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CONSULTANCY REPORT

ON

WORK COMPLETED DURING PERIOD JUNE 5 TO 28, 1989

CONCERNING PROJECT SPONSORED BY UNITED STATES

AGENCY FOR INTERNATIONAL DEVELOPMENT AND INDIAN COUNCIL

OF AGRICULTURAL RESEARCH

PROJECT NO.386-0470

Agricultural Research Umbrella

Sub-project 5

CONVERSION OF BIODEGRADABLE ANIMAL WASTES FOR LIVESTOCK FEED

Submitted by

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I. INTRODUCTION

The purposes of the assignment were to participate in the All India Workshop on "Agricultural By-Products for Animal Feed", at which the subproject 5 - "Conversion of Bio-degradable Animal Wastes for Livestock Feed" was reviewed, and to visit all centers collaborating in the subproject. The consultant arrived in Delhi June 5, 1989 and his itenerary during his stay in India is given in Annexe A.

The workshop was held at the Haryana Agricultural University (HAU), Hisar. During the workshop, research progress and plans were discussed by scientists from HAU and Punjab Agricultural University (PAU). Following the workshop, the consultant and Dr. A. Colin McClung, Winrock International, New Delhi, met with scientists from HAU, PAU and the Central Toxicological Laboratory (CTL), Hisar. The agenda consisted of equipment purchase, training of scientists, and other management and fiscal matters.

The consultant visited with scientists involved with the subproject at the following institutions:

- Bombay Veterinary College (BVC), Bombay
- Haryana Agricultural University, Hisar
- Kerala Agricultural University, Trichur
- Punjab Agricultural University, Ludhiana.

At HAU he visited with the coordinator of the subproject and of the Central Toxicological Laboratory, now located at Hisar. The consultant visited also with Dr. N.M. Rao, Central Leather Research Institute, Madras and Mr. Sharish Magar, Magar Farm Pvt. Ltd., Pune. Dr. Rao has conducted research with the consultant on slaughterhouse waste, and has an interest in the subproject. Mr. Magar, a former graduate student of the consultant, has fed poultry waste to sheep on the Magar Farm.

The consultant presented seminars at HAU during the Workshop, PAU, HAU and the Central Leather Research Institute.

The report is divided into the following sections:

I. Introduction
II. Summary
III. The Workshop
IV. Visits to participating institutions and other locations
V. Recommendations

Utilization of these bio-dagradable wastes would increase the feed supply significantly, which would subsequently increase the supply of animal products. Appropriate use of these by-product wastes would lower feed cost, thereby increasing profit for livestock producers and lowering food cost for consumers. Use of the wastes as livestock feed would also solve some environmental problems.

It is hoped that this report will be useful to the Indian Council of Agricultural Research (ICAR) and Indian scientists working on the research covered by the subproject.

II. SUMMARY OF THE CONSULTANCY REPORT

The scientists at each participating institution reported on the progress of the research at the workshop and/or during the visit by the consultant. Technical programs were outlined for the next year. Generally, progress of the work was satisfactory. There has been a delay in developing the Central Toxicological Laboratory. With relocating the Laboratory at HAU, it appears that the Laboratory will be developed in the immediate future. The technical programs for the research at the centers are directed toward the subproject objectives.

General and specific recommendations are made.

A. General Recommendations

1. At each location the research should continue to be directed toward the objectives of the sub-project.
2. Efforts should be initiated toward technology transfer, especially demonstrations of processing and feeding wastes.

3. Sound experimental designs and sufficient replications should be employed.
4. Use of computer equipment should be increased for computing, storing, retrieving and statistical treatment of data.
5. The workshop, in connection with the workshop on the All India Project on by-products, should be continued, with careful advance planning.
6. Research progress at all locations should be closely monitored.
7. Interactions with scientists from the U.S. and other countries should be strengthened, including use of special consultants.

B. Specific Recommendations

1. The Central Toxicological Laboratory should be developed immediately and become fully operational by March, 1990.
2. The training programs should proceed without delay.
3. The equipment to be obtained under the subproject should be installed and be operational soon after items are received.

4. A U.S. extension specialist should be invited as consultant to assist in initiation of technology transfer programs.
5. The scientists should submit completed research for publication in peer-reviewed journals when sufficient data have been obtained.

III. THE WORKSHOP

On June 6 and 7 a workshop was held on the All India Coordinated Research Project on Agro-Industrial By-Products for Evolving Economic Rations for Livestock and Poultry. A copy of the program for the workshop is given in Annexe B, Section A. The ICAR considers the research conducted under the subproject as part of the All India Project. Research was reported from various institutions throughout India on crop residues, industrial, forest, aquatic and slaughter house by-products, and animal organic waste.

Included in the program of the Workshop were reports from HAU and PAU on research conducted under the subproject. These reports included progress and plans of the research. Reports of the research progress from these two institutions are in Annexe B Section B. Unfortunately, scientists from BVC and KAU were not able to participate in the workshop. Progress of the research at these institutions is given in Section IV.

IV. VISITS TO PARTICIPATING INSTITUTIONS AND OTHER LOCATIONS

Visits were made to the five participating centers to review the status of the research under the sub-project, discuss the training program and equipment acquisitions, and discuss plans for future research. The central Toxicological Laboratory has been moved to the campus of HAU, Hisar.

A. General:

Dr. A.C. Mc Clung and the consultant met with representatives from all units except BVC and KAU, at the HAU Campus, following the workshop.

The agenda items consisted of management and fiscal matters. Dr. McClung indicated that there was opportunity for real progress, but stated the need for speeding up the training program. He reviewed the status of the training program and of the equipment purchase.

Scientists were asked to start working on the Life-of-Project work plan of the sub-project. Plans for training schedules and use of consultants should be finalized. A tentative schedule for the training program is given in Annexe C, Section A and for consultants in Annexe C, Section B.

B. Haryana Agricultural University:

Excellent progress was made in the research on large animal waste (Annexe B, Section B). The completed and planned experiments were discussed in detail with the scientists.

1. Completed Experiments

a. Studies on chemical composition and IVDMD of bedding materials. The research results showed that the nutritional value of straw can be enhanced by use as bedding for a few days. For example, crude protein was increased from 2.52 to 12.33 % after use as bedding for 7 days. Neutral detergent fiber was reduced from 81.5 to 68.1 %.

b. Ensiling of wheat and paddy straw based beddings. Ensiling was not satisfactory when bedding was ensiled alone or with up to 10% molasses. The reason is probably too high a level of waste in the bedding. It is estimated that the proportions were 85% waste and 15% straw. Addition of green forage improved ensiling, especially with 10% molasses. The improvement was probably due, at least partly, to decreased proportions of waste to straw in the silages.

c. Ensiling of wheat straw based bedding in mixtures with green maize and molasses. Addition of molasses improved firmentation. As level of waste in bedding decreased from about 75% to 70% and 65%, ensiling was improved, especially with addition of molasses. Adding green fodder did not consistently improve fermentation. In previous work it has been shown that the waste should not exceed 40%, wet basis, when mixed with dry forage.

d. Studies on conservation of animal wastes by sun drying and through urea - ammonia treatment. Feed intake was much lower in buffaloes in which straw bedding replaced 66 % of oat hay. The intakes may have increased with adaptation to the rations.

2. Planned Experiments

a. Laboratory ensiling of cattle waste with wheat straw, green fodder and molasses. Preliminary results indicate some of these mixtures ensiled satisfactorily. The levels of waste were probably too high at the higher levels (75:25, 70:30) Another experiment was tentatively planned in which the ratios of waste to straw would be 70:30, 60:40, 50:50 and 40:60 with 0, 5, 10 and 15 % molasses.

b. Urea-ammonia treatment of the mixture of fresh cattle waste and wheat straw. It was suggested, if it is possible to use six treatments, that an additional treatment of cattle waste: straw of 3:1 be used.

C. **Punjab Agricultural University**

The scientists at this institution continue to make excellent progress on the research on poultry wastes (Annexe B, Section B). Detailed discussions were held with three of the participating scientists. One scientist has gone to the U.S. for training, and another was participating in a conference in Canada.

1. Completed Experiments:

a. Evaluations of poultry litter/poultry droppings as ruminant feed. This experiment is the first to measure changes in chemical composition of poultry litter with time. The lower crude protein in the final litter than usually measured in the U.S. appears to be due to deeper bedding than used in U.S. The data on pathogenic organisms show some destruction of pathogens in the litter.

It appears that poultry droppings are not effective in supplying ammonia to improve fiber digestion when deep stacked with straw. Perhaps, the lack of response, compared to urea treatment, is due to a smaller rise in temperature.

b. Isolation and characterization of fungal species isolated from dried poultry droppings: Three non-toxic fungi isolates have potential to synthesize protein and digest fiber from poultry droppings.

c. Comparison of promising fungal isolates with new fungal cultures: A few isolates show promise for protein synthesis from poultry droppings. Sufficient quantities of the fungi will need to be produced for evaluation in chicks.

d. Standardization of fungal bio-mass production on poultry droppings through solid state fermentation. The decreases in uric acid and crude fiber, the increase in true protein, and high *in vitro* pepsin/trypsin digestion indicate that Caprina sp. may be valuable in protein synthesis from poultry droppings.

2. Planned experiments:

a. Use of Caprin sp for protein synthesis from poultry droppings: The plan is to produce a sufficient amount to conduct chemical and biological evaluations. The plans to determine amino acid content and biologicl evaluations will yield results which will be valuable in determining the nutritional value of the synthesized protein. Future experiments will include growth trials and studies of digestion in different parts of the digestive tract.

b. Deep stacking poultry litter and straw. Litter and straw (1:1) will be deepstocked at 35, 50 and 70% moisture for 6 and 9 days.

c. Nutrient utilization of poultry litter by buffaloes. Broiler litter will be deep stacked for 4 to 6 weeks. The litter will replace 25, 50, and 100% of the concentrate in buffaloes. A metabolism trial will be conducted.

d. Time of deep stacking poultry litter. An experiment will be conducted to study changes in litter deep stacked for 6 days, 9 days, 4 weeks and 6 weeks. Changes in composition, temperature, pathogens, *in vitro* and perhaps in *vivo* digestibility will be determined. Deep stacking will be compared to ensiling poultry litter. This experiment may be conducted by a trainee while in the U.S.

C. **Toxicological Laboratory**

This laboratory has been relocated at HAU, Hisar. Ample space and some faculty and support staff are being provided by HAU. Some equipment has been purchased by ICAR and major items of equipment will be supplied by USAID.

In addition to the coordinator, the staff will include a Biochemist/Toxicologist, Microbiologist and Pathologist. It is planned that the laboratory will be fully operative by March, 1990. It is recommended that a Biochemist/Toxicologist Consultant go to Hisar in February - March, 1990 to assist in getting this laboratory fully operational.

D. Bombay Vetenirary College

Considerable progress was made on the research on slaughterhouse by-products. Since they were not able to participate in the workshop at Hisar, no report was available. However, detailed discussions were held with the scientists involved with the research under the sub-project. Some data are given in Annexe B, Section B.

1. Experiments completed or in progress:

a. Chemical analysis of rumen digesta. Chemical analyses were copleted for digesta collected at the slaughter plant from cattle/buffaloes and sheep slaughtered at different times of the year. Results of analysis of rumen digesta from cattles/buffaloes digesta are given in Annexe B - Section B. Composition of digesta from sheep was similar to that of cattle/buffalo digesta. Also, composition was similar for digesta collected during different seasons. The residue was obtained by manual squeezing. The dry matter concentration was approximately doubled by squeezing. Crude protein was higher for the residue for digesta obtained directly from the rumen at slaughter or from the collection pit. There is no easy explanation for this change, especially since the filtrate was highest in crude protein. The low digestibility (17.4%) of digesta indicates the material has low energy value. Perhaps, treatment with urea would enhance the energy value.

b. Ensiling of rumen digesta and blood. Ensiling was attempted at 40 - 45% moisture, including mixtures of rumen contents, blood, straw and molasses but ensiling was not satisfactory. They found that satisfactory ensiling was achieved at 65 % moisture. The results of ensiling rumen digesta with 40, 50 and 60 % paddy straw with 5 and 10% malasses are given in Annexe B, Section

B. The pH values of 5.4 to 5.8 indicate that good fermentation was achieved. The low crude protein and high crude fiber are expected, since the animals are fed mainly paddy straw prior to slaughter.

c. Mycoprotein production from rumen ingests. This study, although not part of the sub-project, was conducted by a Ph.D. student from Bombay University, in cooperation with BVC scientists. A non-pathogenic and non-toxic fugal isolate was used for converting protein by submerged or solid substrate fermentation. It was concluded that rumen ingesta can be effectively converted to protein with a suitable fungal culture, but protein conversion was more efficient for the solid substrate fermentation. The fungal protein was fed to chicks. Normal feed efficiency was obtained, and no toxicological or pathological effects were observed.

2. Planned Experiments:

a. Pathogen studies. Microorganisms will be identified from rumen digesta and it will be determined which are pathogenic. Methods will be developed to destroy the pathogens.

b. Ensiling of rumen contents and blood. Different proportions of rumen contents and blood (1:0, 1:1 and 2:1) will be ensiled with different levels of paddy straw (40,50 and 60%) with 5 and 10 % molasses. Chemical composition and ensiling characteristics will be measured.

c. Feeding ensiled mixtures of slaughterhouse waste and straw. The three best ensiled mixtures obtained in the small silo experiment will be ensiled in large silos, and will be fed to calves, sheep or goats. Growth rate and digestibility will be measured.

d. Solar drying of rumen digesta. The effect of sun drying and drying under solar panels on chemical composition and pathogen destruction will be studied. Pressed digesta will be used.

e. Urea treatment of rumen digesta. Pressed digesta will be treated with 4 and 5.3% urea (dry basis), and sun dried. Chemical composition and digestibility of the treated and untreated digesta will be determined. Growth and digestion trials may be conducted, as time permits.

E. Kerala Agricultural University:

Due to the uncertainity of the status of the subproject at KAU, including the delay in sending scientists for training, progress during the past year was limited. Some contacts were made with seafood processors. An experiment not directly related to the subproject was conducted on the feeding value of prawn waste to swine. The waste appeared to have only limited value for swine. Due to the high chitin content, undoubtedly, the waste would have more value for ruminants.

1. Planned experiments:

Large amounts of fish and prawn waste are available along the coast. The prawn waste consists of the waste from processing the prawns, and fish waste includes waste from processig the fish, and fish caught in excess of processing capacity. In one village near Kakkaam Beach it is estimated there are 200 prawn processing plants, and each of these may process up to 500 kg per day. Assuming 50% waste, as much in 50 tons of waste may be available per day. Presently, the wastes are used mainly as fertilizer, after sun drying.

a. Pathogens in waste. Prawn and fish waste will be collected from processors and screened for pathogenic microbial load, including clostridia and salmonella.

b. Chemical composition of wastes. Prawn and fish wastes will be chemically analyzed to begin assessing nutritioned value.

c. Microbial degradation of prawn waste. Suitable microbial agents, capable of degradation of prawn waste will be identified, and inoculations will be prepared.

d. Ensiling of prawn waste. Different proportions of prawn waste and straw will be ensiled. Indoubtedly, substantial levels of molasses will be required for satisfactory ensiling. The following measurements will be made on the ensiled mixtures: pH, lactic acid, acetic acid, trimethylamine, ammonia, proximate composition, microbial population, especially pathogens, and *in vitro* digestibility.

F. Other Visits

1. Mr. Sharish Magar, Magar Farms Pvt. Ltd. Pune. The consultant visited with Mr. Magar in Bombay. Mr. Magar completed his M.S. degree under the direction of the consultant over a year ago. His M.S. thesis research was concerning processing and feeding poultry waste. His interest has continued in this subject, and he has started applying the technology on the Magar Farm. He has ensiled layer waste with sugarcane leaves. A 100,000 hen layer unit will be constructed in the near future, and Mr. Magar plans to process the waste by ensiling with sugarcane by-products and feed the ensiled material to sheep.

2. Central Leather Research Institute, Madras. The consultant visited with Dr. N.M. Rao and other scientists working on animal by-products. Dr. Rao had done research on slaughter house by-products in Virginia with the consultant, while on a FAO fellowship. He and others have a research program in rumen digesta, blood and tissue from dead animals. They are processing the waste by ensiling and other processes to destroy the pathogens and produce acceptable feeds. They have adapted processing methods for the small livestock producers.

V. RECOMMENDATIONS

A. General

1. The research at each location should continue to be directed toward the objectives of the sub-project. The research program at each center should be planned so that by the termination of the sub-project the technology can be used profitably by livestock producers.

2. Efforts should be initiated towards technology transfer. Efforts should be made to initiate demonstrations of processing and feeding of the biodgradable wastes on private farms. Perhaps some of the farms participating in the survey for the All India Project on By-product Feeds would be interested in such demonstrations.

3. Sound experimental designs should be employed for all experiments, so valid statistical treatment of the data will be possible. Wherever possible, negative and positive control treatments should be used. Sufficient numbers of replications should be used, so valid results will be obtained. Statisfical treatment and summarizing of the data should be done immediately after completing an experiment.

4. More use of computer equipment should be made for computation, storage, retrieval and statisfical treatment of data. This could include mainframe and/or personal computers. Use of computer should be included in the program of all trainees.

5. Workshops should continue to be held annually. The practice of holding these in connection with the workshop on the All India Project on By-Products seems reasonable. However, a significant and identifiable portion should be devoted to the sub-project. The program for the workshop should be planned in detail in advance (minimum of 2 months) and a firm agenda developed. This should be done by the sub-project coordinating committee, perhaps, with input from the lead consultant.

6. Research progress at all locations should be monitored periodically by ICAR and USAID/Winrock. Reports should be submitted and reviewed promptly at 3 month intervals. Each location should be visited two or three times during the year.

7. Interaction with scientists from the United States and other countries should be strengthened. Most scientists involved in the training program and technology components of the sub-project should be invited as consultants to participate in the workshops and to visit participating centers. A suggested consultant schedule is given in Annexe C - Section A. Usually, the persons involved with the training program should be invited after the training of Indian scientists in that laboratory has been completed.

B. Specific Recommendations

1. Central Toxicological Laboratory. The establishment of this laboratory, essential for the program at all other centers, should be done immediately. Perhaps, the relocation at HAU will enable the laboratory to be established and be fully operational within the next few months. It is recommended that in order to speed up the starting up the laboratory, a biochemist/toxicologist be invited to HAU after the equipment items have been purchased to assist in the start up of the laboratory. This could be done either before or after the 1990 workshop.

2. Training Program. The first two scientists began their training programmes in early June. The proposed schedule for the trainees is given in Annexe C - Section B. Terms of reference are in Annexe C-Section C. It is imperitive that the schedule be adhered to for satisfactory progress of the work under the subproject, and to complete the training before the program lapses.

3. Equipment Installation: The equipment is scheduled to be delivered by October, 1989. The consultant has reviewed space, electrical connections and locations of each equipment item with scientists at each center. It is critical that the equipment be installed and operative soon after delivery. The delivery, installation and standardization of the equipment must be coordinated among ICAR, USAID/Winrock and the participating institutions.

4. Technology Transfer: Use of a U.S. consultant specializing in technology transfer should be initiated within the next 8 - 10 months. Persons were identified by the sub-project management team in their report in 1987 who have been successful in stimulating adoption of technology of feeding waste materials by livestork feeders. It is recommended that one of these Extension Specialists be invited to participate in the 1990 workshop, and another be invited to the 1991 workshop, and to visit the participating institutions to assist in planning technology transfer programs at each center.

5. Publication of Research. Some of the research has progressed to the point that the results should be published. It is recommended that the scientists at each participating institution summarize the data promptly, and when it appears sufficient data have been collected in a given area, that they proceed to prepare a manuscript to submit to a recognized peer-reviewed journal.

ADDENDUM

The consultant was informed that funding for the subproject had been reduced by $200,000. A suggested revised budget was developed by the consultant. In the revised budget funds for equipment purchases were not changed. The revised budget includes funds for the training program and consultants as outlined in Annexe C, Sections A and B. Values used to estimate training costs are given in Annexe D- Section A, and a summary of the revised budget is given in Annexe D- Section B.

ANNEXE A

PROGRAM AND ITINERARY

Dr. Joseph P. Fontenot

JUNE	5	MON	Arrive Delhi		
			Stay at Taj Palace Hotel		
	6	TUE	Depart Delhi	0600 hrs.	by car
			Arrive Hisar	0900 hrs.	
			Stay at Faculty Club		
			Participate in the workshop and visit collaborating center		
	10	SAT	Depart Hisar	1600 hrs.	by car
			Arrive Ludhiana	1930 hrs.	
			Stay at Sutton House		
			Visit PAU Center		
	14	WED	Depart Ludhiana	0600 hrs.	by car
			Arrive Delhi	1100 hrs.	
			Stay at Taj Palace Hotel		
	15	THU	Depart Delhi	1035 hrs.	IC-182
			Arrive Bombay	1225 hrs.	
			Stay at Taj Mahal HOtel Visit Bombay Vet. College		
	17	SAT	Depart Bombay	0700 hrs.	by car
			Arrive Pune	1000 hrs.	
	18	SUN	Depart Bombay	1030 hrs.	IC-191
			Arrive Cochin	1215 hrs.	
			Depart Cochin	1400 hrs.	by car
			Arrive Trichur	1630 hrs.	
			Stay at Elite Hotel Visit Kerala Agr. University		
	21	WED	Depart Trichur	1030 hrs.	by car
			Arrive Cochin	1330 hrs.	
			Depart Cochin	1300 hrs.	IC-536
			Arrive Madras	1500 hrs.	

JUNE	21	WED (cont.)	Stay at Connemara Hotel		
	22	THU	Depart Madras Arrive Delhi	1830 hrs. 2100 hrs.	IC-458
			Stay at Taj Palace Hotel		
	23-26	FRI-MON	Final discussions with ICAR/USAID/Winrock and preparation of report		
	27	TUE	Depart for U.S.		

PROGRAMME OF THE INAUGURAL FUNCTION OF 16TH ANNUAL WORKSHOP OF AICRP ON DETERMINATION OF THE AVAILABILITY.....LIVESTOCK AND POULTRY(ICAR) TO BE HELD AT HAU, HISAR ON 6-7TH JUNE 89.

6.6.1989 (Tuesday)	8.00 - 9.00 hrs	Registration of the delegates.
	9.00 - 9.55 hrs	Inaugural Session
	9.00 - 9.05 hrs	Welcome address by Dr S.C.Chopra, Dean, College of Animal Sciences.
	9.06 - 9.14 hrs	Remarks by Dr P.K.Dwarkanath, Addl. Director of Research (V&AS), HAU.
	9.15 - 9.30 hrs	Keynote address by Dr R.M.Acharya, Dy.Director General (AS), ICAR.
	9.31 - 9.41 hrs	Report by Dr M.L.Punj, Project Coordinator, AICRP (ABP)
	9.42 - 9.50 hrs	Presidential address by Dr S.P.S. Karwasara, Director of Research, HAU.
	9.51 - 9.55 hrs	Vote of thanks by Dr Vidya Sagar, HOD (Animal Nutrition), HAU.
	9.56 - 10.15 hrs	Tea Break
	10.16 - 11.30 hrs	Technical Session I Review of the progress of work of Anand and Hyderabad centres. Chairman : Dr S.P.Arora Co-chairman : Dr D.C.Joshi Rapporteur : Dr S.C.Khirwar
	10.31 - 12.30 hrs	Technical Session II Review of the progress of work done at Pantnagar and Uruli-Kanchan centres. Chairman : Dr B.S.Gupta Co-chairman : Dr P.C.Das Rapporteur : Dr T.B.Chauhan
	12.31 - 13.30 hrs	Technical Session III Review of the progress of work done at Ranchi, Guwahati and Madras centres. Chairman : Dr V.D.Mudgal Co-chairman : Dr P.M.Puntambekar Rapporteur : Dr K.K.Singal
	13.31 - 14.40 hrs	Lunch break
	14.41 - 15.30 hrs	Technical Session III continued.
	15.31 - 17.30 hrs	Technical Session IV Review of the work done at Ludhiana, Hisar, Trichur, Bombay and Reference Laboratory. Chairman : Dr R.M.Acharya Co-chairman : Dr K.Nath Rapporteur : Dr Arun Verma

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7.6.1989 (Wednesday)	7.30 - 9.30 hrs	Visit to Central Institute for Research on Buffaloes and National Research Centre on Equines, Hisar.
	9.31 - 11.30 hrs	Technical Session V Achievement [illegible] of each centre and discussion on the recommendations of the Mid-term Appraisal Committee. Chairman : Dr K.Pradhan Co-chairman : Dr Vidya Sagar Rapporteur : Dr S.K.Bhatia
	11.31 - 11.45 hrs	Tea break
	11.46 - 13.30 hrs	Technical Session VI Formulation of the Technical programme of each for 1989 and 8th Five Year Plan. Chairman : Dr [illegible].Gill Co-chairman : Dr [illegible] Reddy Rapporteur : Dr J.[illegible] Kaushal
	13.31 - 14.40 hrs	Lunch break
	14.41 - 16.30 hrs	Technical Session VII Plenary session Chairman : Dr K.Pradhan Co-chairman : Dr U.B.Singh Rapporteur : Dr J.P.Srivastava.

VENUE :

Inaugural Session - Auditorium, College of Basic Sciences & Humanities.

Technical Sessions- Committee Room -do-

Best Available Document

ANNEXE B - SECTION B

Progress Reports and Tables from:

Bombay Veterinary College

Haryana Agricultural University

Punjab Agricultural University

Note: Progress Reports and Tables are after Annexe D.

ANNEXE C - SECTION A
Suggested Schedule for Consultants

Year	Name	Location	Specialty	No. Weeks	Consulting activity
1	Dr. A.D. Tillman	Okla State Univ. (Retired)	Animal Nutrition	5	Advising concerning training & equipment.
1	Dr. J.P. Fontenot	V.P.I. & S.U.	Animal Nutrition & Waste Feeding	3	Review of technical program at each location, suggested training sites & equipment needs.
2	Dr. J.P. Fontenot	V.P.I. & S.U.	- do -	4	Review of research & technical program; advised on training schedule, specifications for equipment; participate in workshop.
3	Dr. J.P. Fontenot	V.P.I. & S.U.	- do -	4	Participated in All India Workshop; review research progress and technical programs, and advised concerning training.
3	Dr. J.P. Fontenot (Lead Consultant)	V.P.I. & S.U.	Animal Nutrition & Feeding Animal Waste	2	Assist in training program in U.S. & equipment purchases.
4	Dr.H.J.Gerken,Jr.	V.P.I. & S.U.	Extension animal Scientist	4	Participate in workshop, visit each participating center and advise on technology transfer concerning feeding processed animal wastes.

ANNEXE C - SECTION A (continued)

Year	Name	Location	Specialty	No. Weeks	Consulting activity
4	Dr. J. Minyand	Miss. State Univ.	Biochemistry/ Toxicology	4	Participate in workshop. Visit Central Toxicology Laboratory & advise on operation of Laboratory.
4	Dr. J.P. Fontenot	V.P.I. & S.U.	Animal/Nutrition & Feeding Animal Waste	4	Review research progress & technical programs at each center, participate in workshop & assist concerning processing sea food and slaughter-house waste.
4	Dr. B. White	Univ. of Ill.	Microbiologist	4	Participate in workshop and assist in research on microbial protein synthesis from poultry and cattle waste.
4	Dr. J.P. Fontenot (Lead Consultant)	V.P.I. & S.U.	Animal Nutrition & animal waste	4	Assist in and monitor training program in U.S.
5	Dr. T.A. McCaskey	Auburn Univ.	Microbiology (pathogenic)	4	Participate in workshop and assist in research on quantifying and destruction of pathogenic microorganisms.
5	Dr. J.P. Fontenot	V.P.I. & S.U.	Animal Nutrition and Feeding Animal Waste	4	Participate in workshop and assist in research on processing and feeding poultry and cattle waste.

ANNEXE C - SECTION A (continued)

Year	Name	Location	Specialty	No. Weeks	Consulting activity
5	Dr. B.G. Ruffin	Auburn Univ.	Extension Animal Science	1	Participate in worskhop and assist in developing technology transfer programs on feeding animal waste.
5	Dr. J.P. Fontenot (Lead Consultant)	V.P.I. & S.U.	Animal Nutrition & Feeding Animal Waste	4	Assist in and monitor training program in U.S.

ANNEXE C - SECTION B[a/]
TRAINING PROGRAM FOR 1989-90

Participant no.	Speciality	Institution in India	Field of Training	Starting date	Suggested Institution/ Scientist
1.	Microbiology	Haryana Agr. Univ.	Protein synthesis by pure cultures of microorganisms	1-6-1989	Univ. of ILL, Urbana (Dr. B. White)
2.	Microbiology	Punjab Agr. Univ.	Growing pure cultures of microorganisms	1-6-1989	Univ. of ILL, Urbana (Dr. B. White)
3.	Animal Nutrition	Haryana Agr Univ.	Ensiling and nutritional value of cattle waste	6-7-1989	V.P.I. & S.U., Blacksburg (Dr. J.P. Fontenot)
4.	Animal Nutrition	Punjab Agr. Univ.	Processing and feeding poultry waste	6-7-1989	V.P.I, & S.U., Blacksburg (Dr. J.P. Fontenot)
5.	Animal Nutrition	Bombay Vet. Coll.	Processing and feeding slaughterhouse waste	10-8-1989	Wash. State Univ., Pullman (Dr. J.R. Males)
6.	Microbiology	Bombay Vet. Coll.	Pathogenic microbial aspects of feeding slaughterhouse waste	10-8-1989	Auburn Univ., Auburn (Dr. T.A. McCaskey)
7.	Microbiology	Kerala Agr. Univ.	Pathogenic microbial aspects of feeding aquatic waste	10-8-1989	Auburn Univ. Auburn (Dr. T.A. McCaskey)

a/ Terms of reference for participants 5-17 are in Annexe C - Section C. Participants 1-4 have been approved.

ANNEXE C - SECTION B (continued)

Participant no.	Speciality	Institution in India	Field of Training	Starting date	Suggested Institution/ Scientist
8.	Biochemistry/ Toxicology	Central Tox. Lab, Hissar	Toxicological aspects of feeding biodegradable animal waste	1-9-1989	Miss. State Univ. (Dr. J. Minyand)
9.	Animal Nutrition	Kerala Agr Univ.	Processing and feeding shell fish waste	1-11-1989	V.P.I. & S.U., Blacksburg (Dr. J.P. Fontenot)
10.	Animal Nutrition	Kerala Agr Univ.	Technology transfer concerning feeding sea food waste	1-11-1989	V.P.I. & S.U., Blacksburg (Dr. H.J. Gemke, Jr. & Dr. J.P. Fontenot)
11.	Animal Nutrition	Haryana Agr Univ.	Processing and feeding large animal waste	1-12-1989	Purdue Univ., Lafayette (Dr. A. Suttor)
12.	Microbiology	Punjab Agr. Univ.	Pathogenic microbial aspects of feeding poultry waste	15-3-1990	Auburn Univ. Auburn (Dr. J.A. McCaskey)
13.	Microbiology	Central Tox. Lab.	Pathogenic microbial determination & destruction in biodegradable animal wastes	15-3-1990	Auburn Univ. Auburn (Dr. T.A. McCaskey)

a/ Terms of reference for participants 5-17 are in Annexe C - Section C. Participants 1-4 have been approved.

ANNEXE C - SECTION B (continued)

Participant no.	Speciality	Institution in India	Field of Training	Starting date	Suggested Institution/ Scientist
14.	Animal Nutrition	Bombay Vet. Coll.	Ensiling & nutritional value of slaughter-house wastes	1-4-1990	V.P.I. & S.U., Blacksburg (Dr. J.P. Fontenot)
15.	Animal Nutrition	Kerala Agr. Univ.	Ensiling & nutritional value of sea food waste	1-4-1990	V.P.I. & S.U., Blacksburg (Dr. J.P. Fontenot)
16.	Animal Nutrition	Punjab Agr. Univ.	Protein quality evaluations as related to fungal protein	1-4-1990	Univ. of ILL, Urbana (Dr. D. Baker)
17.	Animal Pathology	Central Tox. Lab.	Pathogical aspects of feeding biodegradable animal wastes	1-1-1990	Univ. of Calif, Davis (Dr. Ben Norman)

a/ Terms of reference for participants 5-17 are in Annexe C - Section C. Participants 1-4 have been approved.

ANNEXE C - SECTION C

Terms of Reference for Trainees

Terms of Reference for Participant No. 5

I. Objectives:

The overall objective is to obtain training concerning utilization of slaughter-house waste as livestock feed. Specifically, this should include training in processing the wastes and measuring the nutritional value of the wastes.

II. Training:

- The training is to include:

1. Reviewing previous research in this area, and preparing a research proposal.

2. Learning procedures for determining chemical composition of the wastes and processed products. This may include analyses for proximate components, cell walls, major and minor minerals, and fermentation parameters such as pH, lactic acid and volatile fatty acids.

3. Development of procedures for processing slaughter-house waste to be included in practical rations for livestock.

4. Procedures for measuring utilization of nutrients. This may include *in vitro* digestibility, *in vivo* digestibility and nutrient balance.

5. Use of computer with appropriate software to store, retrieve and statistically analyze data.

6. Formulation of rations by least cost linear programming, incorporating the processed wastes as feed ingredients. This will be done by using mainframe or personal computer.

7. Summarize the research data and prepare a manuscript according to the format for a peer reviewed journal.

8. Participate in seminars, attend national or sectional scientific meetings and visit one or more other locations working in this area.

Terms of Reference for Participant No. 6

I. Objectives:

The primary objective is to learn procedures for quantifying pathogenic microorganisms in processed slaughter-house waste and to determine processing methods to destroy the pathogens. Included will be procedures for quantifying different types of pathogens and conditions necessary to destroy these.

II. Training:

The training is to include:

1. Reviewing previous work or this subject and preparing a research protocol.

2. Learning procedures for quantifying different pathogens which may be present in the waste, including, coliforms, fecal coliforms, salmonella, shigella, proteus, E-coli., and spore formers such as Clostridium botulinum.

3. Develop processing methods for destroying the pathogens and determining the effectiveness of the processes.

4. Conduct experiments in which the pathogens will be inoculated in the wastes and evaluate the effectiveness of the processing methods in destroying these.

5. Use of computer equipment with appropriate software to store, retrieve and statistically analyze the data.

6. Summarize the data and prepare a manuscript according to the format for a peer-reviewed journal.

7. Participate in seminars and national or regional scientific meetings, and visit one or more other locations working on this subject.

Terms of Reference for Participant No. 7

I. Objectives:

The overall objective is to learn procedures for quantifying pathogenic microbes in processed aquatic waste and to determine procedures for processing the wastes to destroy the pathogens. Included will be procedures for quantifying different types of pathogens and conditions necessary for destruction of these.

II. Training:

The training should include:

1. Reviewing previous research or this subject and preparing a research protocol.

2. Learning methods for quantifying different pathogens which may be present in aquatic wastes, including coliform, salmonella, E.coli, and spore farmers such as Clostridium botulinum.

3. Develop practical processing methods for destroying the pathogens, and evaluate the effectiveness of the methods.

4. Conduct experiments in which the pathogens will be inoculated in the wastes, and evaluate the effectiveness of the processing methods in destroying these.

5. Use of computer technology, with appropriate software to store, retrieve, summarize, and statistically analyze the data.

6. Summarize the data and prepare a manuscript according to the format for a peer-reviewed journal.

7. Participate in seminars and national and regional scientific meetings, and visit one or more other centers working in this area.

Terms of Reference for Participant No. 8

I. Objectives:

The primary objective is to become familiar with potential toxins in processed biodegradable animal wastes and to learn the development of procedures to detect and quantify the toxins. Included will be learning the operation of sophisticated laboratory equipment used to quantify the toxins.

II. Training:

The training will include:

1. Previewing previous work or this subject, and preparing a plan of work.

2. Learning the adaptability of different sophisticated laboratory equipment to determine levels of toxins in the waste products.

3. Learning the operation and standardizing these equipment items including: high pressure liquid chronalography (HPLC), high performance thin layer chronalography (HPTLC), atomic absorption spectrophometer (AA) and gas-liquid chromatography (GLC).

4. Conduct experiments in which known quantities of the toxins are present, and use appropriate procedures to quantify these.

5. May conduct experiments in which laboratory animals are fed certain toxins and monitor physiological effects.

6. Use computer equipment with appropriate software to store, summarize, retrieve, and statistically analyze the data.

7. Summarize the data collected and prepare a manuscript according to the format of a peer-reviewed journal.

8. Participate in seminars and national and sectional meetings, and visit one or more other centers working in this area.

Terms of Reference for Participant No. 9

I. Objectives:

The overall objective is to obtain training in methods of processing shellfish waste to produce a product to be incorporated in rations for livestock. Included will be ensiling and perhaps other processes, analyses for various components and measuring nutrient utilization.

II. Training:

The training will include:

1. Review of previous research on the subject of processing and feeding seafood waste and develop on acceptable research proposal.

2. To develop skills in processing shellfish wastes by ensiling and other methods.

3. Learn laboratory procedures to evaluate nutritional value and ensiling parameters, including analyses for proximate components, cell walls, chitin, major and minor minerals, and fermentation parameters such as pH, lactic acid and volatile fatty acids.

4. Procedures for measuring utilizing of nutrients, such as *in vitro* and *in vivo* digestibility and nutrient balance.

5. Use of computer with appropriate software to store, retreive, summarize and statistically analyze data.

6. Formulation of rations by level cost linear programming. This will be done by using mainframe or personal computer.

7. Summarize the research data and prepare a manuscript according to the format of a peer-reviewed journal.

8. Participate in seminars, attend national or sectional scientific meetings and visit one or more other locations working in this area.

Terms of Reference for Participant No. 10

I. Objectives:

To obtain training in transfer of technology concerning processing of degradable animal wastes, especially as related to seafood waste.

II. Training:

The training will include the following:

1. Review previous research done in processing and feeding of seafood wastes.

2. Become familiar with technology transfer in animal agriculture in U.S.

3. Develop a program of study involving technology transfer concerning processing and feeding seafood wastes.

4. Learn methods which have been effective in U.S. in technology transfer concerning other by-products.

5. To participate in research program on processing and feeding seafood waste.

6. Participate in demonstration on a private farm of processing and feeding seafood waste.

7. Use computer for storage, retrieval and statistical analysis of data.

8. Learn to compute least cost rations by linear programming on computer, using processed seafood wastes as feed ingredients.

9. Prepare report using format of peer reviewed scientific journal.

10. Participate in seminars, attend a national or sectional scientific meetings and visit one or more other locations working in waste processing and feeding.

Terms of Reference for Participant No. 11

I. Objectives:

The overall objective is to obtain training concerning utilization of large animal waste as livestock feed. Specifically, this should include training in processing the wastes and measuring the nutritional value of the wastes.

II. Training:

The training is to include:

1. Reviewing previous research in this area, and preparing a research proposal.

2. Learning procedures for determining chemical composition of the wastes and processed products. This may include analyses for proximate components, cell walls, major and minor minerals, and fermentation parameters such as pH, lactic acid and volatile fatty acids.

3. Development of procedures for processing large animal waste to be included in practical rations for livestock.

4. Procedures for measuring utilization of nutrients. This may include *in vitro* digestibility, *in vivo* digestibility, nutrient balance or growth trials.

5. Use of computer with appropriate software to store, retrieve and statistically analyze data.

6. Formulation of rations by least cost linear programming, incorporating the processed wastes as feed ingredients. This will be done by using mainframe or personal computer.

7. Summarize the research data and prepare a manuscript according to the format for a peer reviewed journal.

8. Participate in seminars, attend national or sectional scientific meetings and visit one or more other locations working in this area.

Terms of Reference for Participant No. 12

I. Objectives:

The primary objective is to learn procedures for quantifying pathogenic microorganisms in processed poultry waste and to determine processing methods to destroy the pathogens. Included will be procedures for quantifying different types of pathogens and conditions necessary to destroy these.

II. Training:

The training is to include:

1. Reviewing previous work or this subject and preparing a research protocol.

2. Learning procedures for quantifying different pathogens which may be present in the poultry waste, including, coliforms, fecal coliforms, salmonella, shigella, proteus, E-coli., and spore formers such as Clostridium botulinum.

3. Develop processing methods for destroying the pathogens and determining the effectiveness of the processes.

4. Conduct experiments in which the pathogens will be inoculated in the poultry wastes and evaluate the effectiveness of the processing methods in destroying these.

5. Use of computer equipment with appropriate software to store, retrieve and statistically analyze the data.

6. Summarize the data and prepare a manuscript according to the format for a peer-reviewed journal.

7. Participate in seminars and national or regional scientific meetings, and visit one or more other locations working on this subject.

Terms of Reference for Participant No. 13

I. Objectives:

The primary objective is to learn procedures for quantifying pathogenic microorganisms in processed slaughter-house waste and to determine processing methods to destroy the pathogens. Included will be procedures for quantifying different types of pathogens and conditions necessary to destroy these.

II. Training:

The training is to include:

1. Reviewing previous work or this subject and preparing a research protocol.

2. Learning procedures for quantifying different pathogens which may be present in the poultry waste, including, coliforms, fecal coliforms, salmonella, shigella, proteus, E-coli., and spore formers such as Clostridium botulinum.

3. Develop processing methods for destroying the pathogens and determining the effectiveness of the processes.

4. Conduct experiments in which the pathogens will be inoculated in the wastes and evaluate the effectiveness of the processing methods in destroying these.

5. Use of computer equipment with appropriate software to store, retrieve and statistically analyze the data.

6. Summarize the data and prepare a manuscript according to the format for a peer-reviewed journal.

7. Participate in seminars and national or regional scientific meetings, and visit one or more other locations working on this subject.

Terms of Reference for Participant No. 14

I. Objectives:

The overall objective is to obtain training concerning processing and utilization of slaughter-house waste as livestock feed. Specifically, this should include training in processing the wastes and measuring the nutritional value of the wastes.

II. Training:

The training is to include:

1. Reviewing previous research in this area, and preparing a research proposal.

2. Learning procedures for determining chemical composition of the wastes and processed products. This may include analyses for proximate components, cell walls, major and minor minerals, and fermentation parameters such as pH, lactic acid and volatile fatty acids.

3. Development of procedures for processing slaughter-house waste to be included in practical rations for livestock.

4. Procedures for measuring utilization of nutrients. This may include *in vitro* digestibility, *in vivo* digestibility and nutrient balance.

5. Use of computer with appropriate software to store, retrieve and statistically analyze data.

6. Formulation of rations by least cost linear programming, incorporating the processed wastes as feed ingredients. This will be done by using mainframe or personal computer.

7. Summarize the research data and prepare a manuscript according to the format for a peer reviewed journal.

8. Participate in seminars, attend national or sectional scientific meetings and visit one or more other locations working in this area.

Terms of Reference for Participant No. 15

I. Objectives:

The overall objective is to obtain training concerning utilization of seafood wastes as livestock feeds. Specifically, this should include training in processing the wastes and measuring the nutritional value of the wastes.

II. Training:

The training is to include:

1. Reviewing previous research in this area, and preparing a research proposal.

2. Learning procedures for determining chemical composition of the wastes and processed products. This may include analyses for proximate components, cell walls, major and minor minerals, and fermentation parameters such as pH, lactic acid and volatile fatty acids.

3. Development of procedures for processing seafood wastes to be included in practical rations for livestock.

4. Procedures for measuring utilization of nutrients. This may include *in vitro* digestibility, *in vivo* digestibility and nutrient balance.

5. Use of computer with appropriate software to store, retrieve and statistically analyze data.

6. Formulation of rations by least cost linear programming, incorporating the processed seafood wastes as feed ingredients. This will be done by using mainframe or personal computer.

7. Summarize the research data and prepare a manuscript according to the format for a peer reviewed journal.

8. Participate in seminars, attend national or sectional scientific meetings and visit one or more other locations working in this area.

Terms of Reference for Participant No. 16

I. Objective:

The main objectives are to obtain training in evaluating protein quality of microbial protein, especially as related to fungal protein synthesized from poultry wastes.

II. Training:

The training is to include:

1. Review of previous research on this subject and preparation of an acceptable research proposal.

2. Learning procedures for processing fungal protein for amino acid determination.

3. Conduct on experiment with chicks, pigs or laboratory animals to determine protein quality on animals fed single cell protein, preferably fungal protein.

4. Use of computer with appropriate software to store, retreive and statistically analyze data.

5. Formulation of rations by least cost linear programming, incorporating fugal protein as feed ingredient. This will be done by using mainframe or personal computer.

6. Summarize the research data and prepare a manuscript according to the format for a peer reviewed journal.

7. Participate in seminars, attend national or sectional scientific meetings and visit one or more other locations working in this area.

Terms of Reference for Participant No. 17

I. Objectives:

The main objective is to obtain training in pathological procedures to be used in diagnosing possible harmful effects of feeding processed biodegradable animal wastes.

II. Training:

The training is to include:

1. Procedures used in diagnosing health problems in animals consuming toxic substances.

2. To learn necropsy procedures in assessing cause of ill health on death of animals.

3. Histological and histochemical methods in diagnosing harmful effects of toxic substances.

4. Conduct on experiment, if feasible, in which laboratory animals will be fed different levels of a toxin known to produce pathological effects.

5. Necropsy and histological and histochemical examinations on animals fed different levels of toxin.

6. Summarize the data from the experiment, using computer where applicable.

7. Prepare a manuscript summarizing the experiment according to the format for a peer-reviewed journal.

8. To participate in seminars and attend national or sectional scientific meetings and visit one or more locations working in the area.

ANNEXE D-SECTION A

TRAINING BUDGET DETAILS

		Amount ($)	
		Long term	Short term
Travel to U.S.		2,500	2,500
Per diem		6,000	1,500
Miscellaneous		700	400
Travel in U.S.		500	
Training fee		12,000	
	TOTAL	21,700	4,400
	Per week	1,000	1,500

ANNEXE D-SECTION B
SUGGESTED REVISED BUDGET

Item	Project budget	Revised budget	Change
Equipment	484,000	484,000	0
Training	590,000	415,000	-175,000
Technical assistance	215,000	215,000	0
Maintenance	50,000	25,000	-25,000
TOTAL	1,339,000	1,139,000	-200,000

ANNEXE B

For Official use only

Proforma for monitoring of INDO-US Agricultural Research Project

ANNUAL PROGRESS REPORT

Ending December, 1988

1. Name of the Sub Project: Conversion of Biodegradable Animal Wastes for livestock feed. 386-0470 Sub project-7.

2. Name(s) with location(s) of the implementing centre. Department of Animal Science Punjab Agricultural University Ludhiana-141004

3. Staff position (cummulative position since start of project till end of period under report).

Sr. No.	Name of the implementing centre	Catagory of post	Name of the post	Number Sanctioned	Filled	Vacant
1.	MAIN SCIENTISTS					
	AICRP on 'Determination...evolving ..economic..rations for livestock and Poultry (ICAR + STATE)	Scientific	Dr PN Langar Animal Nutritionist	1	1	-
			Dr MPS BAKSHI Assistant Nutritionist	1	1	-
		Technical Supporting	Lab. Techn.	1	1	-
			Lab. Attendant	1	1	-
			Anim. Attendant	1	1	-
			Livestock Assistant	3	2	1
			Mechanic	1	1	-
			Jeep Driver	1	1	-
			Typist	1	1	-

2. Collaborating Scientists:

i.	Intensification of Research on evolving economic rations for Poultry (State Govt.)	Dr J.S. Chawla Poultry Nutritionist
ii.	Utilization of Agricultural Residues and Microbial conversion to food and feed (State Govt.)	Dr V.K. Gupta Assistant Microbiologist
iii.	Isolation and estimation of Pathogens in Poultry Wastes	Dr A.S. Sandhu, Asstt. Prof. Vety. Bact. and Virology
iv.	Transfer of Technology	Dr S.S. Gill, Additional Director of Research

4. Financial Progress: Statement to be supplied centre wise as per annexure enclosed.

5. Training of personal commulative position since start of project till end of quarter under report): a) Provided (Man months) 36
b) Utilized (Man months) None

Sr. No.	Name of the implementing centre	Name and designation	Period From to	Area of training	Name of the training centre with location
	Department of Animal Science Punjab Agricultural Univ. Ludhiana	The names of the Scientists sponsored for training have been sent to the ICAR New Delhi for finalisation.			

6. Visit for consultants (cummulative position since start of project till end of quarter under report: a) Provided (Man months) 10
(b) Utilized (Man months) None

Sr. No.	Name of the implementing centre	Name of the consultant	Field consultancy	Duration date of visit	Whether report is available Yes/No
	Department of Animal Science, Pb. Agril. University Ludhiana	Prof.J.P. Fentanot	Use of Poultry Wastes	Feb. 16'88 to Feb. 19'88	No

7. Seminars/Workshops held (cummulative position since start of the project till end of quarter under report):

Sr. No.	Name of the implementing centre	Number of seminars/ workshops	Duration with dates	Whether proceedings workshop/seminars available. Yes/No
	Department of Animal Science pb. Agril. University Ludhiana	1	Workshop of Project Feb.22,23'88 at ICAR New Delhi	Not yet.

8. Procurement of equipment (cummulative position since start of project till date):

Sr. No.	Name of the implementing centre	Name of the equipment procured	Date of procurement	Whether indegenious/
	Department of Animal Science Punjab Agricultural University Ludhiana	1. Modification in the list of equipment required as per the technical programme of work was finalised with Prof. J.P. Fontenot in Workshop held on 22-23 Feb. 1988)		

9. Accomplishment in terms of construction facilities etc:

The university has provided space for the routine lab. work and for animal experimental work. However in view of the specialised job for isolation and pure culture technology work, assigned to this centre, the modifications, additions, alteration and renovations of the laboratory spaces are essentially required. The required acetylene cylinders needed for atomic Absorption spectrophoto meter and carbon deoxide cylinders for CO_2 incubator and in vitro rumen digestibility determination have been aquired out of ICAR funds.

10. Technical progress: Highlights of achievements made so far keeping in view the objectives of the project:

A) Evaluation of poultry litter/Poultry droppings as ruminant feed:

i. Chemical and pathogenic microbiological changes taking place during litter formation: Saw dust (SD) or rice husk (RH) was spread in 7.5 to 10 cm thickness in 8 pens each as bedding material. Four month old 120 pullets were housed in each pen. The sampling of SD or RH litter was started from 0 month (August, 1987) at 30 day interval till July, 1988 after which the birds were culled. A representative sample from each pen was collected from different spots. Fresh sample was used for differential pathogenic and total viable microbial counts and oven dried (80°C, 24 h) sample used for the chemical assay.

The complete data on the chemical changes during 12 month (Table 1) show very little differences in the chemical composition of the SD or RH based litter available in July, 1988. It suggested that the initial variations (August '87) in the chemical composition observed in SD and RH were levelled off during the 12 months of litter formation. The major decline in the constituents from those in the 0 month were in the organic matter, neutral detergent fibre and cellulose associated with a substantial increase in the crude protein

Table 1: Chemical changes (% DM basis) in deep liter from poultry shed using saw dust (SD) and rice husk (RH) as bedding material.

Month	Litter	Total Ash	OM	CP	NDF	Cellulose	Cell soluble
1987							
August	SD	3.60	96.4	1.68	88.8	46.3	11.2
	RH	19.7	80.3	3.12	84.6	37.6	15.4
September	SD	17.1	82.9	9.60	71.7	30.8	28.3
	RH	21.5	75.5	8.44	71.4	30.1	28.7
October	SD	19.7	80.3	11.5	67.0	25.8	33.0
	RH	23.8	76.2	11.0	67.5	25.5	32.5
November	SD	21.0	79.0	13.0	66.5	27.4	33.5
	RH	23.0	77.0	12.0	65.0	24.1	35.0
December	SD	23.3	76.7	11.8	62.6	24.4	37.4
	RH	24.0	76.0	12.4	61.9	23.1	38.1
1988							
January	SD	25.5	74.5	12.0	60.6	24.4	39.4
	RH	26.3	73.7	12.0	60.6	22.2	40.0
February	SD	26.4	73.6	12.3	61.5	23.5	38.5
	RH	26.7	73.4	12.4	61.6	22.4	38.4
March	SD	25.5	74.5	19.6	59.3	21.3	40.7
	RH	25.8	74.2	13.7	56.0	22.2	44.0
April	SD	25.9	74.1	14.0	57.7	20.4	42.3
	RH	26.1	73.9	14.4	56.4	19.8	43.6
May	SD	25.0	75.0	15.9	NA	18.8	NA
	RH	25.2	74.8	16.1	NA	18.0	NA
June	SD	25.4	74.6	16.6	54.2	-	45.8
	RH	25.4	74.6	16.7	54.5	-	45.50
July	SD	29.2	70.8	16.6	NA	-	NA
	RH	29.8	70.2	16.8	59.2	-	40.8

and cellsolubles. Compared to the initial total ash in RH (20%) and in SD (3.6%) there was a considerable increase in the total ash of final SD litter (29.80%) than in the RH litter (29.2%).

These chemical changes were attributed to the presence of microbial action. Changes in the total viable microbial counts were observed during these 12 months (Table 2). In October and December 1987 and March and May, 1988 months the total viable microbial count was not possible even after 12 serial dilutions due to heavy load of activity. The presence of the pathogenic microorganisms e.g. E.coli, Kleibsella and Salmonella appeared to be more during August-September 1987 as well in the samples collected in December 1987, January and February, 1988. These months cenincide with the hot-humid and cold months when the maintenance of dry litter is problem. Possibly themoisture in litter was responsible for the appearance of pathogens. The types of E. coli were identified as 0.7, 0.29, 0.38, rough types and a few could not be typed. The presence of Salmonella typhimuriumwas confirmed in the Salmonella positive samples by the National Salmonella and Escherichia centre, Kasuli (Himachal Pradesh). However, during the hot-dry months of March, April, May onwards the microbial load was low and the plate counts of all the above mentioned pathogens were negative.

These results suggested that the dry litter available from the sheds during the hot summer months could be safely fed to the animals directly without any further treatment(s). However, the litter available in hot-humid or winter periods may not be safe for direct feeding and a pretreatment like deep stacking or dry heat to eliminate pathogenic microbes was essentially needed.

Table 2: Total differential visible Pathogenic microbial counts during litter formation.

Month	Litter	Total Count	Pathogen load x 10^5				Fungi
			E.coli	Klieb-sella	Salmo-nella	Others	
1987							
August	SD	26.5×10^5	1.5	0.5	-ve	-ve	Aspergillus flavus
	RH	250×10^5	2150	20	-ve	Anthracoid	
Sept.	SD	16000×10^5	30	20	-ve	-ve	Penicillium sp.
	RH	2×10^5	1	-ve	+ve	-ve	
Oct.	SD	-	1	-ve	-ve	Staph epidermides	
	RH	-	0.5	-ve	-ve	Anthracoid	Mucor
Nov.	SD	-	-ve	-ve	-ve	---do---	Sepadonium
	RH	-	-ve	-ve	-ve		
Dec.	SD	-	-ve	-ve	+ve	---do--- &	
	RH	12.7×10^5	160	-	-	Dipthiroid	
1988							
Jan.	SD	5.0×10^{13}	0.45	-ve	+ve	-ve	
	RH	2.55×10^{13}	0.25	-ve	+ve	-ve	
Feb.	SD	5.0×10^{13}	0.40	-ve	+ve	Staph epidermides	Aspergillus
	RH	5.0×10^{13}	0.50	-ve	+ve	---do---	Alternaria -ve
March	SD	-	-ve	-ve	-ve	-ve	-ve
	RH	-	-ve	-ve	-ve	-ve	-ve
April	SD	2.5×10^{13}	-ve	-ve	-ve	Staph epidermides	Mucor
	RH	4.55×10^9	-ve	-ve	-ve	Micrococcus & Psedomonas	---do--
May	SD	-	-ve	-ve	-ve	-ve	Fusarium sp.
	RH	-	-ve	-ve	-ve	-ve	---do---
June	SD	8.5×10^7	-ve	-ve	-ve	Staph epidermides	-ve
	RH	4.1×10^{12}	-ve	-v	-ve	Dipthiroid Micrococcus	-ve
July	SD	2.5×10^{11}	-ve	-ve	-ve	---do---	Aspergillus sp.
	RH	1×10^4	-ve	-ve	-ve	---do---	---do---

(..) During these months the total microbial load was heavy and the total visible count was not possible even at 12 serial dilution.

-ve Negative; +ve; Positive; SD= Saw dust; RH: Rice husk

U.I.: Unidentified.

The repeat experiment on the quantitative litter formation started from March, 1988 could not be completed as due to the incessant rains the litter was damaged and was completely replaced after August, 1988.

ii. *In vitro* digestibility of wheat straw - poultry dropping (PD) mixtures: *In vitro* dry matter and organic matter digestibilities (IVDMD or IVOMD) of wheat straw - poultry dropping mixtures after deep stacking process was also completed during the period under report. From the chemical composition of the different combinations of caged broiler PD - wheat straw - urea (reported in 1987) it was evident that the PD could replace 100% urea on nitrogen basis. Further, the chemical changes after deep stacking of such combination suggested that such processing beyond 4 to 5 days resulted in heavy nutrient losses. The comparative IVDMD and IVOMD of these combinations (Table 3) was higher before stacking than after 9 days stacking in the laboratory.

Table 3: *In vitro* dry matter and organic matter digestibilities of samples of wheat straw stacked with broiler poultry droppings for 9 days in the laboratory.

Parameter		Level of replacement of urea-N by poultry droppings				
		0	25	50	75	100
Dry matter	B	41.8	42.3	41.3	42.8	43.4
	A	38.2	34.6	32.4	30.2	30.5
Org.matter	B	45.1	45.4	43.6	46.5	47.1
	A	40.1	35.9	33.8	32.5	33.8

B - Samples before deep stacking.

A - Samples after 9 days deep stacking at room temperature in perforated polyethylene bags.

Each figure represents the mean of 9 observations.

These studies showed that only 3-4 day stacking (Table 4) was sufficient to treat the PD at 70% moisture as the rise in temperature was above 70°C. The 4 days of deep stacking resulted in less loss in OM and NFE (4-5 units) than carrying the process upto 9 days.

Table 4: Daily change in the *In vitro* DM/OM digestibility in PD-wheat straw mixture stacked for 9 day.

Days	Digestibility (%)	
	DM	OM
0	45.1	47.3
1	42.8	46.4
2	39.5	43.2
3	37.9	41.8
4	37.6	41.1
5	36.6	39.2
6	36.0	38.8
7	34.9	37.4
8	30.1	33.5
9	30.2	33.6

In order to study the effect of deep stacking at low moisture on the temperature rise, chemical changes etc. the wheat straw-PD/litter was stacked at 30,55 and 70% moisture. The processing part has been completed and the analytical work on the samples is in progress. The comparative temperature changes (Table 5) are presented here.

Table 5: Effect of moisture level on the daily temperature changes (°C) during deep stacking in the laboratory.

Day	Poultry litter + wheat straw moisture level (%)			Poultry dropping* + wheat straw
	35	50	70	70
1	43.75	48.00	46.25	61.33
2	36.75	47.25	47.00	61.33
3	36.25	49.75	46.75	50.83
4	37.00	43.25	46.50	47.00
5	37.75	41.25	45.50	42.83
6	38.25	40.00	45.00	42.33
7	37.00	37.00	42.50	40.69
8	35.50	36.00	40.50	39.67
9	35.50	36.50	40.50	39.83

Temperature was recorded morning and evening.
*Reported in detail 1987-88 report.

Compared to the temperature changes observed while deep stacking poultry dropping - straw at 70% moisture (Table 5), the stacking of poultry litter - straw at different moisture levels showed that at the above moisture level the temperature ranged between 45 to 47°C. With 50% moisture the temperature range was comparable to the above upto 6 days after wards the decline in temperature had reached to the temperature range of 35 to 38°C observed throughout 9 days in poultry litter - straw with 30% moisture. As poultry litter has been found to have a pathogenic microbial load during some seasons, it seems necessary that deep stacking be done at 50-70% moisture level.

B. Pure culture technology:

A few promising fungal species capable to raise the nutritive value of poultry dropping (PD) was reported in 1987. Experiments conducted for raising the nutritive value of PD as feed for poultry and swine were also conducted this year.

i. Isolation and characterization of fungal species isolated from caged PD:

Serially diluted aliquote of water suspended PD was inoculated in to synthetic uric acid - Agar medium having glucose at pH 6.0 or 7.5. After 3-4 days incubation (30° or 37°C) the inoculated media developed fungal colonies (Table 6) which were counted and further characterised by morphological and microscopic examination. A few of these isolates were also able to grow on the synthetic medium having cellulose in place of glucose.

Table 6: Standard plate count of fungal flora isolated from 1 g of broiler poultry dropping.

Synthetic Medium	pH	Incubation Temp. °C	
		30	37
Cellulose-Uric acid Agar	6.0	3.5×10^3	2.0×10^2
	7.5	1.0×10^3	3.0×10^2
Glucose-Uric acid Agar	6.0	3.0×10^3	2.0×10^4
	7.5	1.0×10^4	2.0×10^3

The data is an average of 3 isolations carried out on 3 poultry dropping samples.

Further, characterization of these isolates on the cellulose - Uric acic - Agar medium showed that while non toxic fungi (Table 7) Aspergillus niger (FS_1), Mucor sp. (FS_2); and Alternaria sp. (FS_3 and FS_4) could grow at an incubation temperature of 30°C with initial pH of 7.5 the other Alternaria sp. (FS_8), Rhizopus sp.(FS_7) and Pencicellium sp. (FS_{10}) could grow at 37°C temperature with an initial pH of 6.0. The other 3 fungal isolates i.e. Aspergillus flavus (FS_5 and FS_6) and Aspergillus fumigatus (FS_9) were toxic fungi.

Table 7: Fungal species (FS) isolated from poultry dropping with good growth on the cellulose-uric acid Agar medium.

Isolate No.	Identification	Incubation Temp. °C	pH	Nature
FS 1	Aspergillus niger	30	7.5	Non toxic
FS 2	Mucer sp.	"	"	"
FS 3	Alternaria sp.	"	"	"
FS 4	Alternaria sp.	"	"	—
FS 5	Aspergillus flavus-1	"	"	Toxic
FS 6	Aspergillus flavus-2	"	"	Toxic
FS 7	Rhizopus sp.	37	6.0	Non toxic
FS 8	Alternaria sp.	"	"	"
FS 9	Aspergillus fumigatus	"	"	Toxic
FS 10	Penicillmin sp.	30	6.0	Non toxic

Toxic nature was observed from the reported character of the particular fungal organism from literature.

Subsequently the PD (1 g) suspended in 50 ml tap water in a 250 ml conical flask after autoclaving (15 psi for 20 min) was inovulated in duplicate with a loopful of the above isolated non toxic fungal isolates. These flasks were incubated at 30°C±2 on a rotary shaker and the mycelial growth, pellett formation as well as final pH changes were observed upto 72 to 96 h. Although all the test fungi could utilize PD as substrate but maximum mycelial growth and pellett formation after 72 h incubation (Table 8) was observed in Alternaria sp. (FS_3 and FS_4) and Rhizopus sp. (FS_7). In these species continuation of incubation upto 96 h. possibly as a result of ammonia accumulation resulted in high pH (7.75–7.80) with auto termination of the fungal growth.

Table 8: Relative growth, pellet formation and final pH in the culture medium on broiler dropping as substrate.

Isolate No.	Relative growth (72 h)	Pellet formation (72 h)	Final pH (96 h)
FS 1	+	-	7.05
FS 2	++	-	7.70
FS 3	+++	+++	7.80
FS 4	++++	++++	7.75
FS 7	++++	++++	7.80
FS 8	++	-	7.60
FS 10	++	-	7.60

Mean of duplicate culture of each isolate.

Initial pH of the medium for respective isolate is mentioned in Table 2.

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ii. Comparison of promising fungal isolates with knew fungal cultures:

These above 3 isolates were further investigated along with 6 other known cellulolytic fungal species on a PD media buffered with 0.05 M citerate buffer solution at pH 5 under liquid shake condition. In this medium 2 g of dried PD was suspended in 100 ml of 0.05 M citerate buffer in a 500 ml conical flask and autoclaved (15 psi, 20 min). Duplicate flasks were incubated with 2 ml of the respective mycelial suspension (Table 9) prepared in 0.01% Tween 80. The flasks were incubated at 30±2°C on a rotary shaker (120 rpm). In these flasks after 7 days incubation the relative growth along with residual substrate biomass (RSB) was determined. For the RSB determination contents of an individual flask were filtered through what man-1 filter paper. The residue after several washings with hot distill water was oven dried (60°C) to give RSB in which the crude protein (Nx6.25) was estimated and expressed as % DM and as total CP/100 g PD initially used as substrate.

Out of the 9 fungal species (Table 9) only, i) Myrothecium verrucaria, ii) Trichoderma viridae; iii) Trichoderma harzianum; iv) Cheatomium cellulyticum and v) Alternaria sp. c(FS_4) had the relative growth score above 3+ with substrate utilization score of 4+. However, the final medium pH except in T. harzianum remained below 7. Because of the acidic reaction the CP in RSB was above 20% with final protein coefficient range of 14 to 19%.in the above 4 fungal species (i, ii, iv and v). Their, substrate utilization capacity was indicated by the close range of final biomass coefficient (67 to 73%). Further work is in progress.

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Table 9: Relative growth, substrate utilization and protein production during the fungal growth on a media containing poultry droppings (PD)

Fungal species inoculum	Visual observations: Relative growth	Visual observations: Substrate utilization	Final pH in medium	Residual Substrate (R & B) g/2 g	Final* biomass coefficient (%)	Final protein content (% DM)	Final** protein coefficient (%)
1. *Aspergillus niger*	2 +	1 +	6.95	1.764	88.2	13.1	11.6
2. *Myrothecium verrucaria*	3 +	4 +	6.45	1.434	71.7	20.3	14.6
3. *Sclerotium rolfsii*-12	2 +	4 +	5.74	1.430	71.5	17.4	12.4
4. *Trichoderma viridae* QN-9414	4 +	4 +	6.47	1.476	73.6	25.6	18.9
5. *T. harzianum*	3 +	2 +	7.81	1.636	81.8	16.0	13.0
6. *Chaetomium cellulyticum*	4 +	4 +	5.94	1.347	67.4	24.4	16.4
7. Alternaria sp. FS-3	2 +	3 +	6.33	1.437	71.9	16.1	11.6
8. Alternaria sp. FS-4	4 +	4 +	6.52	1.359	68.0	25.0	17.0
9. Rhizopus sp. FS-7	1 +	2 +	5.83	1.535	76.8	12.8	9.9

*g biomass produced/100 g substrate supplied initially.

**g protein produced/100 g protein initially present in PD

Initial pH: 5.0, Incubation temperature 30±2°C for 7 days in rotary shaker (120 rpm).

Figures are mean of duplicate incubation.

iii. Standardisation of fungal biomass production on poultry droppings through solid state formulation:

In the early report (1987) Coprinus sp. or Pleurotus Ostreatus inoculation resulted in the maximum uric acid degradation. However, the rise in pH due to ammonia release resulted in auto-degradation of Coprinus sp. Therefore quantity of sulphuric acid required to maintain pH 6 for optimum Coprinus growth was standardised before finding the in vitro pepsin or pepsin - trypsin digestibility.

a) Determination of sulphuric acid requirement: The initial pH of caged broiler PD varied around pH 7.25. PD (100 g) suspended in 1000 ml of distilled water with 100 ppm mecuric chloride, to inhibit the microbial activity, was used. The 0-2 ml of concentrated sulphuric acid was serially added in graded levels in the above preparation. These containers were then placed for 4 hr. on a rotary shaker (120 rpm) and pH determined after shaking period was over. From the slope of the curve obtained by plotting change in pH with the concentration of H_2SO_4 used in a PD suspension 1.36 ml concentrated H_2SO_4 per 100 g PD was needed to adjust the initial pH at 6. Therefore, in the subsequent experiments for substrate preparations PD was moistened with 2 volumes of 0.68% H_2SO_4 solution (equivalent to 1.36 ml H_2SO_4 100 g^{-1} PD) which provided 66% moisture and pH 6.

b) Chemical changes and in vitro protein digestibility of PD treated Coprinus sp.: PD (50 g) after moistening with 100 ml of 0.68% H_2SO_4 solution in a conical flask and after

autoclaving (15 psi, 20 min) were surface inoculated with 2.5 g of wheat spawn grain of Coprinus sp. These flasks were incubated for 13 days in BOD incubator ($30^{o}\pm1^{o}C$) and triplicate flasks with drawn on 0,3,7 to 13 days for individual determination of crude protein (CP, Nx 6.25), true protein (TP), uric acid (UA) and in vitro pepsin and pepsin-trypsin digestibility of the treated contents. Comparisons were made within the samples collected on different days and also with the PD samples not subjected to autoclaving or fungal treatment (control).

Visual mycelial peneteration was observed on 2 and 5 day of incubation. Upto 5 day sufficient time was allowed for peneteration when marginal fall in the UA without change in the TP or CP contents was observed (Table 9). By 10 day full colonisation of Coprinus sp. was associated with a substantial fall in the UA with a simultaneous rise in both the CP and TP content, but the in vitro protein digestibility did not improve. However, incubation for further 3 days revealed that the sample of 12 day incubation had 82.1% reduction in UA with 4.80% rise in TP and 78.2% in vitro pepsin-trypsin digestibility. After the 13 day incubation period the pepsin and pepsin-trypsin digestibilities had decline in the treated PD.

Further, experiments for standardising procedure for the mass fungal treatment of PD with Coprinus sp. within 12 days are in progress.

Table 10: Periodic chemical changes (% DM) and in vitro protein digestibility of PD during the growth of *Coprinus* sp.

Incubation period (days)	CP	TP	TP as % of CP	Uric acid	Ash	CF	In vitro digestibility % Pepsin only	Pepsin-trypsin
0	23.06	11.65	50.52	5.[illegible]	27.9	13.9	67.03	72.31
5	23.38	11.75	50.26	4.73	26.1	10.4	66.23	71.10
7	24.29	12.05	49.61	4.02	27.2	11.8	66.00	69.35
8	24.35	12.23	50.23	3.51	24.9	10.4	65.95	68.00
9	24.13	12.28	50.89	2.18	27.8	10.9	64.82	67.73
10	24.76	12.91	52.14	1.87	28.6	N.A.	64.72	67.34
11	25.48	13.59	53.33	1.12	27.1	N.A.	65.67	71.19
12	24.75	13.71	55.39	0.91	29.2	N.A.	70.11	78.25
13	24.59	13.81	56.16	0.87	24.9	N.A.	69.52	73.42
Control (unautoclaved)	24.33	11.73	48.21	5.13			66.33	70.83

N.A.: Not available.

11. Indicate the constraints and bottlenecks experience in the implementation of the project:

No difficulty has been experienced so far, except for the identification and typing of other micro-organisms and fungi isolated during litter formation.

12. Any other comments based on your experience for effective implementation of the project:

1. Additions alterations requested for improving laboratory facilities appropriate to the technical programme are needed. Facilities for a covered shed and storage of treated materials for animal experiments are required.

2. Equipments to be provided under the project if made available on time will improve the execution of technical programme.

3. Training programme for the scientists involved under this project need to be expedited at the earliest for maintaining continuity the enthusiasm and smooth working of the project.

(P.N. LANGAR) 14/2	(MEHAR SINGH)	(K.S. NANDPURI)
Animal Nutritionist	Professor-cum-Head	Director of Research
Scientist Incharge	Dept of Animal Sci.	P.A.U. Ludhiana
	P.A.U. Ludhiana	

Expenditure statement for the sub project entitled "Biodegradable Animal Wastes as livestock feed" in respect of Ludhiana Centre for January, 1983 to December 1988.

Sr. No.	Budget Sub Head	Expenditure	Contribution of USAID	I.C.A.R.
1.	Pay and allowances	Rs 275330/-	Nil	Rs 275330/-
2.	T.A.	Rs 11544/-	Nil	Rs 11544/-
3.	Maintenance Contingency (Operational Research)	Rs 71950/-	Nil	Rs 71950/-
4.	Non recurring/contingency			
	1. Equipment	Rs 8500/-	Nil	Rs 8500/-
	2. Building	Nil	Nil	Nil
	3. Vehicle	Nil	Nil	Nil
5.	Seminar/Workshop Conference etc.	Nil	Nil	Nil
	Total	Rs 367324/-		Rs 367324/-

NOTE: 1. The expenditure pertains to the main project of AICRP involved with the implementation of programme.

2. The expenditure involved by the collaborating Scientist is not included above.

ANNEXE B

CONVERSION OF BIODEGRADABLE ANIMAL WASTE FOR LIVESTOCK FEED

INDO-USAID Project No. 386-0470- sub project-7

Annual Technical Report for the year 1988

HISAR CENTRE

1988

Report No. 2

Department of Animal Nutrition
Haryana Agricultural University
Hisar - 125 004 Haryana
INDIA

The perusal of data in table 1 indicated that higher quantities of straw used as bedding increased the dry matter, NDF, ADF, cellulose and lignin and reduced the crude protein content in the resultant beddings. The mixing of feces and urine with the straw for 7 days increased the crude protein content and reduced the dry matter and cell wall constituents as compared to 3 days.

2. Studies on the laboratory ensiling of bedding material

Two separate experiments were conducted under this study.

Expt.1: Ensiling of wheat and paddy straw based beddings

Wheat and paddy straw were used as bedding materials in the pens of lactating crossbred cows. The material was frequently turned to ensure proper mixing of feces and urine. The beddings were removed after two weeks and were ensiled in mixture with green oats and molasses as follows.

T_1 - Wheat straw bedding alone

T_2 - Wheat straw bedding + 5% molasses.

T_3 - Wheat straw bedding +10% molasses

T_4- Wheat straw bedding (60%) + green oat (40%).

T_5- Wheat straw bedding(60%)+ green oat(40%)+5% molasses.

INDO-USAID PROJECT ON

CONVERSION OF BIODEGRADABLE ANIMAL WASTE FOR LIVESTOCK FEED - Project No. 386-0470-SUB-PROJECT-7

"BIODEGRADATION OF LARGE ANIMAL WASTE"

ANNUAL TECHNICAL PROGRESS REPORT (1988)

Technical Programme for the year (1988)

1. Studies on the chemical composition and IVDMD of bedding materials.

2. Studies on the laboratory ensiling of bedding materials.

3. Studies on the conservation of animal wastes by sundrying and through urea-ammonia treatment.

Progress of work

Studies on chemical composition and IVDMD of bedding materials.

Varying quantities of wheat straw i.e. 40(B1), 80(B2) and 120(B3) kg were used as bedding in the pens of lactating cross bred cows. In each pen two lactating crossbred cows were kept and the feces and urine voided by them were allowed to be mixed for period of 3 and 7 days. The beddings were turned each day in order to ensure through mixing of feces and urine with wheat straw. Representative samples from each pen were taken at 3 and 7 days and were subjected to chemical analysis. The results, thus, obtained are presented in table 1.

T_6- Wheat straw bedding (60%)+ green oat(40%)+ 10% molasses.

T_7 - Wheat straw bedding(40%)+ green oat(60%).

T_8 - Wheat straw bedding(40%)+Green oat(60%)+5% molasses.

T_9 - Wheat straw bedding(40%)+green oat(60%)+10% molasses.

T_{10}- Paddy straw bedding alone.

T_{11}- Paddy straw bedding + 5% molasses

T_{12} - Paddy straw bedding + 10% molasses.

T_{13} -Paddy straw bedding (60%)+ green oat(40%).

T_{14} -Paddy straw bedding(60%)+green oat(40%)+5% molasses.

T_{15} -Paddy straw bedding(60%)+ green oat(40%)+10% molasses

T_{16} -Paddy straw bedding(40%)+ green oat(60%).

T_{17} -Paddy straw bedding(40%)+ green oat(60%)+5% molasses.

T_{18} -Paddy straw bedding(40%)+green oat(60%)+10% molasses.

These mixtures were ensiled in duplicate in 1.5kg capacity glass jars. The material was unloaded after 42 days of ensiling and were subjected to chemical and biochemical evaluations.

The data with regard to the chemical composition and IVDMD of original mixtures are presented in Table 2. The addition of molasses and oat fodder in the mixtures reduced the dry matter contents to a very low level. However, cell contents were increased. The crude protein contents were almost similar in all the treatment mixtures. Addition of molasses and oat fodder in various mixtures

decreased the NDF, ADF, cellulose, lignin and silica contents. The IVDMD values were also increase with the addition of molasses and green oat. The IVDMD in case of treatments with paddy straw beddings were somewhat superior to those mixtures prepared with wheat straw beddings.

Per cent dry matter losses and biochemical parameters in the resultant silages have been presented in Table 3. The addition of molasses increased the losses when compared to ensiling of bedding alone. However, addition of oat fodder alongwith molasses was in general helpful in reducing the losses of dry matter. The data with regard to pH indicated that bedding alone cannot be ensiled satisfactorily. However, addition of 40% oat fodder with 5 and 10% molasses was helpful in lowering the pH. The pH value of 4.2 was obtained in mixtures having 40% wheat straw bedding + 60% green oats and 10% molasses (T9). The other biochemical parameters were also in permissible limits, indicating thereby that reasonably good silage can be prepared by this mixture. Similar trend was exhibited by the paddy straw bedding based silages (T_{17} & T_{18}).

The chemical composition of silages is presented in Table 4. The DM, CP and other cell wall constituents showed mixed trend and the values were more or less

comparable with those of the original mixtures. In most of the treatments IVDMD values were reduced to some extent after ensiling in both types of silages made with wheat and paddy straw bedding. The IVDMD values were slightly higher in paddy straw bedding based silages in comparison to wheat straw bedding based silages.

Experiment 2: Ensiling of wheat straw based bedding in mixture with green maize and molasses.

The wheat straw was used as bedding material in the sheds of lactating crossbred cows. Three different levels of wheat straw (40, 80 and 120kg) were used to prepare the three different beddings (B_1, B_2 and (B_3) by keeping similar number of cows in the pens for a period of one week. The material was frequently turned in order to ensure proper mixing of feces and urine with the straw. The beddings were wilted for two dyas and then were ensiled either alone or in mixture with wilted maize fodder and molasses in various combinations. There were 18 treatment combinations having four replications each. In all 72 laboratory silages were prepared in 3kg capacity polythene bags. Details of various treatment combinations were as follows.

Treatment combination	Treatment	Details of material used
T_1	B1FOMO	Bedding 1 without maize and molasses
T_2	B1FoM1	Bedding 1, no maize, with 2% molasses
T_3	B1F1Mo	Bedding 1, 40 parts maize, no molasses
T_4	B1F1M1	Bedding 1, 40 parts maize, 2% molasses
T_5	B1F2Mo	Bedding 1, 50 parts maize, no molasses.
T_6	B1F2M1	Bedding 1, 50 parts maize, 2% molasses
T_7	B2FoMo	Bedding 2, without maize and molasses
T_8	B2FoM1	Bedding 2, no maize, 2% molasses
T_9	B2F1Mo	Bedding 2, 40% maize, no molasses
T_{10}	B2F1M1	Bedding 2, 40% maize, 2% molasses
T_{11}	B2F2Mo	Bedding 2, 50% maize, no molasses
T_{12}	B2F2M1	Bedding 2, 50% maize, 2% molasses
T_{13}	B3FoMo	Bedding 3, no maize & molasses
T_{14}	B3FoM1	Bedding 3, no maize, 2% molasses
T_{15}	B3F1Mo	Bedding 3, 40% maize, no molasses
T_{16}	B3F1M1	Bedding 3, 40% maize, 2% molasses
T_{17}	B3F2Mo	Bedding 3, 50% maize, no molasses
T_{18}	B3F2M1	Bedding 3, 50% maize, 2% molasses

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The silos were unloaded after a period of 42 days and were subjected to chemical and biochemical evaluations. The data regarding chemical composition and IVDMD of original mixture have been presented in Table 5. The DM content was lower in bedding B_1 based silages as compared to B_2 & B_3 beddings. The addition of maize fodder further reduced the DM in the mixtures. The DM content in various combinations ranged from 33.40 to 48.00%. The CP content was higher in bedding B_1 as compared to B_2 & B_3 beddings. The mixtures prepared by using various beddings also showed the same trend with regard to crude protein values. However, in general, the cell wall constituents were higher in bedding B_3 followed by B_2 and lower in B_1 in descending order. Thus reflected that the higher amount of straw was used in beddings B_3 & B_2 as compared to B_1. The IVDMD values of beddings B_1, B_2 & B_3 alone was 23.80, 23.65 and 32.00%, respectively. Addition of green maize and molasses in various mixtures increased the IVDMD values.

Dry matter losses and biochemical parameters of various laboratory silages are presented in Table 6. The dry matter loss ranged from 4.25 to 12.67% in B_1 silages, while in B_2 and B_3 based silages it ranged from 5.12 to 17.98 and 4.42 to 10.72%, respectively.

The dry matter loss was lower in B_3 based silages. High dry matter content of these silages was helpful in reducing the losses. These silages also had lower pH and comparatively higher lactic acid values as compared to B_1 and B_2 based silages. The ammonia-N as per cent of total-N ranged from 13.98 to 22.59%. This value is quite high indicating that the quality of silages was not good.

The chemical composition and IVDMD of different silages is presented in Table 7. There were considerable losses of crude protein due to proteolytic activity in the silages as evidenced by higher ammonia-N as per cent of total-N. The cell wall constituents in general were more or less the same. Some reduction in the IVDMD values of silages was noticed, probably due to over drying of the samples in which some of the volatile substances were lost. Results of this experiment were not encouraging and the effect of some other combinations incorporating various levels of cereal fodder and molasses needs further investigation.

3: Studies on conservation of animal wastes by sun drying and through urea-ammonia treatment.

For this experiment, a wheat straw bedding was prepared by putting 40kg of wheat straw per lactating

cow for a period of 7 days. In all 40 cows were there in the shed and their urine and feces were allowed to be mixed with the wheat straw by turning it frequently. The bedding so prepared halved into two portions. One portion was completely dried under the sun light, the second portion was wilted to a dry matter level of around 50% and was treated with 5.% urea. This treated material was stacked under a polythene sheet for a period of 4 weeks.

A feeding trial was conducted on 12 adult male buffaloes divided into 3 groups of 4 animals each. The control group of animals was offered oats hay (T_1) ad-lib, while in treatment 2 and 3, 66% of oat hay was replaced by treated and dried beddings on W/W basis, respectively. The feeding was continued for a period of 20 days followed by 5 days collection period. The animals were weighed before and after the experiment. The samples of feeds and their residues and feces were collected during the trial were subjected to chemical analysis. (Table 8). The nutritive value and digestibility coefficients of oat hay, treated and dried beddings were evaluated by difference method.

Average body weights and dry matter intakes of the experimental animals are presented in Table 9. The total dry matter intake in T_1, T_2 and T_3 was

7.98, 6.39 and 5.85kg/day, respectively. The dry matter intake/100kg body weight in the same order was 2.35, 1.96 and 1.84kg. The statistical analysis of the data revealed that incorporation of treated and dried beddings alongwith oats hay depressed the dry matter intake significantly as compared to control group.

The average digestibility coefficients of various nutrients were significantly higher in control groups as compared to T_2 and T_3 (Table 10) feeding of treated and dried bedding significantly reduced the digestibility coefficients of various nutrients except the ether extract.

The digestibility coefficients of nutrients in treated and dried beddings were calculated by difference method and presented in Table 11. The treatment of bedding with 5% urea increased the digestibilities of DM, CP, EE, NFE and organic matter but the values were not significantly different when compared to dried bedding. The use of 5% urea did not bring out desirable results. The ammonia produced during the process did not react effectively with the bedding and most of it escaped when the stack was opened. This was evidenced by pungent smell of ammonia around the stack when it was opened.

On the basis of the chemical composition and digestibility coefficients the nutritive value of oats hay, treated and dried beddings were calculated and have been presented in table 12. The DCP contents of oat hay, treated and dried beddings were 3.67, 3.38 and 1.55%, respectively, while the TDN values were 63.35, 28.19 and 24.08, respectively. The treatment of bedding increased the DCP content significantly as compared to dried bedding but the TDN values were not significantly different. Treatment of bedding with 5% urea did not produced desirable results during this experiment. It will be worthwhile to repeat this experiment by treating larger quantities of material and conducting a feeding trial for longer period to confirm the findings.

Technical Programme for the year 1989

1. Laboratory ensiling of cattle waste with wheat straw, green fodder and molasses

Three different mixtures of cattle waste and wheat straw, i.e. 75:25 (A), 70:30 (B) and 65:35(C) W/W will be prepared. These mixtures will be ensiled with three levels of fodder, i.e. 0, 10 and 20 parts and without and with 5% molasses. Thus, there will be 18 treatment combinations with 3 replications each

and in all 72 silages will be made in 3kg capacity double walled polythene silos. The silos will be unloaded after 42 days of ensiling and will be subjected to detailed chemical and biochemical evaluation.

2. Urea-Ammonia treatment of the mixture of fresh cattle waste and wheat straw

Cattle waste and wheat straw will be mixed in 1:1 ratio on dry matter basis. The mixture will be mixed thoroughly with 5 per cent urea and stored in a compact stack covered with polythene sheet to avoid any loss of ammonia. The stack will be opened after the expiry of 4 weeks. A long term feeding trial will be conducted in male animals by replacing 25 and 50% of oats hay with urea-ammonia treated material. Towards the end, a digestibility trial will be conducted to know the nutritive value of various feeds.

Table 1. Chemical composition of beddings

Particulars of bedding	Day of removal	Dry matter	Per cent chemical composition on DM basis								IVDMD
			CP	OC	NDF	ADF	Cellu.	H.cellu.	Lignin	Silica	
B_1	3	26.09	10.15	27.58	72.42	50.05	27.70	22.37	10.40	11.95	
	7	22.00	12.33	31.87	68.13	50.40	27.95	17.73	10.55	11.90	
B_2	3	35.15	7.95	30.00	70.00	51.20	30.15	18.80	9.85	11.20	
	7	28.00	10.15	38.62	61.38	42.80	23.70	18.58	9.25	12.20	
B_3	3	36.00	5.73	26.45	73.55	52.05	33.10	21.50	9.25	9.60	
	7	27.90	9.43	30.50	69.50	49.65	29.50	19.85	9.50	10.55	
Wheat straw	-	91.35	2.52	18.50	81.50	50.80	38.00	30.70	6.30	6.50	

Table 2. Chemical compsotion of original mixtures and IVDMD(%) on DM basis

Treat-ments	DM	CP	CC	NDF	ADF	Cellu-lose	Hemi-cellulose	Lignin	Silica	IVDMD
T_1	34.75	9.41	40.85	59.15	47.51	25.69	11.64	10.09	11.74	30.80
T_2	34.00	10.19	39.25	60.75	47.57	26.39	22.51	9.34	11.83	31.10
T_3	33.75	10.59	42.85	57.15	44.81	23.69	12.34	9.51	11.61	34.60
T_4	27.25	9.72	40.62	59.38	47.77	27.26	11.62	9.29	11.22	32.40
T_5	26.25	10.32	34.55	65.45	45.59	26.60	19.86	8.53	10.47	34.20
T_6	26.80	9.59	38.63	61.37	48.24	28.35	13.14	8.92	10.98	32.90
T_7	21.50	10.06	41.90	58.10	43.83	27.09	14.27	8.05	8.69	35.10
T_8	22.50	10.50	36.15	63.85	42.48	23.80	[illegible].36	9.00	9.68	31.40
T_9	21.50	10.37	36.02	63.98	41.68	24.80	22.30	7.30	9.58	33.50
T_{10}	34.50	9.36	32.02	67.98	46.56	25.62	21.42	8.86	12.08	35.90
T_{11}	31.75	9.76	36.93	63.07	47.39	26.14	15.69	9.82	11.44	35.90
T_{12}	32.90	9.54	37.80	62.20	46.65	25.16	15.55	9.27	12.22	34.90

Contd....

Table 2 contd...

Treat-ments	DM	CP	CC	NDF	ADF	Cellulose	Hemi-cellulose	Lignin	Silica	IVDMD
T_{13}	27.50	9.44	41.48	58.52	42.34	24.87	16.18	8.20	9.27	36.30
T_{14}	26.25	9.94	40.20	59.80	42.27	25.64	17.53	7.50	9.13	36.20
T_{15}	25.80	10.15	37.65	62.35	39.85	23.15	22.50	8.50	8.20	36.20
T_{16}	23.00	10.50	35.75	64.25	47.72	27.31	16.54	8.74	11.67	37.60
T_{17}	22.75	10.16	35.22	64.78	44.79	26.41	19.99	7.47	10.90	33.90
T_{18}	22.50	10.28	36.10	63.90	41.88	23.95	22.02	7.90	10.03	37.70

Each value is an average of two observations.

Table 3. Percent DM losses and biochemical parameters in various silages

Treat-ment	DM loss (%)	pH	Ammonia-N as% of total-N	Average content (%) of various acids (on DM basis)					
				Lactic acid	Acetic acid	Propionic acid	Butyric acid	Isovaleric acid	n-valeric acid
T_1	5.30	6.10	9.78	0.78	-	-	0.01	-	-
T_2	8.77	5.80	11.16	0.95	0.37	-	0.01	-	0.04
T_3	13.14	5.60	9.65	0.76	0.60	-	-	-	-
T_4	14.60	6.00	18.09	0.90	0.14	0.07	0.09	-	-
T_5	14.88	5.41	21.27	0.70	1.72	1.46	1.82	0.14	0.60
T_6	13.54	4.72	17.24	0.75	2.15	1.53	0.59	0.63	0.15
T_7	18.40	5.39	36.24	0.69	1.90	1.26	2.27	0.95	0.21
T_8	13.01	5.27	13.29	0.66	3.22	1.04	2.01	0.08	0.05
T_9	14.33	4.20	12.01	0.70	2.43	-	0.93	0.01	0.07
T_{10}	12.63	6.36	5.44	0.93	1.04	0.02	0.05	-	-
T_{11}	8.42	5.74	10.53	0.96	0.99	-	0.08	0.01	-
T_{12}	12.54	5.54	9.52	0.92	0.97	-	-	-	-
T_{13}	12.03	5.88	16.78	0.72	0.90	0.12	0.07	0.08	-
T_{14}	14.43	5.44	14.04	0.74	0.91	0.22	0.01	0.03	-
T_{15}	12.68	5.04	7.62	0.74	2.18	0.69	1.54	0.07	0.07
T_{16}	17.94	5.37	14.57	0.66	1.74	0.32	-	-	-
T_{17}	18.98	5.32	10.25	0.67	0.91	0.58	-	0.05	-
T_{18}	18.80	4.56	15.89	0.72	3.81	1.71	0.62	0.37	0.27

Table 4. Chemical composition of silages (%) on DM basis

Treat-ments	DM	CP	OC	NDF	ADF	Cellu-lose	Hemi-cellu-lose	Lignin	Silica	IVDMD
T_1	33.50	11.43	38.75	61.25	49.65	24.70	11.60	11.37	13.58	31.60
T_2	34.00	11.71	40.50	59.50	42.78	20.98	16.73	9.20	12.60	30.30
T_3	32.75	10.89	39.95	60.05	44.09	22.59	15.96	9.12	12.38	30.20
T_4	24.90	12.65	33.05	66.95	45.82	25.22	21.13	10.00	10.60	28.30
T_5	25.40	12.36	41.30	58.70	41.76	22.10	16.91	11.37	10.85	29.00
T_6	25.75	13.37	41.20	58.80	45.52	26.13	13.28	9.78	9.63	30.20
T_7	19.80	10.61	42.50	57.50	42.66	27.26	14.84	8.45	6.95	35.30
T_8	21.80	15.30	42.45	57.55	39.18	21.93	18.37	7.55	9.70	29.30
T_9	19.35	14.25	47.00	53.00	32.26	21.81	20.75	50.06	6.39	28.80
T_{10}	32.10	11.82	41.85	58.15	44.39	21.84	13.76	9.85	12.70	32.00
T_{11}	31.20	12.95	43.00	57.00	43.76	24.36	13.24	9.37	11.27	30.70
T_{12}	32.75	11.65	43.30	56.70	45.80	26.02	10.91	9.08	10.70	34.10
T_{13}	25.00	14.73	41.90	58.10	48.23	26.46	9.88	9.72	12.05	28.30
T_{14}	26.10	13.80	46.60	53.40	43.61	26.64	9.79	7.61	9.37	32.80
T_{15}	25.75	13.38	39.15	60.85	39.43	22.50	21.43	6.40	10.50	42.10
T_{16}	21.70	14.63	38.90	61.10	45.64	27.74	15.46	7.50	10.40	39.40
T_{17}	22.20	14.59	44.15	55.85	41.75	21.88	14.10	10.78	9.10	38.80
T_{18}	22.30	12.58	45.38	54.62	38.94	23.83	15.68	6.82	8.29	33.90

Each value is an average of two replications.

Table 5. Chemical composition and IVDMD of original mixtures (on DM basis)

Treat-ment	Chemical Composition (%)									IVDMD
	DM	CP	NDF	CC	ADF	Cellulose	Hemi-cellulose	Lignin	Silica	
T_1	40.40 ±0.47	11.63 ±0.38	69.10 ±0.15	30.90 ±0.15	51.25 ±0.28	23.31 ±0.43	17.85 ±0.41	11.84 ±0.19	16.10 ±0.61	23.80 ±0.64
T_2	43.90 ±0.65	10.61 ±0.12	68.65 ±0.79	31.35 ±0.79	51.00 ±0.33	23.65 ±0.36	17.65 ±0.49	11.65 ±0.08	15.70 ±0.33	23.20 ±0.95
T_3	37.20 ±1.10	10.53 ±0.37	69.16 ±0.29	30.84 ±0.29	50.13 ±0.67	25.88 ±0.19	19.03 ±0.71	10.48 ±0.19	13.78 ±0.61	24.35 ±0.66
T_4	35.70 ±0.17	10.94 ±0.35	70.51 ±0.34	29.49 ±0.34	49.80 ±0.31	25.98 ±0.26	20.71 ±0.46	10.10 ±0.14	13.73 ±0.32	25.20 ±0.73
T_5	34.10 ±0.36	11.80 ±0.48	70.91 ±0.64	29.09 ±0.65	50.51 ±0.26	26.94 ±0.45	20.40 ±0.87	9.95 ±0.23	13.63 ±0.48	23.90 ±1.42
T_6	33.40 ±0.59	10.56 ±0.46	68.39 ±0.54	31.61 ±0.54	50.20 ±0.39	27.30 ±0.43	18.19 ±0.53	9.93 ±0.21	12.98 ±0.34	25.80 ±0.76
T_7	48.00 ±0.37	11.33 ±0.34	69.14 ±0.56	30.86 ±0.56	51.58 ±0.18	25.80 ±0.23	17.56 ±0.71	11.33 ±0.02	14.45 ±0.19	23.65 ±0.86
T_8	47.10 ±0.22	10.91 ±0.45	68.13 ±0.68	31.88 ±0.68	49.90 ±0.13	25.03 ±0.42	18.22 ±0.60	10.98 ±0.06	13.90 ±0.41	25.75 ±0.98

Contdd...

Table 5 contd..

Treat-ment	Chemical Composition (%)									IVDMD
	DM	CP	NDF	CC	ADF	Cellulose	Hemi-Cellulose	Lignin	Silica	
T_9	39.00 ±0.36	11.56 ±0.52	69.83 ±0.69	30.18 ±0.71	50.36 ±0.36	26.28 ±0.24	19.46 ±1.00	10.18 ±0.18	13.91 ±0.15	26.95 ±0.40
T_{10}	40.00 ±0.32	11.34 ±0.36	70.60 ±0.69	29.40 ±0.69	49.90 ±0.20	25.93 ±0.30	20.70 ±0.85	10.23 ±0.14	13.75 ±0.30	27.95 ±0.80
T_{11}	38.80 ±0.40	9.93 ±0.59	71.45 ±0.39	28.55 ±0.39	52.25 ±0.35	25.53 ±0.75	19.20 ±0.25	9.55 ±0.34	17.18 ±1.37	33.25 ±2.88
T_{12}	38.80 ±0.45	9.71 ±0.30	71.19 ±0.26	28.82 ±0.26	50.64 ±0.26	27.73 ±0.43	20.55 ±0.46	9.53 ±0.09	13.39 ±0.30	36.55 ±0.96
T_{13}	45.70 ±0.17	8.62 ±0.30	69.63 ±0.56	30.38 ±0.56	52.88 ±0.37	27.93 ±0.56	16.75 ±0.30	11.13 ±0.11	13.83 ±0.46	32.20 ±0.79
T_{14}	46.90 ±0.55	8.77 ±0.23	68.66 ±0.52	31.34 ±0.62	52.48 ±0.17	28.95 ±0.63	16.19 ±0.64	10.98 ±0.09	12.55 ±0.48	34.65 ±0.31
T_{15}	40.20 ±0.70	7.65 ±0.36	70.26 ±0.21	29.74 ±0.21	51.68 ±0.26	29.98 ±0.21	18.59 ±0.23	9.70 ±0.08	12.00 ±0.24	35.20 ±0.42
T_{16}	39.40 ±0.30	8.81 ±0.32	70.98 ±0.41	29.03 ±0.41	50.78 ±0.41	28.30 ±0.54	20.20 ±0.73	9.65 ±0.03	12.83 ±0.50	37.50 ±0.87
T_{17}	38.20 ±0.68	8.83 ±0.36	71.59 ±0.29	28.41 ±0.50	51.30 ±0.34	28.68 ±0.53	20.29 ±0.38	9.28 ±0.11	13.35 ±0.71	36.55 ±1.08
T_{18}	37.60 ±0.24	9.72 ±0.29	68.94 ±0.64	31.06 ±0.64	50.11 ±0.20	28.83 ±1.09	18.83 ±0.79	8.98 ±0.06	12.31 ±1.11	40.20 ±1.28

* Each value is average of four observations.

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Table 6. Dry Matter losses and Biochemical Parameters of Different Laboratory Silages*

Treatments	DM loss %	pH	Lactic acid % DM basis	Ammonia-N as % of total-N
T_1	4.25 ±0.15	6.69 ±0.05	0.91 ±0.09	22.20 ±1.08
T_2	6.11 ±0.27	6.70 ±0.01	0.81 ±0.12	17.58 ±1.83
T_3	12.67 ±0.60	6.60 ±0.02	0.74 ±0.06	17.40 ±0.86
T_4	7.05 ±0.16	5.71 ±0.27	0.78 ±0.02	20.95 ±1.80
T_5	9.97 ±1.00	5.98 ±0.13	0.88 ±0.12	20.97 ±1.85
T_6	7.04 ±0.39	5.35 ±0.12	1.07 ±0.08	20.63 ±1.25
T_7	5.12 ±0.51	6.78 ±0.02	1.15 ±0.0[illegible]	17.96 ±2.52
T_8	5.77 ±0.22	6.77 ±0.01	1.25 ±0.16	13.98 ±0.85
T_9	14.00 ±0.63	6.59 ±0.01	0.87 ±0.06	14.38 ±1.35
T_{10}	9.89 ±0.54	6.23 ±0.06	0.95 ±0.0[illegible]	21.76 ±2.38
T_{11}	17.08 ±0.35	6.[illegible] ±0.03	0.95 ±0.19	16.73 ±0.[illegible]
T_{12}	9.78 ±1.[illegible]	5.34 ±0.02	1.15 ±0.19	15.58 ±1.42
T_{13}	4.42 ±0.40	6.62 ±0.03	1.05 ±0.05	1[illegible].66 ±1.35
T_{14}	5.21 ±0.36	6.53 ±0.02	1.7[illegible] ±0.22	1[illegible].91 ±1.40
T_{15}	10.72 ±0.20	6.43 ±0.02	1.31 ±0.16	18.20 ±0.84
T_{16}	5.60 ±0.21	5.40 ±0.03	1.03 ±0.18	19.25 ±1.07
T_{17}	6.36 ±0.56	5.53 ±0.07	1.45 ±0.08	19.02 ±1.20
T_{18}	6.81 ±0.34	5.22 ±0.01	1.38 ±0.0[illegible]	22.59 ±0.62

* Each value is an average of four observations.

Table 7. Chemical composition and IVDMD of different silages* (DM basis)

Treat-ment	Chemical Composition (%)									IVDMD
	DM	CP	NDF	CC	ADF	Cellulose	Hemi-cellulose	Lignin	Silica	
T_1	40.88 ±0.32	6.50 ±0.41	68.53 ±0.87	31.47 ±0.87	53.00 ±0.33	24.68 ±1.27	15.53 ±1.19	12.38 ±0.19	15.95 ±1.52	27.20 ±2.25
T_2	42.63 ±0.27	9.28 ±0.87	68.95 ±0.89	31.05 ±0.89	53.18 ±0.27	24.43 ±0.83	15.78 ±1.07	12.23 ±0.10	16.53 ±0.89	21.00 ±0.35
T_3	35.50 ±0.18	10.08 ±0.19	68.87 ±0.65	31.13 ±0.65	52.96 ±0.54	25.18 ±0.51	15.91 ±0.81	11.68 ±0.10	16.11 ±0.98	24.10 ±1.00
T_4	36.00 ±0.10	9.80 ±0.42	68.36 ±0.52	31.65 ±0.52	52.18 ±1.00	24.80 ±0.75	16.18 ±0.73	11.38 ±0.29	16.00 ±0.70	26.15 ±2.22
T_5	33.25 ±0.38	9.82 ±0.42	69.64 ±0.55	30.36 ±0.55	53.85 ±0.38	25.89 ±0.87	15.79 ±0.42	11.74 ±0.12	16.23 ±0.70	24.80 ±1.52
T_6	33.63 ±0.20	10.52 ±0.52	69.95 ±0.92	30.06 ±0.92	54.14 ±0.49	28.41 ±1.23	15.81 ±0.99	11.40 ±0.09	14.33 ±1.10	28.60 ±1.10
T_7	47.75 ±0.41	9.16 ±0.79	72.84 ±0.13	27.16 ±0.13	52.69 ±0.44	25.03 ±0.62	20.15 ±0.36	11.96 ±0.48	15.70 ±0.50	24.40 ±1.50
T_8	46.13 ±0.11	10.32 ±0.06	73.28 ±0.66	26.73 ±0.65	51.55 ±0.41	25.40 ±0.33	21.73 ±0.60	11.98 ±0.17	14.18 ±0.52	24.00 ±0.42
T_9	38.25 ±0.13	10.66 ±0.34	73.60 ±0.97	26.40 ±0.97	51.78 ±0.52	20.45 ±1.11	21.83 ±1.40	11.83 ±1.18	13.50 ±0.62	23.70 ±0.38

Table 7 contd..

Table 7 contd...

Treat-ment	Chemical composition (%)									IVDMD
	DM	CP	NDF	CC	ADF	Cellulose	Hemi-cellulose	Lignin	Silica	
T_{10}	39.50 ±0.31	8.99 ±0.41	70.14 ±0.20	29.86 ±0.26	52.94 ±0.49	24.99 ±0.72	17.20 ±0.30	11.69 ±0.18	16.26 ±0.74	24.68 ±0.51
T_{11}	36.63 ±0.27	10.87 ±0.12	69.64 ±0.45	30.36 ±0.35	52.70 ±0.37	24.58 ±0.60	16.94 ±0.45	11.89 ±0.20	16.24 ±0.84	27.60 ±0.83
T_{12}	38.63 ±0.21	9.78 ±0.02	70.73 ±0.53	29.28 ±0.53	53.00 ±0.29	25.39 ±0.98	17.73 ±0.24	11.69 ±0.10	15.93 ±0.81	26.35 ±0.35
T_{13}	48.38 ±0.37	9.15 ±0.18	72.71 ±0.72	27.29 ±0.72	55.33 ±0.47	26.53 ±1.73	18.39 ±0.44	12.63 ±0.43	15.18 ±1.45	28.40 ±0.61
T_{14}	45.13 ±0.21	9.53 ±0.46	72.29 ±0.71	27.71 ±0.71	54.21 ±0.19	25.64 ±1.03	18.08 ±0.53	12.28 ±0.34	16.30 ±1.05	26.90 ±0.38
T_{15}	37.38 ±0.21	9.20 ±0.15	72.03 ±0.84	27.98 ±0.84	54.08 ±0.33	27.01 ±1.19	17.95 ±1.03	12.04 ±0.10	15.03 ±1.13	30.55 ±1.20
T_{16}	38.63 ±0.37	8.83 ±0.03	71.14 ±0.50	28.86 ±0.50	51.83 ±0.42	26.23 ±0.75	19.31 ±0.49	10.60 ±0.24	15.00 ±1.12	28.65 ±0.36
T_{17}	36.50 ±0.17	8.82 ±0.02	72.40 ±0.71	27.60 ±0.50	52.75 ±0.51	27.68 ±0.17	19.65 ±1.12	10.91 ±0.30	14.76 ±0.07	27.00 ±1.06
T_{18}	35.50 ±0.37	8.09 ±0.16	69.78 ±0.60	30.23 ±0.60	52.41 ±0.67	25.85 ±1.02	17.36 ±0.34	10.83 ±0.20	15.74 ±1.18	29.80 ±1.47

* Each value is an average of four observations

Table 8. % Chemical composition of oats hay, treated and dried beddings on DM basis

Item	Oats hay	Treated bedding	Dried bedding
DM	90.00	65.50	87.50
CP	6.48	11.63	8.55
CF	31.06	26.91	30.73
EE	0.70	0.38	0.63
NFE	50.75	37.56	37.44
Ash	10.95	23.57	22.65
Organic Matter	89.05	76.48	77.35

Table 9. Average body weights and dry matter intake of experimental animals*.

Item	T_1	T_2	T_3
No. of animals	4	4	4
Av.Body Weight (kg)	343.00 ±21.40	332.75 ±27.99	331.50 ±37.97
Dry matter intake (kg)			
Oat hay	7.98	2.88	2.40
Bedding	-	3.51	3.45
Total	7.98[a] ±0.08	6.39[ab] ±0.08	5.85[bc] ±0.15
DMI/100 kg B.W.	2.35[a] ±0.17	1.96[b] ±0.16	1.84[b] ±0.22

Each value is an average of four

Table 10. Average digestibility coefficients of various nutrients in experimental diets.

Item	T_1	T_2	T_3
Dry matter	67.59[a] ±1.64	49.41[b] ±3.29	45.58[b] ±2.63
Crude protein	56.58[a] ±1.95	39.9[b] ±3.41	32.08[b] ±[illegible]
Crude fibre	71.43[a] ±2.49	55.73[b] ±2.85	55.44[b] ±1.76
Ether extract	60.45 ±2.81	74.1[illegible] ±2.4[illegible]	62.37 ±1.45
NFE	71.85[a] ±1.41	54.62[b] ±3.77	47.44[b] ±3.15
Organic Matter	70.44[a] ±1.77	53.39[b] ±3.04	48.33[b] ±1.76

Table 11. Average digestibility coefficients of test material*

Item	Oat hay	Treated bedding	Dried bedding
Dry matter	67.59[a] ±1.64	34.63[b] ±5.78	30.01[b] ±4.30
Crude protein	56.58[a] ±1.94	29.02[b] ±4.82	18.10[b] ±5.66
Crude fibre	71.43[a] ±2.49	40.52[b] ±5.16	41.74[b] ±3.50
Ether extract	60.51[a] ±2.86	81.01[b] ±[illegible].46	61.41[a] ±6.95
NFE	71.85[a] ±1.41	35.18[b] ±7.65	23.87[b] ±6.[illegible]
Organic Matter	70.[illegible][a] ±1.77	36.49[b] ±5.58	30.63[b] ±3.92

* Each value is an average of four.

Table 12. Nutrition value of individual feed constituents *

Feeds	% on DM basis	
	DCP	TDN
Oat hay	3.67[a] ±0.13	63.35[a] ±1.61
Treated bedding	3.38[a] ±0.56	28.19[b] ±4.31
Dried bedding	1.55[b] ±0.48	24.08[b] ±3.11

* Each value is an average of four.

ANNEXE D

BOMBAY VETERINARY COLLEGE

Proximate Analysis of Silage (on % DM basis)

Proportion	DM	Cr.Protien	Cr.Fibre	EE	Total ash	NFE	AIA	pH
40,1:0,5	34.00	5.21	29.00	2.10	17.50	31.30	14.9	5.6
40,1:0,10	32.20	5.30	25.70	2.40	17.30	35.50	13.8	5.4
50,1:0,5	32.20	5.40	28.20	2.15	18.20	30.95	15.1	5.5
50,1:0,10	36.50	5.48	25.00	2.40	18.50	34.22	14.4	5.8
60,1:0,5	34.00	5.45	28.50	2.16	18.90	29.60	15.40	5.4
60,1:0,10	35.80	5.50	28.00	2.30	19.00	30.11	15.09	5.4

Physical Appearance - Golden yellow colour. + moist.

Odour - pleasant aroma.

ANNEXE B

BOMBAY VETERINARY COLLEGE

Proximate Analysis of Rumen Digesta (% D.M. basis)

Pit	As such	Residue	Filtrate
Dry Matter	II.78	22.88	2.94
Crude Protein	7.I6	I0.28	I5.30
Crude Fibre	30.94	30.52	I.85
Ether Extract	I.45	I.56	0.79
Total ash	I5.23	I3.73	–
A.I.A.	I0.09	I0.07	–
N.F.E.	45.22	43.5I	–
Ca.	0.4I	0.45	–
P.	0.95	0.92	–
Rumen			
Dry Matter	I2.09	27.57	3.3
Crude Protien	7.26	9.I4	I7.44
Crude Fibre	25.58	30.20	I.31
Ether Extract	I.40	I.40	0.5I
Total ash	20.I3	I9.7I	–
A.I.A.	I5.08	I7.23	–
N.F.E.	45.63	39.55	–
Ca.	0.33	0.30	–
P.	0.84	0.80	–

Rumen Digesta Digestibility (Nylon Bag Technique).

Digestibility Coefficient= I7.40 %.

% of Residue – 41.0 %

% of Filtrate – 49.4 %

– % of Residue – 45.0 %

" – Filtrate – 42.0 %