilisation of rumen digesta in our country ~~xxxx~~ systematically.

Bhattacharya and Taylor (1975) reviewed the work on animal wastes and it mainly consisted pertaining to the Dehydrated cage layer manure, Broiler litter, cattle manure and the swine wastes. In addition, the work pertaining to the Health hazards aspect has also been reviewed. Ichponani and Lodhi (1976) have also reviewed the work done on the Recycling of animal waste as feed. However, as indicated earlier, almost no work has been reported on the rumen digesta/ingesta. The most important limitatiOn in the use of rumen digesta is its low dry matter content and any study for its utilisation has to be directed to reduce the moisture content, increase the dry matter content, and that the measures suggested should be feasible. It is from this point of view of this the following measures are suggested.

1: Reducing the moisture content and / or increasing the dry matter content: This can be achieved by the ensiling.
2: Reducing the moisture content: By mechanical sqeezing, followed by sun drying.
3: Sun-drying of the material as such or after mechanical sqeezing for reducing the moisture content.
4: Mechanical drying of the material in such a way that the process becomes feasible/economical.

In addition, the microbiological aspects of this study have also to be studied not only from the health hazards point of view but also from the enrichment and degradation point of view.

From the microbiological point of view, conversion of rumen ingesta into microbial protein is an important aspect which has tremendous scope in future. In this department (Microbiology) isolation of the cellulolytic organisms and their screening for the cellulolytic activity by measuring their filter paper shredding activity and the other aspects were undertaken on pilot scale.

This department has also undertaken pilot projects on the meat and offal meal and the blood meal prepared in the Deonar slaughter house in case of broilers/pullet chicks.

BLOOD MEAL:

The important feature of this study is that unlike in similar other studies, the blood meal was mechanically prepared in the blood rendering plant at Deonar, Bombay. An experiment of 16 weeks duration was undertaken on 120 day-old pullet chicks to evaluate the value of sheep blood meal. It was evaluated to study as a source of protein to replace fish meal on protein basis. The levels selected were 0, 25, 50 and 100 percent replacement of fish meal protein with the blood meal. The blood meal had about 85 percent protein. The study included gain in weights, feed consumption, feed conversion efficiency and metabolic trial. The results indicated that the blood meal may safely replace 25 to 50 per cent of fish meal protein in grower mashes. However, in view of the comparatively lower gain in weights, complete replacement of fish meal protein by blood meal is not desired.

MEAT AND OFFAL MEAL:

The meat and offal meal was also prepared in the rendering plant at Deonar, Bombay. This had about 60 per cent protein, The study was carried out on 148 day-old broiler chicks to evaluate it as a source of animal protein. The meat and offal meal replaced, 0,25, 50 and 100 per cent of fish meal protein the mashes. In general, it was observed that the replacement of fish meal with meat meal upto a level of 50 percent was most satisfactory. With regards to the gains, feed consumption and feed efficiency along with carcass quality, the results indicated the comparable performance of broilers receieving meat meal or fish meal protein.The complete replacement of the fish meal protein is also possible as non-significant results were noticed. However, this aspect needs further detailed studies on a large scale.

II. Immediate Specific Objectives: For this, the rumen contents and the Blood which is available from the slaughter house to a very great extent would be considered.

1. To test Rumen Contents for ensiling with dry roughages and to subsequently undertake Nutritive Evaluation of the same with laboratory techniques and or feeding trials.

2. Drying of the Rumen Contents : Partial drying of the rumen contents and studies on ensiling as stated above. Complete drying of the rumen contents-Sun or Mechanical drying would be considered and their practical feasibility would also be considered with feeding trials.

3. Chemical treatments and Oxidation: These aspects would also be considered and their efficacy would be considered with the microbiological and nutritive evaluation and the feeding trials.

4. Processing Technology : This includes (in addition to the drying), finding out the feasibility of converting the rumen contents as such or with supplementation into "Bricks" of suitable size. Similarly, it would be studied, alternately, to find out the possibility of using the processed rumen contents into "Complete Rations".

5. Blood Meal : The blood would be collected and efforts would be made to convert it into blood meal - the practical aspects in its drying would also be considered. Subsequently, nutritive evaluation and feeding trials would be undertaken in case of briolers.

III. General Methodology :

Rumen Contents: 1. The rumen contents from the different types of animals and from different classes would be analysed for their chemical analysis in detail.

a) Ensiling : The rumen contents would be ensiled with the available dry roughages like hay and straws. The chemical and microbiological changes during the ensiling would be studied. For this; different combinations of moisture levels, dry roughages and time would be also considered and from these 2-4 promising combinations would be considered for the In Vitro or In Vivo Nylon bag technique and would be used and subsequently for the feeding trials in case of growing stock.

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b) Drying : Sun and Mechanical drying would be considered for the rumen contents and for the latter various temperature and time combinations would be used. In this; initial partial sun drying followed by mechanical drying would be considered and also methods for the quicker sun drying like drying on asbestos/galvanised sheets would be also considered.

After drying; the material would be analysed chemically and with the help of this the most feasible processing aspect would be considered. The microbiological work would also be undertaken to avoid the problem of pathogens/spores.

Subsequently, the material would be used in the formulations and used as a feed ingredient and formulations undertaken for the feeding trials in growing stock., will be undertaken.

c) Chemical treatment/Oxidation Studies: The rumen contents would be chemically treated and oxidation work studies will be undertaken and this would be followed by chemical analysis and the microbiological studies. The processed rumen contents would be used for the feeding trials in growing stock.

d) Processing Technology : The dried rumen contents would be supplemented with suitable materials and would be converted into "Complete Rations" and or "Bricks" and the final product would be used for the feeding trials in growing stock.

e) Blood Meal : The blood would be collected and efforts would be made to remove the moisture so that the blood meal is obtained. For this; blood from different species would be collected and the dehydration would be undertaken. Various temperature and time combinations would be considered and the best combination (from nutritive value and microbiological quality) would be used for undertaking feeding trials in broilers.

f) Technical Programme (Microbiology) Aspects).

1) Screening of micro-organisms which have potential to convert the rumen contents and blood into proteins.
2) Studies on the presence in rumen contents and blood before and after processing of pathogens or spores.
3) Studies on aerobic and anaerobic formentations and the micro-organisms and measures to control the process.
4) Steps to reduce or eliminate the pathogens and spores.
5) Any other aspects that would be encountered during the project.

contd.....4.

g) Methodology : Standard Methods used in Microbiology for these purposes, will be followed.

IV. Equipments Required : 1) Atomic Absorption Sectrophotometer. ONE.

This would be required for the nutritional studies.

2) Batch/Tray drier : THREE.

This would be required for the rumen contents and blood work - 2 for the former and one for the latter.

3) "Brick" making machine : ONE.

For the conversion of rumen contents alone or with supplementation into bricks.

4) Press for the partial removal of moisture for the rumen contents and if found suitable would also be used for the blood ; ONE.

5) It would be advisible to provide a vehicle as the work involved is of slaughter house and it would be necessary to visit the same very frequently and to bring the material for subsequent processing and utilisation to the department/college.

6) Fermenter and its other accessories 15 Litre capacity, Laboratory Centrifuge.

V. Additional Manpower required : Enclosed.

VI. Training needs in USA : This is an important aspect of this project and as all the aspects needs to be probed into for developing the indigenous process technology for its adaptation under our conditions, with suitable modifications, This study for the senior scientists (Animal Nutrition and Microbiology) and the Junior Res.Officer (Microbiology) for studying the respective aspects and to overcome the hinderances/obstacles that are encountered during this study. This would also give an opportunity for the senior scientists and the Research and Junior Research Officer to study the current developments and advances in US and also its application under our conditions. For this the following places are suggested, where relevent, work is being undertaken.

Animal Nutrition: 1) Virginia Polytechnique Institute and State University, BLACKSBURG. 2) Ruminant Nut. Laboratory, & 3) Research Institute, SEA. Univ. of Illinosis, URBANA.

Research Contacts :

1) L.W.Smith - Biological waste management Lab.Agril. Environmental Quality Institute, Science & Education Administration, U.S.Dept. of Agriculture, Beltsuille. Maryland 20705 U.S.A.

2) B.A.Weiner - Fermentation Lab. Northern Regional Research Centre, U.S.Dept. of Agriculture, Agril. Research Service, 1815 N.University, Peoria, Illinois 614601 U.S.A.

3) J.P.Fontenot - Dept. of Animal Science, Verginia Polytechnique Institute & State University, Blacksburg, Virginia 24061 U.S.A.

4) Deane F.Weber - Cell culture & nitrogen. Fixation Lab. U.S.Dept. of Agriculture, Beltsville, Maryland.

5) Bernard A.Weiner - Northern Regional Research Centre, U.S.Dept. of Agriculture, Peoria, Illinois.

VII. Relevent information of the Slaughter House:

The Slaughter House at Deonar, Bombay during the years 1982-83 and 1983-84 had undertaken slaughter of about 24.7 lakhs of sheep and goats; 93 to 97 thousand of bullocks; 50-65 thousand buffaloes and about 5 thousand male buffaloe calves and in addition slaughter of 36 to 43 thousand of pig and piglings.

From this about 6 to 7 M.T. of rumen contents are available daily, and the same is not utilised presently. The blood from the pig and piglings and the clotted blood as a by-product from the pharmaceutical industry is available and is not used presently. Presently, they manufacture only 68 M.T. of blood meal (1983-84).

Thus, it can be seen that large quantities of rumen contents are available and this figure is likely to increase in future as the same is not utilised. Similarly, large quantities of blood is also available and the same can be utilised by its processing. Thus, it can be seen that this slaughter house has a big potential for this type of work.

VIII. Work undertaken : Pilot studies on the various rumen liquor fractions have already been undertaken in this department. Similarly, pilot studies on the rumen contents are in progress. The work on blood and meat meal has been also undertaken on a pilot scale by this department. A small project in broilers is also undertaken by this department.

contd.....6.

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This department is also working on the "Brick" making or the conversion of roughages into "Brick" but because of lack of facilities like non-availability of equipments, machinery and manpower etc. not much progress has been made so far. However, the "Bricks" have been prepared from the ground and chaffed roughages.* "Complete Rations" in case of growing stock. Work done in the Microbiology Laboratory at Bombay. By creating a rumen fistula the culture samples were collected and the following bacteria have been isolated on special media like cellulose agar medium and other media.

Bacteroides succinogenes.
Bytyrvibrio fibrosolvens.
Ruminococcus albus.
Clostridium longisporum.
Streptococcus bovis.

The feasibility of suing any one of them as converters of rumen contents and blood into proteins, will be considered.

* Similarly, this department has also undertaken trial on the

TECHNICAL PROGRAMME :

I YEAR: Initial Screening and Compositional Assays :

1.Analysis of Rumen ingesta/digesta and Abomasal contents samples from various species and classes of livestock in different seasons.

2.Studies on drying of these samples in different seasons for-

a) Sun drying.

b) Mechanical squeezing followed by sun drying.

c) Mechanical squeezing followed by mechanical drying.

d) Mechanical squeezing followed by sun and mechanical drying.

Studies on Rate of Evaporation,
Time for Evaporation,
Input Expenditure.

3. Conservation of Rumen contents with Urea at lower moisture contents.

4. In vitro and in vivo (Nylon bag studies of these samples).

II YEAR: :Above studies alongwith ---

A) 1. Ensiling studies with different Dry Roughage Sources like hay, jowar, and paddy straw etc.-- either alone or in combinations.

2. Ensiling with supplimentation & enriching.

B) In vitro and in vivo studies (Nylon bag Technique) of the different combinations of Ensiled materials and effects on the digestibility of different Nutrients.

III YEAR: Growth studies on growing calves with Ensiled/Enriched materials of 4-8months duration in comparison with the the traditional sources of roughages.

Digestibility & Balance trials during growth studies.

Rumen liquor studies with SRL from growing calves on different combinations and different nitrogen fractions.

IV YEAR: Studies on Broilers: Use of Dried Rumen Liquor in different combinations.

V YEAR: Studies on use of dried Rumen Ingesta in Milking animals. Effect on milk yield and composition and Digestibility of Nutrients.

CONVERSION OF RUMEN INGESTA INTO MICROBIAL PROTEIN

A report :

Rumen ingesta accumulated in slaughter houses is burned, buried or used as land fills. Various types of agricultural cellulosic wastes have been converted into single cell protein or their nutritive value has been augmented by solid substrate fermentation and ensiling methods.

In this research project, efforts are directed towards the conversion of cellulosic wastes in the form of roughages from the rumen of slaughtered animals into microbial protein by submerged fermentation and also by solid substrate fermentation.

The raw rumen-ingesta has been analysed for its trude protein, fat, fiber, lignin, cellulose and bemicellulose content. To ensure the degradation of the cellulosic component which is in 50% amounts, delignification with NaOH, NaOCl (Sodium Chlorite) and Gamma irradication have been tried.

Cellulolytic organisms were isolated from various sources like the rumen ingesta itself and soil around slauthter house and around byres. Many cellulolytic fungi and bacteria were isolated using cellulose as the sole carlon source in a mineral salt medium.

The isolates were screened for their cellulolytic activity by measuring their filter paper shredding ability, potency of the cellulase enzyme, biomass formation and a high protein production. With these criteria, two fungal isolates and two bacterial isolates have been selected for the fermentation proper.

The selected fungi were screened for any aflatoxin production by U.V.flourescence method and later injected peritoneally into albino mice for confirmation.

The pretreated ingesta was used as substrates in one percent amounts in submerged fermentation and it was found that fungal isolates showed a recovery of 12-27% protein per gram substrate in different mineral salt media.

The solid substrate fermentation of the rumen-ingesta fibers supplemented with Nitrogen-salts showed an increase of 20% protein when inoculated with various fungal isolates and some standard cellulolytic fungi after a 7-10 days incubation period.

(9)

The bacterial isolates were found to be less active than fungal isolates. Though their protein content was higher, (55-75%), the biomass yield was less (18-25%).

The fungal isolates have been tentatively identified as Penicillium, while the bacteria as Cellulomonas and Aeromonas sp.

The optimization tests for the nitrogen salt requirements pH, temperature and aeration requirements for getting higher yields are being performed. The above studies can be done with larger amounts of substrates to get better yields in a pilot fermentor if available.

The amino acid profile of the obtained protein has to be determined. Metabolic trials in animals have to be carried out to assess the nutrient values in vivo.

Title of Project: "Availability of animal feed resources and their utilization with special emphasis on crop residues, byproducts of industries, forest, aquatic and slaughter house in origin and animal organic wastes for evolving economic rations of livestock and poultry."

Yearwise Technical Programme

First year

1. Equipments including jeep shall be purchased and laboratory facilities developed.

2. Survey of available feed resources both conventional and non-conventional (crop residues, agro-industrial byproducts, forest, aquatic, and animal organic wastes including slaughter house byproducts and wastes shall be conducted as per the programme approved.

3. Samples of these feed resources, spilled feed and animal organic wastes shall be collected and their chemical composition determined.

4. Preparation of report.

Second year

1. Survey work shall be continued.

2. Detailed chemical composition shall be conducted on the samples collected during the survey to bring out the effect of different plane of nutrition on the composition of animal wastes. The following parameters will be studied:

   a) Proximate principles.

   b) Cell wall constituents.

   c) Mineral elements.

   d) Caloric value.

   f) IVDMD.

3. Preliminary work will be initiated to screen the animal organic wastes for pathogenic organisms and parasites.

4. Preparation of report.

Third year

1. Survey work shall be continued.

2. Methods shall be standardised for drying the cattle wastes including urine and losses due to different drying processes be determined.

3. Studies shall be conducted to delineate the effect of drying on pathogenic organisms and parasites.

4. Preparation of report.

Fourth year

1. Survey work shall be continued.

2. Standardisation of processing techniques to improve the nutritive value of poor quality roughage and animal wastes.

3. Study the relative composition and nutritive value of these improved feed ingredients in comparison to the basal roughage in animals.

4. Preparation of report.

Fifth year

1. Animal experiments shall be conducted on the rations formulated for maintenance and growth.

2. Identification of the toxic/incriminating factors present in these byproducts and wastes, study of the chemical nature, development of detoxification methods and the effect of detoxification treatments on animals.

3. Studies on the utilization of various byproducts separately and in combination through long term feeding trials on various categories of livestock and poultry will be taken up.

4. Formulation of balanced and economical rations for non-producing animals, growing stock and for the production of milk, meat, egg etc. by incorporating byproducts from agro-industries.

5. Preparation of final report.

CON ERSION OF BIODEGRADABLE ANIMAL WASTES FOR LIVESTOCK FEEDS

"Biodegradation of wastes from aquatic animal industries into animal feeds."

Department of Animal Nutrition,
Kerala Agricultural University,
Mannuthy, Trichur.

STATE OF PRESENT KNOWLEDGE

Shortage of quality feeds and forages is the major constraint in the development of livestock farming in Kerala. The major items of feed come from the neighbouring states and the extent of deficiency in concentrates is about 60% and of fodder about 25% in the state. Under such a situation, the only alternative to find source of feed for the livestock is to exploit wastes from Agricultural or animal farms. Over forty items of agricultural, animal and fish wastes are found to be potential sources of nutrients which could be utilised for animal feeding after proper processing. Biodegradation of these wastes is one of the methods which can be adopted for their effective utilisation. Microbial fermentation of such wastes with a wide array of micro organisms - algae, bacteria and fungi - alone or combined with physical or chemical processes and production of single cell protein will enhance their feeding value considerably. Appropriate research is needed for developing suitable technology for microbial conversion of such wastes. The utilisation of such converted feeds offer an important approach for improving livestock feeding.

India has a total coast line of about 6000 kms out of which Kerala's share is 590 kms const tuting approximately 10% of countries total coast line. Moreover, Kerala with backwaters of about 390 kms length rivers and canals of nearby 480 kms length, fresh water ponds, lakes and reservoirs of about 8500 hectares and of paddy lands suitable for prawn cultivation with an area of nearly 4050 hectares, has an important place in the fishing map of India. The mechanisation of fishing operation is fast progressing in the state and there is considerable scope for extending

the fishing operations to off shore and oceanic regions. The total quantity of fish landing in Kerala for the year 1981-82 was estimated as 3 lakh tonnes worth 623 million rupees. The details on species-wise quantity and value of marine fish landings in Kerala, fish landings - inland waters - Kerala and India 1977-1982, Inland fish landings in Kerala and Marine products export from Kerala and India are shown in tables 1, 2, 3 and 4 respectively. According to the study group of ICAR (1967), a considerable portion of fish catch and their processing wastes available in Kerala are either being used as manure or thrown into sea itself and only a part is being converted into fish meal or dried fish. With the rapid development of fishing by mechanised boats, the total catch including prawn and miscellaneous fish in the state has been steadily increasing. This has posed a problem of better and more effective utilisation of fish products. The large quantities of waste materials produced from such extensive fishing operations and fishing industries in the State, if properly treated, will have a potential for adding to the feed resources of India in general and Kerala in particular. The project will attempt on the development of biotechnology for the conversion of wastes of marine origin to animal feeds using a wide array of microorganisms, algae, bacteria and fungi. The nutritive values of many such marine products have already been worked out in the department of nutrition, a brief account of which is given below:

Shrimp shell powder(prawn waste) for broiler chicks:

Shrimp shell powder is a waste product of shrimp processing industry and consists largely of discarded portions viz, the heads and shells of the shrimp. The material is found to contain about 32 percent of total protein, 9 percent calcium and 1.3 percent phosphorus. Feeding experiments with broiler chicks have shown that the material can be safely incorporated in place of dried fish with monetary benefits.

Fish silage for poultry: Fish silage, an ensiled product, obtained from fish wastes is found to contain about 48 percent of total protein, 5 percent calcium and 2 percent phosphorus on dry matter basis. Feeding experiments with laying hens

have indicated that dried fish component of layer ration can be effectively replaced by fish silage even though the high moisture content of the material is a factor to be reckoned with in its incorporation in commercial poultry rations.

Frog meal for growth in chicks: Frog meal, a byproduct of frog leg industry was found to contain 66.8% of crude protein, 11.75 percent of calcium and 5.38 percent phosphorus. Investigations carried out to find out the suitability of frog meal as a substitue for fish meal in chicl rations indicated that complete replacement of fish meal (10%) in chick ration with frog meal on an isoprotemic basis resulted in better growth rate, higher feed efficiency and greater economic returns.

Land snail (Achatina fulica) for pigs: Feeding experiments in weanling pigs with dried land snail with 59% of crude protein indicated that the incorporation of the material at a level of 7.5 percent or replacing 50% of the fish meal in the diet did not produce any deleterious effect in pigs and promoted growth rate as efficiently as a ration containing 15% fish meal.

Background Information:

A. State: The state of Kerala occupying 1.03% of the total geographical area of Indian Union, has got a total of 38,864 sq. km. area. It lies in the North lattitude between 8° - 18' and 12° - 48' and in the East longitude between 74° - 52' and 77° - 22'. It has a coastal line of 580km. in the West and has a total of 44 rivers.

Livestock Population (1977 Census):

1. Cattle	:	30.06 lakhs
2. Buffaloes	:	4.54 "
3. Goats	:	16.83 "
4. Sheep	:	2546 Nos
5. Pigs	:	1.72 lakhs
6. Fowls	:	130.56 "
7. Ducks	:	4.29 "
8. Total milk production	:	7 lakh tonnes
9. Per capita availability of milk		79 g. per day
10. Production of eggs	:	1050 million
11. Fish landing	:	3,45,000 tonnes
12. Total number of cattle slaughtered per year	:	1 million

....4/-

Department of Microbiology

B. Department of Nutrition:

Staff Position:

1. Professor & Head of Department	- 1	1
2. Professors	- 5	1
3. Associate Professor	- 1	—
4. Assistant Professor	- 4	5
5. Junior Assistant Professor	- 2	
6. Research Assistants	- 3	
7. Farm Assistants	- 3	

Laboratory Facilities:

1. U.G. Laboratory	one	800 sq. Ft.
2. Analytical Lab	one	600 Sq. ft.
3. Post Graduate Lab	one	600 Sq. ft.
4. Biological Investigation room	one	400 Sq. ft.
5. Fodder Research Room	one	400 Sq. ft.
6. Preparation Room	one	200 Sq. ft.
7. Special Equipment Room	one	200 Sq. ft.
8. Digestion Room	one	200 Sq. ft.
9. Store	one	200 sq. ft.
10. Staff Room	Four	600 sq. ft.

Metabolism Stalls:

1. Metabolism stall for Calves with 24 stalls
2. Metabolism stall for adults with 12 stalls
3. Metabolism stall for Goats with 12 cages
4. Metabolism stall for Pigs with 20 cages

Experimental Animal Facilities:

1. Small Animal Breeding Station

Rats	- 70
Rabbits	- 60
Mice	-150
Gunica Pig	- 30

2. University Livestock Farm, Mannuthy

Milk cows	- 100
Dry	- 50
Young stock.	- 100
Total strength	- 250

3. Goat Farm

Adults
Kids } 562

4. Poultry Farms:

The Farm had an area of 5.26 Ha.

Total strength chicken	:	10,000
Incubation per year	:	60,000
Cage houses - 4 Nos. with 1600 birds each		
Ducks	:	1,000
Turkeys	:	85
Japanese quail	:	450

5. Pig Breeding Farm:

Total area of the farm is 2.0 Ha.

Total strength : 376

6. Cattle Breeding Farm, Thumboormuzhi:

Strength : 250

7. Livestock Research Station, Thiruvazhamkunnu:

Total area of the farm is 163.3 Ha.of which nearly 32 ha. are uncleared forest. An area of 78.37 ha. is used for fodder cultivation and 42.93 ha. are grazing land for animals.

8. Fodder Research and Development Scheme, Mannuthy:

Out of the total area of 65 ha. of land, 60 ha. are set apart for fodder production. Approximately 2,404 tonnes of fodder is being produced each year.

Analytical Facilities:

Equipments Available

1. Muffle furnace
2. Soxhlet Extraction apparatus
3. International Centrifuge
4. P.H. Meter
5. Water bath
6. Kjeldahl Digestion Unit
7. Monopan Balance
8. Flame photometre
9. Hot air oven
10. Willey mill
11. Chromatographic Equipments
12. Bomb Calorimeter
13. Shaker water bath
14. Feed grinding and Mixing Unit

.....6/-

ICAR Projects Operated in the Department

1. AICRP on Agri. By-products.
2. Energy Protein Ratio in Pigs (Completed)

Kerala Agricultural University Projects

Completed Projects

Post Graduate

1. Studies on the metabolic disturbances associated with methionine toxicity.
2. Studies on the biological utilisation of carbohydrates.
3. Effect of dietary calcium and phosphorus on growth and skeletal development of young pigs.
4. Copper and Zinc interrelationship in Pigs.
5. Fundamental Studies on the Physiological responses of albino rats maintained on qualitatively and quantitatively different diets.
6. Biological evaluation of the nutritive value of pulses.
7. Studies on the nutritional status of farm animals maintained on standard rations with and without incorporation of unconventional feeds and fodders of local importance.
8. Studies on copper and iron deficiencies of growing pigs
9. Enquiry into the tiological factors involved in caprine urolithiasis with special reference to minerals.
10. Studies on the utilisation of unconventional feeds and fodders in ruminent rations.
11. Utilisation of tapioca starch waste in Swine ration.
12. Studies on the influence of physiolocal functions such as growth and production on the digestibility of nutrients in rations.
13. Studies on silk cotton seed cake as a component of concentrate ration for milk production.
14. Evaluation of the feeding value of tapioca leaf-meal for poultry with special reference to growth, egg production and egg yolk pigmentation.
15. Evaluation of the feeding value of rubber seed cake for producing growth in calves.
16. Studies on growth rate, feed efficiency and carcass characteristics of pigs reared upto different market weights on two dietary treatments.

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17. Studies on the nutrient requirements of kids.

18. Enquiry into the ethilogical factors involved in caprine urolithiasis with special reference to minerals.

19. Studies on the influence of carbohydrates on utilisation of proteins.

20. Evaluation of the nutritive value of pulse proteins with and without supplementation of amino acids.

21. Optimum level of protein in concentrate mixture of kids for growth.

22. Growth and carcass characteristics of pigs maintained on rations containing different levels of dried tapioca chips.

23. Lucern meal as an ingredient in calf starter.

Ongoing P.G. Projects:

1. Comparative feed conversion efficiency of cross-bred Jersey and cross-bred Brown Swiss cattle.

2. Degradability of protein and protected protein in ruminants.

Other Research Projects Completed:

1. Evaluation of the Nutritive value of African payal.
2. Evaluation of the Nutritive value of rain tree fruits on feed for cattle.
3. Studies on the nutritive value of hy-brid varieties of paddy straw.
4. Establishment of feeding standards for goats
5. Evaluation of the nutritive value of tea waste in Swine rations.
6. Tannic Acid content and digestibility of nutrients in tree leaves.
7. Toxic principles of leaf fodder with special reference to Hydrocyanic acid.
8. Rearing of rabbits for economic meat production.
9. Comparative evaluation of conventional and unconventional feed for evolving cheap and economic ration for livestock.
10. Crop-livestock integration project (Goats and Banana)
11. Long term trials with Rubber seed cake on milch cows.
12. Studies on the effect of supplementation of tallow on digestibility of nutrients in ration containing agricultural by-products.
13. Trace minerals in poultry feed ingredients - Manganese.

Ongoing Projects:

1. Utilisation of paddy straw treated with urea and molasses in cattle feed.
2. Poultry litter as cattle feed
3. Eupatorium adenophorum as a fodder for cattle.
4. Non-traditional techniques for silage making in high rain fall areas.
5. Cocoa pods as an animal feed.
6. Utilisation of water weeds as silage for cattle.
7. Utilisation of water hyacynth for swine feeding.
8. Studies on kid starters.
9. Mineral status of locally available fodder crops.
10. Establishment of nutrient requirements of rabbits.
11. Studies on anti-nutritional factors in locally available fodders.
12. Rumen degradability of common feeds.
13. Establishment of nutrient requirements of ducks.

Technical Programme:

In order to achieve the broad and specific objective of the subproject, the following experiments/studies will be planned and executed yearwise as detailed below:

First Year:

1. Collection of the various aquatic wastes viz, Fish waste including the intestines, scales and heads, trash fish, snails, shell fish, crabs, prawn waste and frog waste in adequate quantities.
2. Complete chemical analysis of the above materials for the nutrient contents including the micronutrients and characterisation by microbiological, chemical and physical methods.
3. Assessment of the microbiological profile of each waste.

Second year:

1. Continuation of the work in the first year.
2. Identification of the most suitable microorganism for fermentation of each waste by culture studies.

Third year:

1. Continuation of the work in the second year.
2. Aerobic and anaerobic fermentation of each waste.
3. Chemical analysis for nutrient contents and fermentation products at weekly intervals of storage and fermentation.
4. Screening for toxic and other harmful products in the fermented wastes.

Fourth year:

1. Continuation of the work in the third year.
2. Assessment of nutritive value of the fermented product from each identified waste by
   (a) Feeding trials in chicks
   (b) Feeding trials in pigs.

Fifth year:

1. Continuation of the work in the fourth year.
2. Assessment of the economics of inclusion of the above products in animal rations.
3. Transfer of viable biotechnology developed from the above studies to the farmers.

Requirements:

1. Equipments:

   Nutrition

   1. Spectronic 2000 - Double beam spectrophotometer
   2. Electronic analytical balance
   3. Gas chromatographic equipment
   4. Kjeltec system
   5. Soxtec system
   6. Fibretec system
   7. Pelleting machine
   8. Amino acid analyser
   9. Rapid N analyser
   10. Bomb calorimeter
   11. Infrared analyser
   12. Micropulveriser
   13. Feed grinding and mixing unit of 1 ton/hour.
   14. Refrigerated van.

.....10/-

Microbiology

1. Bacterial identification - Automatic.
2. Sonicater
3. Anaerobic chamber
4. Luminar Flaw device
5. Carbondioxide incubator
6. Water purifier
7. Fraction collector with UV monitor
8. Micro pH meter
9. Freeze drying unit
10. Deep freezer - 80°C
11. Nephlometer
12. ELISA Reader
13. Electrofocussing apparatus
14. Chromoscan
15. Top pan balance

II. Training of staff associated with the project:

The scientific staff associated with the project have to be trained in special areas of Animal Nutrition and microbiology in different laboratories in India and abroad where such type of studies are being carried out. The training may be for a period of 12 months. Fellowships may be offered for the Scientist I/c for visit and training in research institutes in U.S.A. for a period of four months. The institutes or laboratories to be visited for training will be decided by the ICAR.

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Biodegradation of Animal Wastes As Animal Feed - Poultry Waste

Abstract

Quantitative availability of animal excreta waste has been described. The utility of poultry droppings or litter as compared to dung is mentioned. The reported investigations on utilizing poultry dropping/ litter both in the ruminant and poultry rations indicate that the poultry waste has a potential use for recycling as animal feed.

Presence of certain substances in the poultry wastes has been attributed for causing abortions or other clinical symptoms when high level of layer waste was included in livestock ration. Several pathogenic fungal and bacterial species have been isolated from the poultry waste and for their elimination dry heating or autoclaving process has been recommended. Alternatively the thermophilic fermentation of the poultry wastes before feeding to animal has been described as the most economical process to eliminate pathogens.

Based on the 9 day natural thermophilic fermentation process for upgrading the nutritive value of urea - straw developed at the Ludhiana Centre application of this processes has also been envisaged for the poultry wastes. Some preliminary results on the thermophilic fermentation of poultry dropping - straw mixtures have been reported. The future technical programme of work for investigations on the above line has been proposed in the annexure.

Biodegradation of Animal Wastes as animal feed - Poultry wastes

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The animal excreta waste dry matter (DM) production (Ton/head/annum) is 1.5, 0.75, 0.30 and 0.005 respectively for ruminants, equines, swine and poultry[1]. In India the annual availability of DM from ruminant and poultry excreta waste is estimated to be around 282.5 and 2.0 million tonnes respectively[2] Recent reports on dung utilization suggest that only the soluble nutrient fractions than the residual fraction may be of nutrition significance for ruminants[3,4]. Earlier, reports indicate that chemical treatment of dung like straws or producing wastelage by ensiling dung and hay can improve the nutritive value of dung[5]

On the contrary the poultry dropping (PD) available either as litter or as PD from batteries and slatted floor have chemical composition and nutritive value governed by the age of the doner, spilled feed, undigested feed protein, metabolic feacel nitrogen and microbial protein from ceacum[6]. The crude protein (CP), true protein (TP) uric acid, crude fibre (CF), total amino acid and ash in the dried poultry manure ranges respectively between 184-385, 106-148, 23-114, 118-291, 51-120 and 201-494 g/kg manure[7,8]. Therefore, the potential feeding value of PD is promising both for the ruminants and non-ruminants. While the poultry litter can be considered more as a ruminant feed the PD can also be incorporated in the poultry mashes.

Performance of gestating - lactating ewes on rations containing chicken litter was not different than that having soya bean meal[9]. The growing cattle fed on poultry litter comprising 24% of the ration DM had an average daily gain of 0.99 kg as against 0.94 kg under the control[10]. However, with wheat straw based poultry litter from layers 60% replacement of

a concentrate mixture than 37% resulted in depressed growth rate[11]. In the subsequent experiment on growing buffalo heifers the 27 and 37% replacement of a concentrate mixture with the above litter resulted in a daily gain of 0.389 and 0.356 kg respectively as against 0.420 kg under the control concentrate mixture[12]. These reported differences in the growth performance with the PD litter could have been due to the difference in the nutritive value of the roughage fed as well as the ash content in a ration.

The cage PD fed to cattle resulted in the weight gain of 1.15 kg than 1.07 kg under the conventional feed and the feed to gain ratio was 6.49 and 7.25 respectively[10]. These authors also observed that sheep fed on a diet containing 17% dried PD had an average weight gain of 0.189 kg with 7.06 feed to gain ratio than a gain of 0.17 kg with 6.59 ratio under the control diet. Further, presence of 12% PD in the diet of milking cows increased the DM consumption by 0.30 kg/day without effecting the milk yield or fat content.

The cage PD in graded levels (5 to 20%) in a broiler mash depressed the growth rate as the level of inclusion had increased[1] and 10% level in isonitrogenous and isocaloric chick starter mash had no depressant effect[14]. But in layers mash 10% PD showed significant depression in the egg production during 3 laying tests of 305 days each[15]. With 20% level in a layer mash the 4 week mean body weight of egg type chicken and egg production was not depressed[16] even though replacement of 25 to 50% ground nut cake with PD was reponsible for reducing the feed efficiency per dozen of eggs laid. These differences in the experimental results could possibly be attributed to the mash formulations, the uric acid, ash and CF content present in the PD containing mash.

In our laboratory the mineral profile of a broiler PD was used for adjusting the inclusion of mineral supplement in a semi-purified or practical type broiler mash containing PD to maintain low ash content without effecting the mineral requirement of a growing broiler. The *Pleurotus* or *Fusarium* specie of fungi

were employed for treatment to obtain a PD with low uric acid (0.9%) and CF content[17]. With these manuplations growth rate equivalent to that under control mash was achieved in a broiler with the mashes containing upto 15 and 25% of untreated or fungal treated PD replacing extracted groundnut cake on nitrogen basis[17]. Higher levels of PD than the above had depressed the growth rate due to increase in uric acid above 1% or due to increased CF in a mash. Further, lower ME content than control in a practical type PD mash also depressed the growth rate indicating that the PD could not be used as a replacement for energy source[17].

Inspite of using PD/litter as non-protein nitrogen source with wheat straw as roughage without any disease problem[18,19], some reports on clinical and pathological manifestations by the animals are available. Incidence of abortion was reported in cows fed poultry litter having oestrogenic activity due to 10 ug diethyl-stillboestrol equivalent/100 g litter[20]. Similarly, inclusion of 45 and 60% dried layer PD in weanling lamb ration resulted in reduced feed intake, hypoalbumiuaemia, ascites, contrilobular necrosis and liver fibrosis in 8 weeks, while inclusion at 15% level or high levels of broiler PD had no such effect in lambs[21]. Although no experimental evidence was provided but these clinical symptoms were attributed to the presence of some toxic substances in the dried layer PD. Possibly, certain additives added in mash to enhance poultry production on excretion after metabolism may have been reponsible for showing the above symptoms when layer PD was fed at high levels.

The bacteriological examination of field samples have also shown different pathogenic bacteria[23]. The litter or PD samples collected from the various sheds at 8 weeks or after 365 days were found to contain fungi, coliform, lactobacillus, enterococci but no solmonella species[23,24]. Besides the excreta or litter also possess Ova or spores of the pathogenic parasites with which a doner flock was infested. In order to eliminate the risk of pathogenicity to the healthy animals processing of PD/litter before recycling through a mash or a ration either by dry heat or autoclaving becomes essential. Under such a situation the energy cost of processing and handling can be uneconomical.

On the contrary stacking or ensiling of PD/litter alone or with a feed stuff as a result of heat of fermentation make the waste product pathogen free. During the thermophilic natural fermentation process of urea-wheat straw by stacking under field condition the stack temperature reached to 70°C in 3 days. Within 9 days the fermented straw preparation of a high nutritive value was available to maintain an adult buffalo[25]. Further, while standardising the above process 11% rice husk based poultry litter, 1.0% urea and wheat straw was composted for 30 days and the chemical changes monitored in this compost were similar to that in a standard compost.[26]

Therefore, during the year under report (1986) cage PD replaced 25,50,75 and 100 urea-N (Table 1) and each straw mixture was packed in polyethylene punched bags in triplicate for 9 days fermentation. The daily temperature record (Table 2) in these bags reached to 60°C on 2 day followed by a drop to 50°C on 3 day and by 6 day the temperature remained around 40°C. The chemical changes on the final day as against 0 day (Table 3) showed increase in total ash, CP associated with fall in OM and CF. These changes enhanced as the level of PD had increased from 25 to 100%.

In the second experiment PD replaced 100 urea-N and the chemical changes in the bags were monitered daily for 9 days. It was observed that after 4 days the increase in ash or CP or decline in OM was at the minimum rate. It appeared that continuation of the fermentation in the bags after 4 days was not necessary (Table 4). However, the final conclusions will be possible only after the *in vitro* rumen OM digestibility data, (under progress) is available. This will be helpful in assessing the appropriate stage of stopping the fermentation process suitable for improving the utilization of PD/litter with straw based rations.

Based on the experiments conducted above and the earlier experimental results available on broiler[17] and wheat straw-poultry litter fed to buffalo[11,12] the outline of the technical programme of work for 5 years is planned.

Table 1 Replacement of urea-N with that of PD-N

Treatment	T_1	T_2	T_3	T_4	T_5
Replacement level of Urea-N (%)	0	25	50	75	100
Urea (g)	52.50	39.40	26.20	13.12	-
PD (g)	-	150	300	450	600
Straw (g)	1447.5	1310.6	1173.8	1036.9	900
Water (ml)	3,000	3,000	3,000	3,000	3,000

Note: Urea-N replaced with poultry dropping-N on isonitrogen basis.

Table 2: The daily temperature record (^{o}C)

Treat-ment	T_1	T_2	T_3	T_4	T_5
Days 1	58.5 ±0.29	63.33 ±0.17	63.83 ±0.83	62.17 ±0.73	61.33 ±0.33
2	45.30 ±0.33	53.00 ±0.00	62.00 ±0.50	61.73 ±0.33	61.33 ±0.17
3	44.00 ±0.58	50.33 ±0.33	54.00 ±0.47	52.00 ±0.00	50.83 ±0.44
4	43.30 ± 0.33	47.50 ±0.28	48.00 ±0.47	45.67 ±0.67	47.00 ±0.47
5	40.67 ±0.33	40.83 ±0.44	41.00 ±0.47	41.17 ±0.33	42.83 ±1.20
6	39.17 ±0.17	39.33 ±0.33	39.83 ±0.17	40.33 ±0.33	42.33 ±0.17
7	37.67 ±0.17	38.33 ±0.33	36.00 ±0.47	37.00 ±0.47	40.69 ±0.33
8	38.67 ±0.33	38.00 ±6.00	36.66 ±0.33	37.33 ±0.33	39.67 ±0.33
9	38.33 ±0.33	38.00 ±0.29	36.6[illegible] ±0.33	37.50 ±0.23	39.83 ±0.44

Each figure tothe average of temperature recorded from 3 bags.

Table 3: Effect of fermentation on chemical composition (on % DM basis).

		1	2	3	4	5
Ash	Before	8.14	10.40	13.11	13.25	13.38
	After	10.24 ±0.30	13.75 ±0.31	16.50 ±0.18	19.35 ±0.18	20.26 ±0.08
OM	Before	91.86	89.60	86.89	86.75	86.62
	After	89.76 ±0.30	86.25 ±0.31	83.50 ±0.18	80.69 ±0.18	79.74 ±0.08
CP	Before	4.93	6.08	8.29	9.02	10.06
	After	5.00 ±0.17	8.76 ±0.14	10.46 ±0.47	12.95 ±0.05	14.19 ±0.22
CF	Before	40.20	39.95	38.42	36.90	36.75
	After	44.79 ±0.32	38.40 ±0.20	35.12 ±0.63	28.18 ±1.11	24.36 ±1.34

Each figure of after fermentation is the average ± SE of 6 observations.

Table 4: Daily variation in the chemical composition (DM basis) when 100% urea-N was replaced by PD-N.

Days	Total ash	Organic matter	Crude protein
0	13.36	86.64	10.21
1	15.23	84.77	10.44
2	17.90	82.10	11.16
3	17.58	82.42	11.58
4	19.04	80.96	12.14
5	20.27	79.73	13.49
6	20.06	79.94	13.37
7	20.08	79.92	13.74
8	20.37	79.63	14.48
9	21.16	78.84	15.00

Note: a) PD (600 g) and wheat straw (900 g) was moistened to 70% with 3000 ml water and each individual 5 kg capacity bag was filled with above material.

b) In all 20 such bags were packed and each day 2 such bags were used as separate sample for duplicate chemical analysis.

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6. Poultry droppings after fermentation to reduce uric acid will be used in poultry rations for evaluation in broiler and layer mashes.

7. Hatchery waste products will be used in the calf starter rations by replacing fish meal, meat meal or skimmed milk powder.

Facilities and Equipment required:

A detailed note about the requirements was submitted in Jan., 1985 when the programme of work was discussed. However, for thesmooth working of the project the following additional equipments will be required:

1. Equipment:
   a) Atomic absorption spectrophotometer for mineral analysis (one).
   b) Amino acid analyser (one)
   c) Dehydrater Oven (Two)
   d) Heavy duty grinder (One)
   e) Rotary shaker (One)
   f) Laboratory fermentor (one)

2. Other Physical facilities:

Apart from the available laboratory facilities arrangement in the form of a Covered platform shed is required for conducting biodegradation work all around the year.

Annexure I

Plan of work for 5 years

1. Chemical analysis of poultry organic wastes available under different feeding and management practices will be carried out for:-

   a) Soluble sugars.
   b) Total-N and nitrogen fractions
   c) Crude fibre and VanSoest analysis
   d) Mineral profile (Macro and micro elements)

2. Experimental conditions will be standardised for bioconversion of poultry organic wastes after mixing with straw by determining:

   a) Chemical changes for OM, cellulose, NDF and AD Lignin
   b) Extent of uric acid break down
   c) In vitro rumen OM digestibility of the final preparation.

3. Comparative rumen degradability of DM, OM, cellulose and protein using nylon bag technique will be assessed in:-

   a) Poultry dropping and litter
   b) Straw
   c) Final product(s) from (2) above
   d) Unfermented Poultry dropping/litter-straw mixture of (c)

4. Poultry droppings/litter replacing urea on nitrogen basis in the preparation of fermented straw by stacking will be conducted under field conditions for in vivo nutritive evaluation on buffalo using following ration combinations:-

   a) Unfermented PD/litter - straw
   b) Fermented PD/litter - straw
   c) Straw based ration with a concentrate supplement.

   The mineral supplement in (a) and (b) rations will be adjusted as per the average mineral profile of the PD or litter used and the availability of mineral to the animals from this source worked out. (This will be carried out subject to the availability of Atomic Absorption Spectro-Photometer).

5. Based on the results available from above experiments (4) ration combination with fermented poultry dropping/litter - straw will be assessed in a 180 day feeding cum-metabolism trial on growing and lactating buffaloes.