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REPORT

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CONSULTANCY REPORT

CONVERSION OF BIODEGRADABLE ANIMAL WASTES FOR LIVESTOCK FEED

February 7 - 27, 1988

Agricultural Research Project (386-0470)

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WINROCK INTERNATIONAL
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CONSULTANCY REPORT
ON
WORK COMPLETED DURING PERIOD OF FEBRUARY 7 TO 26, 1988
CONCERNING PROJECT SPONSORED BY THE
INDIAN COUNCIL OF AGRICULTURAL RESEARCH

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

Submitted by:

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I. INTRODUCTION

The consultant arrived in Delhi February 7, 1988 in connection with subproject 5 (Conversion of Biodegradable Animal Wastes for Livestock Feed). The purposes of the assignment were to visit some collaborating institutions, assist in and participate in Annual Workshop concerning the subproject, assist in preparing training programs and refining equipment specifications. The workshop was held at Krishi Bhavan on February 22 and 23, 1988. During the workshop the research progress and plans at each participating institution were discussed.

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

- Bombay Veterinary College, Bombay
- Haryana Agricultural University, Hissar
- Kerala Agricultural University, Trichur
- Punjab Agricultural University, Ludhiana.

The consultant was honored with the opportunity to present seminars at the Workshop and while visiting some of the participating institutions.

The report is divided into the following sections:

I. Introduction

II. Summary

III. Visits to participating institutions

IV. The Workshop

V. Recommendations

The research covered by this subproject is of vital importance to India. Utilization of these biodegradable wastes would increase significantly the feed supply, which would result in a substantial increase in the production of animal products. Appropriate use of these wastes would lower the feed cost, thereby, increasing the profit for livestock producers.

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

II. SUMMARY OF THE CONSULTANCY REPORT

At the Workshop the scientists at each participating institution reported on progress of the research. The Technical Programs for the next year were presented by these scientists and after discussions, these final Technical Programs were approved by the Workshop participants. Items of equipment to be purchased were prioritized by scientists at each location.

General and specific recommendations are made, especially concerning the Technical Programs, equipment purchase and training of scientists.

A. General Recommendations

1. Research should be directed towards meeting the objectives of the subproject.

2. Scientists are urged to continue keeping abreast of world literature, especially as related to the subproject, and avoid unnecessary duplicative research.

3. In all experiments appropriate statistical designs should be used, and the treatments should be replicated sufficiently for statistical treatment.

4. Use should be made of computer equipment for storage, retrieval, summarization and statistical treatment of data, whenever possible.

5. Annual workshops should be held, and these should be planned in detail in advance.

6. The research should be monitored at intervals by ICAR and USAID/Winrock International.

7. Scientists from the U.S.A. or other countries should be invited to India to interact with Indian scientists working in their discipline, in consultation with the Lead Consultant.

B. Specific Recommendations

1. Scientists at all participating institutions should make efforts to accomplish the research outlined for the Technical Program for the next year.

2. Scientists devoting major efforts to the subproject should be sent for training in foreign laboratories.

3. Purchase of equipment for use in the subproject should be handled expeditiously.

III. VISITS TO PARTICIPATING INSTITUTIONS

Four of the participating institutions were visited to review the status of the research under the subproject, observe the available facilities and have discussions with scientists directly involved with the subproject.

A. Bombay Veterinary College, Bombay

The senior faculty members in animal nutrition and microbiology have the expertise to do the research on slaughter house wastes. A number of younger scientists are anxious to get

involved in the project. Unfortunately, participation in the subproject had not been approved by the state, so only limited work has been initiated.

B. Haryana Agricultural University, Hissar

The university has identified competent scientists to devote full time or part time to the research on large animal wastes. A new laboratory is being equipped for use on this project. Some research has been initiated on cattle and buffalo waste. It appears that there is strong support for the research at all levels in the University. The consultant presented a seminar on "Processing and Feeding of Large Animal and Poultry Wastes".

C. Kerala Agricultural University, Trichur

A strong team of scientists in Animal Nutrition and Microbiology has been identified to work on the subproject. Good animal and laboratory facilities are available. Radiotracer and analytical laboratories outside the departments directly involved with the research are available for work on the subproject. Limited research has been initiated. A seminar was presented by the consultant on "Utilization of Seafood Wastes as Feedstuffs".

D. Punjab Agricultural University, Ludhiana

The faculty members working on the subproject are very competent and enthusiastic concerning the research. They have initiated pertinent research on poultry wastes and have made substantial progress. Scientists from Veterinary Science as well as Animal Science are working on the research. The animal facilities are very good and usable for research. The laboratory facilities are also quite good. There is strong support and enthusiasm for the research at all levels of the University. The consultant presented a seminar on "Utilization of Poultry Wastes for Feeding Animals".

The scientists arranged for visits with four dairy farmers and an artificial insemination technician in the Ludhiana area. The farmers are receptive to introducing new technology.

IV. THE WORKSHOP

On February 22 and 23, 1988 a workshop was convened to discuss various aspects of the subproject. Scientists from the five participating institutions, administrators from ICAR, and persons from USAID and Winrock International participated in the Workshop.

The agenda consisted of presentations on progress of the research, development of Technical Programs and prioritizing the lists of equipment to be purchased for the different participating institutions, remarks by ICAR administrators, and a seminar by the consultant on "Research Results on Processing and Feeding Animal Waste Products in the United States".

Reports of the research progress are given in Annexe A, Section A. The Technical Programs were presented by the scientists at each participating institution. After thorough discussion final Technical Programs were approved by the Workshop participants (Annexe A, Section B). The equipment items were prioritized for each institution by scientists from that institution (Annexe B, Section A). Specifications for the various equipment items are in Annexe B, Section B.

The consultant assisted ICAR in developing guidelines for use of poultry litter to feed cattle and buffaloes, especially to relieve the hardships of a shortage of feed resulting from the drought.

VI. RECOMMENDATIONS

A. General

1. Research at each location should be directed toward the objectives of the subproject. The research should be

programmed so that by the end of the project, technology developed will be suitable for use by livestock producers. Perhaps, before the end of the project applied research or demonstrations could be done on private farms.

2. Scientists should continue to stay abreast of the world literature, especially as related to the subproject. Repetitive research should be avoided. However, most of the waste materials covered by the subproject are different from those used in previously published research. Thus, in many instances adaptive research will be necessary, using techniques similar to those used in other countries (mainly in USA).

3. All experiments should be planned thoroughly, ensuring that sound experimental designs are employed, so valid statistical treatment of the data will be possible. Sufficient numbers (animals, samples, silages, etc.) should be used so meaningful results will be obtained.

4. If feasible, provisions should be made for the scientists to make maximum use of computer equipment in research. This equipment is useful for computation, storage, retrieval and statistical treatment of data.

5. Workshops should continue to be held annually. In order for them to be most useful they should be planned in detail in advance, and a firm agenda developed. This may be done by the subproject Coordination Committee. The committee may wish to seek input from the consultant.

6. The research at all locations should be monitored periodically by ICAR and USAID/Winrock. Reports should be reviewed at least at 3-month intervals, after which each location should be visited.

7. The subproject could be strengthened by interaction with scientists from the United States or other countries. Scientists working in the same disciplines as Indian scientists involved with the subproject should be identified. Perhaps some of the scientists involved with the Training Program should be invited to India to interact with their Indian colleagues. Probably, it would be advisable to start this activity after training has been completed.

B. Specific Recommendations

1. Technical Programs

The Technical Programs (Annexe A, Section B) were developed by the participants at the Workshop following presentations

by the scientists involved with the research at the different institutions. It is strongly recommended that the programs be followed, and the research outlined be completed by February, 1989. The consultant will be happy to advise and assist the scientists concerning the research as they proceed with the experiments.

It is recommended that research not be postponed until the scientists have participated in the Training Program or until the requested equipment items have been received. The scientists are encouraged to develop a calendar work plan, indicating the times of the year the different experiments will be conducted. This plan should be sent to ICAR as soon as possible. An earnest effort should be made to remain on schedule.

Development of the toxicology laboratory at NDRI has not occurred. Staffing for the laboratory should proceed without delay if the laboratory is to be useful to the subproject.

2. Equipment Purchase

The list of equipment with priority for each institution was developed by scientists working on the subproject at that institution (Annexe B, Section A). Based on the prioritized list of equipment for each participating institution and the

performance specifications (Annexe B, Section B), ICAR/USAID/Winrock could initiate procurement action, with consideration to the budgetary allocations made for each institution.

3. Training Program

The list of scientists nominated by their institutions to participate in the Program in 1988, types of training required, suggested scientists with whom they would work by location, and dates training will begin are given in Annexe C. It is suggested that the training periods be for five months. In selecting the locations for training consideration was given to the competence and availability of the scientist, his/her interest in the subject and enhancement of the breadth of the Program. Training at a variety of locations will enhance the Program. While the trainees are in the USA, in addition to the training programs at the institutions identified in Annexe C, it is suggested that they be given the opportunity to visit one or more other institutions involved in similar work and/or participate in major conferences or workshops.

ANNEXE A - SECTION A

Progress Reports from:

Bombay Veterinary College, Bombay

Haryana Agricultural University, Hissar

Kerala Agricultural University, Trichur

National Dairy Research Institute, Karnal

Punjab Agricultural University, Ludhiana

BIODEGRADATION OF WASTES FROM SLAUGHTER HOUSE INTO ANIMAL FEEDS

DEPARTMENT OF ANIMAL NUTRITION,
BOMBAY VETERINARY COLLEGE,
PAREL, BOMBAY-12.

The slaughter house is a very good source of by-products some of which can be utilised by the animal feed industry and even the farmers. Bombay has a most modernised slaughter house and this city and its surroundings area have large number of dairy animals and poultry. However, if the slaughter house by-products are to be utilised in the animal feed, processing of these from the feasibility point of view has to be worked out. These aspects that are considered should be simple and practicable on various scales to put them into practice. This, if undertaken, would enable utilisation of large quantities of these by-products for the feeding of livestock including the poultry. This would also reduce the pressure on some of the traditionally used feed ingredients and thus would help in reducing the cost on the feeding of animals.

Deonar abattoir which is situated in Bombay is one of the biggest slaughter houses in Asia. In this slaughter house per year about 25,00,000 sheep and goats, 1,00,000 bullocks, 65,000 buffaloes, 5,000 male buffaloe calves and 45,000 pigs are slaughtered. Large amount of various by-products are available from this slaughter. At present most of the by-products are wasted. Quantitatively, the most important products of slaughter house are rumen digesta/ingesta, blood meal and meat and offal meal. In such big organised slaughter houses rumen digesta are available in large quantities (67 M.T./day) which are not only unutilised but is a disposal problem for these slaughter houses. Presently, the Corporation is spending huge amount for the disposal of the same.

The present practice in the slaughter house regarding rumen contents is that, after the carcass is opened, rumen is incised and the contents are washed and these washing are then collected in the pits located outside. This material from the pits is disposed off through the contractors and the contractors are paid for this. In view of this initially the rumen contents of two types i.e. before and after washings were collected from cattle slaughter at fortnightly intervals.

The moisture content of these samples was estimated after oven drying and the results were as follows :

Average of two fortnights	Moisture Percentage	
	Rumen contents from rumen. (Unwashed)	Rumen contents from pit (Washed)
1	87.01	93.06
2	87.54	89.76
3	82.78	90.00
4	87.40	88.57

Thus, it was noticed that the Dry Matter content of unwashed rumen contents ranged from 12.46 to 17.22 percent and that in washed rumen contents from 6.94 to 11.43 percent.

Initially, these samples were oven dried as such and analysed chemically (Table-1). Subsequent samples will be subjected to sundrying and also ovendrying and comparisons will be made with regards to chemical composition and nutritive value. In general, it was observed that there was not much difference in the chemical composition of unwashed and washed rumen contents (Table-2), except that the washed rumen contents indicated slightly higher crude fibre and ash content as compared to unwashed rumen contents.

Subsequently, latter two samples each from washed and unwashed rumen contents were squeezed mannually by using musclin cloth to reduce its moisture content and then analysed chemically after oven drying. It was noticed that such squeezing reduced the moisture content from 83-87% to 72-78% in case of unwashed rumen contents and from 89-90% to 77% in case of washed rumen contents (Table-3). The yield of residue after squeezing in the former case was about 49.5% and 47% in latter case. It was noticed that due to squeezing only the NFE content of the rumen contents was reduced and this must have resulted in proportionate increase in other proximates, which was evident in both the type of samples.

Abovementioned two samples of each type (as such-unwashed, as such-washed and unwashed-squeezed, washed-squeezed) were subjected to estimation of in vivo digestibility coefficients by using Nylon Bag Technique. The digestibility coefficients were estimated only for Dry Matter, Crude Protein and Crude Fibre. The results are enclosed (Table-4).

Similarly, the blood samples were also collected from the slaughter house and were oven dried and analysed chemically. The average chemical composition of the blood meal is as follows :

Moisture	8.16
Crude Protein	86.27
Ether Extract	0.14
Crude Fibre	0.94
NFE	1.33
Ash	3.16
Acid Insoluble Ash	0.08
Calcium	1.46
Phosphorus	0.21

Scientist Designate

Associate Dean,
Bombay Veterinary College.

TABLE-1 : PROXIMATE ANALYSIS (% DMB) OF RUMEN CONTENTS COLLECTED FROM RUMEN.

NUTRIENTS	COMPOSITE SAMPLES OF TWO FORTNIGHTS			
	1	2	3	4
Moisture	87.01	87.54	82.78	87.40
Crude Protein	10.71	8.89	10.01	7.64
Ether Extract	1.80	2.00	1.57	1.68
Crude Fibre	24.11	28-44	26.00	28.43
N.F.E.	48.35	49.19	48.66	44.51
Ash	15.03	11.48	13.76	17.74

TABLE-2 : PROXIMATE ANALYSIS (% DMB) OF RUMEN CONTENTS COLLECTED FROM PIT.

NUTRIENTS	COMPOSITE SAMPLES OF TWO FORTNIGHTS			
	1	2	3	4
Moisture	93.06	89.76	90.00	88.57
Crude Protein	10.47	7.20	8.96	7.67
Ether Extract	1.95	1.10	1.24	1.42
Crude Fibre	32.00	32.01	33.05	31.12
N.F.E.	39.30	37.82	40.05	36.59
Ash	16.28	21.87	14.70	23.20

TABLE-3 : PROXIMATE ANALYSIS (% DMB) OF SQUEEZED RUMEN CONTENTS COLLECTED FROM RUMEN AND PIT.

NUTRIENTS	COMPOSITE SAMPLES OF TWO FORTNIGHTS			
	RUMEN		PIT	
	1	2	1	2
Moisture	78.12	72.00	77.00	77.11
Crude Protein	10.43	7.99	8.96	6.69
Ether Extract	2.12	1.52	1.38	1.48
Crude Fibre	30.89	30.22	35.64	34.42
N.F.E.	36.78	42.25	39.41	35.88
Ash	19.78	18.02	14.61	21.53

TABLE-4 : IN VIVO (NYLON BAG TECHNIQUE) DIGE.COEFF.(%) OF AS SUCH AND SQUEEZED RUMEN CONTENTS COLLECTED FROM RUMEN AND PIT

NUTRIENTS	AS SUCH		SQUEEZED	
	RUMEN	PIT	RUMEN	PIT
Dry Matter	37.23	35.43	34.89	32.19
Crude Protein	42.11	41.25	43.12	40.74
Crude Fibre	28.64	27.89	25.78	24.31

Production of Microbial protein from Rumen Ingesta.

The slaughter house wastes are of two types of animal & agricultural origin. The waste of agriculture origin is the fibrous, undigested material from the rumen along with the rumen liquor.

The rumen ingesta samples were analysed for fat, crude protein, fibre, insoluble & total ash cellulose, lignin & hemicellulose contents, The crude protein content was about 7-8 % ; liguin content 14-17%; cellulose 30-40 % and hemicellulose -30-40%.

To increase the degradability of lignocellulosic material the lignin content may be decreased by various methods. Physical methods like milling, heat treatment(autoclaving) & Gamma irradiation and chemical methods like sodium chlorite and sodium hydroxide treatment were studied.

The untreated & treated materials wefe used for enrichment of microorganisms which can grow on the substrate and produce cellular biomass. A number of bacteria and fungi were isolated.

The organisms were screened for a)cellulolytic activity. b) high rate of substrate utilization. c) good protein yield. d) absence of pathogenicity & toxin production. A fungal isolate fulfilling the above criteria was selected for further study.

The fermentation of the rumen ingesta was studied by submerged as well as simple solid state fermentation methods.

The submerged fermentation in 250-500 ml flasks on rotary shaker was standardized for the following parameters.

1)Static & Shaker culture.
2)Amount and age of inoculum.
3)Substrate concentration.
4)Time of fermentation.
5)pH of the fermentation liquor.
6)Addition of various Nitrogen sources like KNO_3, $(NH_4)_2SO_4$, Urea, Ammonium hydrogen phosphate yeast extract, cattle urine, Ammonium hydrogen phosphate yeast extract, & poultry dreppings.

In a scale-up fermentation a 2 litre fermentor was utlized. Daily changes in 1)pH 2) reducing sugar content. 3)protein content. (crude protein + extra cellular protein and 4)substrate utilization were studied. Batch and Fed-batch fermentations were carried out to determine any change in yield.

The end product yielded about 25-33% protein under different conditions of fermentation.

Solid state fermentation of rumen ingesta was carried out by a simple method using shallow trays. Some of the relevant parameter mentioned above were standardized. This method which was very simple, yielded good results.

The product obtained by the above methods is being evaluated for toxicity & nutritive value in Rhode White chicks. The amino-acid content and invitro & invivo rumen digestibilities have to be determined.

An effort is also being made to substitute pure chemicals at pretreatment & fermentation steps with waste materials from other industries so as to make the product economically viable.

CONVERSION OF BIODEGRADABLE ANIMAL WASTES FOR LIVESTOCK FEED

INDO-USAID Project No. 386-0470- Subproject-7
(Annual Technical Progress Report, 1987-88)

INTRODUCTION

Animal wastes represent a vast reservior of cheap nutrients for ruminants. Feeding costs of animals usually represent 50-80% of the total production cost and thus, can be reduced to 20-40% by utilizing these under-utilized feed resources for protein, minerals and other nutrients.

The use of animal wastes as feed ingredients appears to be more economically feasible approach than to use them as fertilizer or to use them as substrate for biogas production. Feeding animal wastes neither affects taste of meat, nor composition and flavour of milk. Thus, these wastes are valuable resources which can be used for a number of purposes. The method of utilization, however, will depend largely on the economics of the various system.

EARLIER RESEARCH FINDINGS AT HISAR

Research on the utilization of various farm animal organic wastes by cattle, buffalo, sheep and poultry has been conducted at the Haryana Agricultural University, Hisar. The findings of various studies are briefly reported here.

The inclusion of optimum level of animal wastes like cattle waste, sheep pellets and biogas plant slurry in animal diets were tested in cattle. The study revealed that these wastes could be incorporated in concentrate mixture upto 30% in adult and 20% in growing cattle without any deleterious effect on their health. The observations

Presented by Dr.Kripal Singh, Scientist, Department of Animal Nutrition, HAU, Hisar

relating to the use of poultry litters as a part of rations in cattle and buffalo were very encouraging and thus, could be incorporated in the rations as a 30% nitrogen replacement of concentrate mixture without any adverse effect. Poultry excreta was included in the sheep rations to replace groundnut cake protein. Replacement of 100% groundnut cake protein by poultry excreta had no effect on digestibility of nutrients and utilization of nitrogen in adult sheep, but only 50% groundnut protein could be replaced by poultry excreta for growing lambs.

CURRENT RESEARCH AT HISAR

Availability

Farm animal wastes are one of the most important under-utilized feed resources and the quantity produced per year is very large. The annual estimated global information of the total animal waste produced is about 14250 million tonnes and the value on the dry matter basis is about 2684 million tonnes. The figure with regard to their availability in India and Haryana State is presented in Table 1. A huge estimated amount of about 2455 and 38 million tonnes of fresh animal wastes is available annually from various animals in India and Haryana, respectively. Of this, about 213 and 3.3 million tonnes of dry matter is collectable and could be used as feed ingredient for livestock production.

Chemical Composition

The chemical composition of different types of animal wastes including dung and urine collected from various farm locations are presented in Table 2. The chemical composition of cattle and buffalo wastes is

Table 1. Sources and estimated annual yield of various animal organic wastes (1000 x tonnes)*

Species	India			Haryana		
	Fresh	Dried	Dried Collectable (50%)	Fresh	Dried	Dried Collectable (50%)
Cattle	1722800	292900	146150	16006.5	2721.11	1360.55
Buffalo	646100	109800	54900	20835.5	3542.04	1771.02
Pig	8600	2800	1400	246.0	81.18	40.59
Sheep	22500	5900	2950	312.6	81.28	40.64
Goat	42400	11000	5500	250.6	65.16	32.58
Chicken	12000	3400	1700	133.3	37.32	18.66
Duck	1100	400	200	247.0	96.33	48.16
Total	2455500	426200	213100	38031.5	6624.42	3312.21

*Note 1. Livestock population used in calculations of animal waste output is taken from FAO(1986) and Statistical Abstract of Haryana (1985) for India and Haryana, respectively.

2. Daily feeces voided per animal and DM% in feeces - as per Smith, L.W(U.S.A.) norms.

Table 2. Per cent Chemical Composition of animal wastes on dry matter basis

Particulars of samples	dung								Urine *	
	DM	CP	NDF	ADF	Cellulose	Hemi Cellulose	Lignin	Silica	N	CP
Cattle										
Milch**	13.62	21.84	60.20	47.10	24.00	13.10	14.50	8.60	0.79	4.96
Milch	14.27	13.96	62.95	42.45	16.05	20.50	18.70	7.30	0.54	3.43
Pregnant	13.50	11.34	66.10	44.50	20.20	21.6	16.30	8.00	0.36	2.28
Heifer (above 1 yr)	17.05	9.18	63.03	49.47	25.37	13.57	16.43	8.67	0.51	3.19
Calves (below 1 yr)	15.10	14.78	52.65	37.95	12.10	14.50	17.80	8.10	0.16	0.99
Buffaloes										
Milch	15.94	21.35	56.62	52.03	26.17	4.59	14.57	10.78	0.67	4.19
Pregnant	15.57	12.87	64.47	51.37	19.61	13.14	14.37	17.35	0.40	2.52
Dry	14.07	11.32	62.31	56.00	28.69	6.31	16.45	10.83	0.44	2.78
Heifer (able 1 yr)	15.00	12.87	69.91	53.92	29.07	15.99	15.00	9.92	0.34	2.15
Calves (below 1 yr)	15.38	12.75	63.85	61.05	33.38	2.80	10.88	16.33	0.71	4.43

* Values per 100 g urine

** Cow fed high concentrate ration

Table 3. Percent chemical composition and IVDMD of spilled feed and bedding on dry matter basis

Particulars of samples	DM	CP	NDF	ADF	Cellulose	Hemicellulose	Lignin	Silica	IVDMD
					Spilled feed				
Pearl millet stover based	92.00	5.63	61.58	47.87	24.67	13.71	11.15	12.47	-
Wheat straw + green rape based	52.85	7.72	66.83	54.23	24.69	12.60	11.58	18.27	-
WS +dung+rape+green berseem	51.89	16.32	61.97	57.51	17.31	4.46	10.81	29.31	30.39
					Bedding				
Wheat straw(1 wk)	30.99	8.79	67.43	52.13	28.05	15.30	10.71	13.36	20.95
Paddy straw(1 wk)	28.50	11.07	64.04	51.13	28.32	12.91	8.86	14.21	29.18

influenced by the kind of feed offered, age and physiological status of the animals. The crude protein content of cattle waste ranged from 9.2 to 21.8%, the highest being in the young calves dung among the normally fed animals. However, higher values of CP in dung (21.8%) and urine (4.96%) were observed in high producing milch cows offered higher level of concentrate in the rations. In case of buffalo wastes the CP value ranged from 12.8 to 21.4%, the highest being in lactating buffaloes waste. Other categories of buffalo wastes did not show much variations. The urine from buffalo had 2.2 to 4.4% CP in different categories of buffaloes. The cell wall constituents, in general, showed a mixed trend.

The spilled feed collected from various locations of animal farm showed variation in nutrient concentration depending upon the type of feeds offered (Table 3). The CP contents of pearl millet stover, wheat straw-rape and wheat straw-berseem-rape based spilled feeds was 5.6, 7.7 and 16.3%, respectively. The cell wall constituents also varied depending upon the feeds offered. The IVDMD value of 30.4% was observed in case of spilled feed having straw, rape, dung and green berseem mixture.

Microbiological examination of faecal samples.

Faecal samples from various categories of cattle and buffaloes have been collected and being examined for pathogenic, fungal and parasitic infestations. The data with regard to pathogens and fungal examination is still awaited. Faeces of almost all categories of cattle had infestation of strongyle eggs. However, faecal samples of all categories of buffalo were free from parasitic infestation except in calves below 6 months of age which were found positive for strongyle eggs.

Bedding materials

Chemical composition and IVDMD

Two types of bedding material viz., wheat and paddy straw were used in the sheds of lactating crossbred cows. The material was allowed to be mixed with faeces, urine and spilled feed and was turned after every alternate day. Samples drawn after one week have been subjected to chemical analysis and *in vitro* dry matter digestibility. Their values are given in Table 3. The paddy straw based feeding contained more crude protein (11.07%) as compared to the wheat straw based (8.79%) bedding. However, the cell wall constituents did not show much variation among the beddings. The IVDMD values were 20.95 and 29.18% for wheat and paddy straw beddings, respectively.

Ensiling

The wheat straw (W) and paddy straw (P) beddings have been ensiled either alone (O_o) or in combination with chaffed oat forage in a ratio of 60:40 (O_1) and 40:60 (O_2), without molasses (M_o) and with 5% (M_1) and 10% molasses (M_2) in laboratory silos. In all there are 18 treatment combinations viz., WO_oM_o, WO_oM_1, WO_oM_2, WO_1Mo, WO_1M_1, WO_1M_2, WO_2M_o, WO_2M_1 and WO_2M_2 and PO_oMo, PO_oM_1, PO_oM_2, PO_1 Mo, PO_1M_1, PO_1M_2, PO_2M_o, PO_2M_1 and PO_2M_2. Molasses wherever added was diluted 1:1 with water and mixed thoroughly. These have been ensiled in duplicate in order to facilitate unloading at 40 and 60 days of ensiling. After unloading the material will be evaluated for biochemical parameters, cell wall constituents and *in vitro* dry matter digestibilities. The samples of original material and mixed herbage will also be subjected for detailed chemical analysis.

Technical programme for the year 1988-89

1. Training of Scientists .

2. Studies on turning and removal of bedding materials in different seasons

   1. Chemical analysis

   2. *In vitro* studies

3. Studies on laboratory ensiling of bedding materials by mixing with different forages and other energy sources at various levels.

4. The bedding materials will be ensiled in large pits by using appropriate levels of forages/ energy sources from experiment 3.

5. Conservation of high moisture bedding materials by mechanical and sundrying.

6. Preparation of reports.

INDO-USAID PROJECT ON

CONVERSION OF BIODEGRADABLE ANIMAL WASTE FOR LIVESTOCK FEED

" Biodegradation of wastes from fish and other aquatic animals for livestock feeds"

Dr. E. SIVARAMAN
DEPARTMENT OF ANIMAL NUTRITION
COLLEGE OF VETERINARY & ANIMAL SCIENCES
MANNUTHY

INTRODUCTION

Acute shortage of quality feeds and forages is the main constraints in the development of livestock farming in Kerala. The deficiency of concentrates is about 60% and of fodder about 25% in the state. In order to mitigate these shortages, the only alternative is to find unorthodox sources of feed for animals. Utilisation of aquatic animal wastes available from about 300 fish processing centres in the coastal region of the state offers great potential for finding alternate feed sources. Microbial fermentation of such wastes with a wide array of microorganisms and converting them into single cell protein will enhance their feeding value considerably.

Kerala has nearly 600 km. of coastal line which constitutes about 30% of the country's total. With nearly 480 km. of rivers and canals and 390 km. of backwaters fresh water ponds and lakes and reservoirs of about 8500 hectres and paddy lands with an area of nearly 4050 hectares Kerala has an important place in the fishing map of India. The total quantity of fish landing in Kerala was estimated to be around 3 lakh tons annually. A considerable portion of fish catch and their processing wastes are either wasted or used as mannure. Only a portion of it is being converted into fish meal. The large qualtities of wastes available from the fishing areas of the state will have a potential for adding to the feed resources. Many such marine byproducts have been tried in preliminary studies in the Dept. of Animal Nutrition. A brief summary of the studies conducted is given below:

1. CHEMICAL COMPOSITION AND FEEDING VALUE OF SHRIMP SHELL POWDER (PRAWN WASTE) FOR BROILER CHICKS

Shrimp shell is the waste product of shrimp processing industry and consisted largely of the discarded portions including heads and shells. The annual availability is estimated to be 40,000 tons. The material was analysed as per AOAC method and a feeding experiment was conducted using broiler chicks. The material had the following chemical composition.

Dry matter	92.4 percent
Crude protein	32.1 "
Crude fibre	6.0 "
Ether extract	5.6 "
Nitrogen free Extract	15.4 "
Total ash	40.9 "
Acid Insoluble Ash	17.4 "
Calcium	.9 3 "
Phosphorus	1.3 "

One hundred and five day old straight run broiler chicks were randomly allotted to 3 groups of 35 chicks each and were maintained under identical managemental conditions. The shrimp shell powder was fed at 5% and 10% levels and the growth rate of chicks was compared with that of chick receiving a control ration containing 10% dried fish. The rations were made iso-caloric and isonitrogenous. The birds were fed for a period of 8 weeks and the data on body weight were recorded at weekly intervals. The average cumulative weight gain for the experimental groups at eight weeks were 1334 and 1073 g respectively for the birds fed 5% and 10% shrimp shell powder in the rations as compared with the control group which weighed 1448 g, the differences between the various groups being significant. However, at 6 weeks of age the average weight gains in the 0% and 5% groups were not significantly different. The overall results indicated that shrimp shell powder was economically beneficial in replacing fish meal in broiler rations.

2. CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF FISH SILAGE FOR POULTRY

A preliminary study on the chemical composition and feeding value of fish silage for poultry was conducted. Fish silage had the following percentage chemical composition on DM basis.

Crude protein	48.37 %
Ether extract	11.61 "
Total ash	13.53 "
Nitrogen Free Extract	26.49 "
Calcium	5.02 "
Phosphorus	2.11 "

Thirty six White Leghorn laying hens were randomly assigned to 3 groups of 12 birds each and maintained on rations containing 5% and 10% of fish silage replacing part or whole of fish meal for 3 months. The control ration contained 10% fish meal. All the rations were made isocaloric and isonitrogenous. The results indicated that the fish silage could be incorporated in place of dried fish at 10% level.

3. NUTRITIVE VALUE OF FROG MEAL FOR CHICKS

Frog meal obtained from frog leg industry was tried as a substitute for fish meal in poultry ration. The material had the following percentage chemical composition:

Dry matter	97.6
Crude protein	66.8
Ether Extract	4.8
Crude fibre	2.3
Nitrogen Free Extract	2.6
Total ash	23.5
Calcium	11.75
Phosphorus	5.38

Thirty day old chicks were ramdomly assigned to two groups of 15 chicks each and maintained on two different diets for a period of 8 weeks. In the experimental ration frog meal replaced

fish meal (10%) on isoprotemic basis. It was found that the chicks on diet containing frog meal showed a significantly higher growth rate the average weight gain being 448.6 g and 245.7 g respectively for the experimental and control groups. The efficiency of utilisation of feed containing frog meal was also high. An overall assessment of the results indicated that complete replacement of fish meal (10%) in chick ration with frog meal resulted in better growth rate and higher feed efficiency.

4. FEEDING VALUE OF LAND SNAIL (ACHATINA FULICA) FOR PIGS

The dried land snail contained 59.90 % crude protein on dry matter basis. A feeding experiment was conducted on growing pigs replacing 50% of fish meal in the diet by dried land snail The data on growth of piglings showed growth effect comparable to that obtained on animals fed on ration containing 10% fish meal.

5. CHEMICAL COMPOSITION OF FISH (MACKEREL) WASTE

Mackerel fish waste obtained from fish processing industry was analysed in the department. It had the following chemical composition on dry matter/basis.

Dry matter	30.0%
Crude protein	39.32 "
Ether extract	39.46 "
Total ash	19.08
Nitrogen Free Extract	2.14
Insoluble ash	0.24 "
Calcium	6.47 "
Phosphorus	3.59

Feeding experiment is to be conducted to find out the feeding value of fish wastes (Mackerel Waste)

Apart from the preliminary works summarised above no detailed study has been conducted on the other aquatic marine wastes, as per the technical programme of the projects during the period. Contacts have already been made with fish industry people and arrangements have been made for the collection and transport of the various waste materials available with them. Investigations including the microbial conversion and feeding experiments will be conducted as per the approved technical programme of the project. Detailed experiments are to be designed and carried out depending on the availability of wastes from fishing industry.

"CONVERSION OF BIODEGRADABLE ANIMAL WASTES FOR LIVE-STOCK FEED" - TOXICOLOGICAL ASPECTS*

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The Project on the conversion of biodegradable animal waste as live-stock feed is being carried out at 5 Centres with the following three broad objectives:

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

b. To evaluate the nutritive value of the fermented feeds for farm animals and to determine means and economics of including these new feeds into practical live-stock rations.

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

The NDRI Unit has been given the technical programme of conducting toxicological studies on animal feeds obtained from biodegradation of animal wastes. This toxicology laboratory would also be equipped and charged with the responsibility of serving all institutions in studies and for training.

As per the decisions taken at the last Workshop of the Project held on 20th February, 1987 at ICAR, Krishi Bhavan

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*Presented at the Indo-USAID Workshop on the sub-Project "Conversion of biodegradable animal wastes for live-stock feed" held on 22-23 Feb., 1988 at ICAR, New Delhi.

New Delhi the various centres would be working on slaughter house by-products and wastes such as rumen contents, blood meal; dung and urine of cattle, wastes of fish and other equatic animals (shrimp shell, fish wastes, frog meal and land snail), poultry waste (poultry litter and droppings)

These materials would be treated/processed suitably i.e. physically, chemically and/or biologically for making them palatable and nutritious for use as live-stock feed. These studies would be conducted at the respective Centres. The materials per se or after suitable treatments would have to be made free from the toxic substances.

The Centre will provide:

1) In country training for designated scientists in India

2) Provide special chemical analysis for the other four cooperating centres of the project.

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

Hence, the Technical Programme of work would be as under:

(i) Screening of the various types of animal organic wastes per se and or after suitable processing/treatment for the presence of toxic/incriminating factors (microbial/pathogens, organic inorganic and pesticide residues etc.)

(ii) Detailed studies on the determination of the structures and functional groups of these toxic factors and development of economical but effective methods of their detoxification.

(iii) Studies on the effect of feeding the undetoxified and detoxified animal organic wastes on laboratory/large animals particularly with respect to nutrient utilization and histopathological studies.

(iv) Making suitable recommendations to the Centres for large scale adoption of the detoxification methods for testing at the Centres on a larger scale.

The transfer of technology part would be done at the Centres as per programme of the Project.

SETTING UP OF THE TEXICOLOGICAL LABORATORY:

Chemicals, glasswares and some routine equipments are being procured for the setting up of the Toxicological-cum-Reference Laboratory. The list of sophisticated equipments has already been sent to the council for their early procurement.

STAFFING POSITIONS:

Two posts of Scientist S-2 - one each in Organic Chemistry/Biochemistry and Toxicology have already been sanctioned by the ICAR and efforts are being made for filling up these positions.

ICAR MANAGEMENT TEAM:

In accordance with the recommendations of the last Workshop of the Project, a Management Team of the ICAR visited various Institutes/Farms in USA where significant work on the use of animal organic waste as animal feed is being carried out. I was one of the members of that Team. The detailed report on the visit enlisting the Institutes and Scientists to be associated with the programme, names of permanent consultants, and Centre-wise list of equipments to be imported from USA has already been submitted to the Council.

TOXICOLOGICAL IMPLICATIONS OF ANIMAL ORGANIC WASTE AS ANIMAL FEED*

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ABSTRACT

Animal organic wastes such as poultry litter, cattle wastes slaughter house by products, carcass of dead animals, wastes and by-products of fish and other aquatic animals have tremendous promise for use as animal feed due to acute shortage of animal feeds in the country. But these wastes require one or the other treatment/processing for converting them into palatable and nutritious feeds. These wastes per se or after necessary process ; may contain some toxic factors which can adversly affect animal health and productivity. These can bedue to the resence of pathogens Coliform bacteria, Clostidium botulimum, Strongyle nematodes, Fasicola Gigantica cysts, Clostridium corynobacterium, Salmonella typhmurium, Actionobacillus, Mypbacterium bacillus, Staphlococcus etc. Similarly many types of viruses have been found in animal excreta. Feeding of animal waste can also result in severe mineral imbalances and the excreta of poultry particularly has been reported to contain arsenic which adversely affect the animal performance. In fish wastes and by-products even

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*Presented at the Indo-USAID Workshop on the sub-Project "Conversion of biodegradable animal wastes for live-stock feed" held on 22-23 Feb., 1988 at ICAR, New Delhi.

after ensiling the presence of trimethylamine should be checked. Similarly the other sea foods may contain some toxic substances like heavy metals and pesticide residies due to industrial/environmental pollution processing of animal wastes particularly those rich in fibre with fungi may lead to production of some mycotoxins. Particularly under Indian conditions, the animal excreta and other animal organic wastes may contain some toxic materials/antimetabolites like oxalates, phytates, nitrates, cyanides, tannins, aflatoxins, mimosine, saponins, alkaloides, lathyrogens, gossypol, lantadone, goiterogens, oestrogens, organometllic compounds etc which the animals eat through non-conventional feeds and a good amount of the antimetabolites get excreted and a part is even accumulated in the animal tissues, hence the animal wastes should be detoxified before recycling as animal feed.

It is, therefore, extremely important to screen the various animal wastes for the presence of toxic/incriminating substances per se and even after processing/treatment and to develop economically viable methods for their detoxification to ensure safe feeding of such materials to animals.

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Report for the year 1988 on INDO-USAID
Sub-project 7 (386-0470) Component VI

'Biodegradation of Poultry Wastes'

Implementing Centre: All India Coordinated Research Project on "Determination---evolving economic rations for livestock and poultry".

Department of Animal Science

Brief outlay of Technical programme of work:

1. Chemical analysis of poultry organic wastes available under different farming practices.

2. Standardisation of experimental conditions for deep stacking of straw-poultry wastes at 30 to 50% moisture for comparison with the results achieved at 70% moisture.

3. Investigations on the pathogenic population load in the poultry litter and effect on these counts after deep stacking.

4. Comparative rumen degradability of different poultry-wastes straw combinations *in vitro* and Nylon bag technique.

5. Comparative animal nutritive evaluation of poultry wastes-straw before and after stacking.

6. Comparative evaluation of ensiled and deep stacked rice straw-oats-poultry dropping/litter for type of microbial population(s) established and nutritive value.

7. Comparative growth and lactation studies on long term basis (Minimum 180 days) using the standardised poultry wastes-straw combination as basal ration.

8. Recycling of poultry droppings after pure culture fungal fermentation in the starters, growers, layers and broiler mashes.

Progress of work (Jan. 1988 to Dec. 1988):

I Deep stacking of poultry dropping (PD) - Wheat straw:

Different combinations of broiler PD + wheat straw (T_2 to T_5) were stacked with 70% moisture for 9 days on laboratory scale. During 9 days appreciable increase in the total ash, CP lignin and cell soluble (~~Table-1~~) from those on 0 day was observed in T_4 and T_5 samples. The T_4 and T_5 combination respectively contained 450 and 600 g of PD in a total biomas of 1500 g as against this the T_2 and T_3 combinations had 150 and 300 g PD respectively. In T_2 and T_3 except for rise in the total ash and lignin and decline in OM content only marginal changes were observed for other parameters. Changes in the NDF content in T_2 to T_5 ran parallel. In case of T_1 having no PD but urea as external nitrogen source the laboratory scale experiment did not simulate the conditions as reported under field with bulk combinations. In this case most of the urea had degraded resulting in low CP and OM content after 9 day stacking. As reported in 1987 compared to the PD-straw combination (T_2 to T_5) in T_1 (Urea-straw) combination the temperature rise was nominal in the laboratory scale preparations. These observations therefore suggest:

i. The presence microorganisms in poultry droppings stimulated the fermentation process even at the laboratory scale, unlike in T_1 having no PD.

ii. This inoculum activity of PD varied with the quantity of PD replacing urea on nitrogen basis and therefore the induction of microbial activity was different in such combination (T_2 to T_5).

iii. The compositional changes induced in T_4 and T_5 suggested that combination of poultry Waste-Straw (T_5) can be successfully employed for upgrading the nutritive value as a basal ration after deep stacking.

Therefore, in the subsequent experiment the result (Table 2) suggested that deep stacking of T_5 combination for 4 to 5 days was sufficient to produce desired changes. Stacking between 5 to 9 days had not resulted in further improvement but cell solubles had declined to 30% on 9 days as against 35% on 5 day. This loss in cell solubles is indicative of low nutritive value of T_5 combination if stacked beyond 4 days.

Confirmation of these observations will be available only when the results of <u>in vitro</u> digestibility along with results on deep stacking at moisture levels lower (30-40%) than 70% are available. Work on these experiments is under progress at the moment.

II. <u>Chemical and microbial changes in the litter</u>:

Saw dust (SD) and rice husk (RH) was laid as bedding material in 7.5 ~~to 10 cm~~ thick layers, for both materials in 8 pens each. Four month old pullets (120 in each pen) were housed in each pen and sampling of litter material from 0 day is done at 30 day interval. For maintaining the litter dry it is raked periodically for aeroation and wet spots if any are replaced with fresh bedding material while raking. The sampling is done from different spots in a pen and respective litter material from 8 pens is pooled at each sampling. Fresh samples are used for microbiological examination and for chemical assay oven dried (80°C, 24 h) samples are used.

Table 1: Daily changes in the chemical composition of T_5 poultry dropping - straw combination

Parameter	0	1	2	3	4	5	6	7	8	9
Total ash	13.4	15.2	17.9	17.[illegible]	19.6	20.3	20.1	20.1	20.4	21.2
OM	86.6	84.8	82.1	82.[illegible]	81.0	79.7	79.9	79.9	79.6	78.8
CP	10.2	10.4	11.2	11.6	12.1	13.5	13.4	13.7	14.5	15.0
CF	34.1	38.3	36.1	34.6	34.6	32.0	36.9	36.2	35.4	35.1
Cellulose	29.4	29.9	30.3	2[illegible].1	27.6	25.9	26.6	26.4	23.6	23.3
NDF	69.7	71.7	67.8	6[illegible].1	65.1	64.9	65.2	64.7	68.8	69.6
Lignin	9.50	8.90	10.5	[illegible].7	11.0	11.0	12.9	12.9	12.8	13.1
Cell soluble	30.3	28.3	32.2	30.9	34.9	35.1	34.8	35.3	31.2	30.4

a) Chemical changes: The initial (0 month) moisture content of 8 to 9% in both SD and RH reached to 23 to 26% after 5 month (Aug to December) of litter making. The total ash content compared to the SD was initially high in RH. Initial variation in the chemical composition (Table 1) between SD and RH for organic matter (OM), crude protein (CP), neutral detergent fibre (NDF), cellulose and cell solubles were present. But during the period of litter making parallel changes were observed in the SD and RH based litter. In 5 month period decline in the OM, NDF and cellulose was associated with parallel rise in total ash CP and cell soluble content of both the litters. These results so far may suggest that irrespective of the bedding material spread in a poultry house the final litter composition could be similar. But final conclusions can be drawn only when the litter is finally removed from the pens after 12 months and comparisons made with respect to 0 month composition.

Table 1: Periodical chemical changes in the deep litter from a poultry house using saw dust (SD) or Rice husk (RH) as bedding material.

Period month	Litter material	Chemical composition (% DM)					
		Total ash	OM	CP	NDF	Cellulose	Cell soluble
0	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
1	SD	17.1	82.9	9.60	71.7	30.8	28.3
	RH	21.5	78.5	8.44	71.4	30.1	28.7
2	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
3	SD	21.0	79.0	13.0	66.5	27.4	33.5
	RH	23.0	77.0	12.4	65.0	24.1	35.0
4	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

b) Microbiological examination: Litter sample (11 g) was suspended in 55 ml sterlized normal saline. The suspension after trituration was filtered through double fold muslin cloth. The

filterate for bacterial count was then serially diluted with normal saline upto 12 dilutions of 1:10. Then from each serially diluted sample 0.1 ml was plated on Eosin methylene blue (EMB) for E. coli, MacConkey's lactose agar (MLA) for family enterobacteriaceae and Nutrient agar (NA) for total viable count in duplicate for each sample.

In the begining trypticase soya agar (TSA) medium was tried for total viable count. But due to profuse growth on the medium colony count was difficult. Therefore, NA medium was used for total bacterial count.

From the first serial dilution the material was also streaked on blood agar medium to detect species of corynebacterium streptococcus etc.

For Salmonella initially brilliant green agar (BGA) medium was employed for direct culturing and quantitative estimation with no success. Therefore, the culturing of salmonella for qualitative purpose was carried in three steps as detailed below:

Step I: Litter (11 g) was suspended in 100 ml of manitol broth and incubated for 24 hr at 41.5°C±1

Step II: One ml of the above was then transferred into 10 ml of selenite-cysteine (SC) broth for incubation at 41.5°C±1 for 48 hr.

Step III: Finally SC broth was subcultured on BGA for qualitative presence of Salmonella in litter sample.

For mycological examination 0.1 ml of filtrate from the first dilution was poured on Sabouraut's Dextrose Agar (SDA) medium in duplicate. One plate of SDA was incubated at 25°C and other at 37°C. These were examined after 3 days and if no growth was observed then incubation was continued upto 14 days. The colonies developed were then identified. Further confirmation of fungal isolates is being got done from international Mycological Institute, UK

The results so far show that there is a dynamic alternation in the total viable bacterial load which show changes in the differential count pattern in different months as will be evident from the table 3. Work is under progress

Table 3: Periodical changes in the total and differential viable plate counts (Mill/g sample) in the saw dust and rice husk based litter.

Month		Total viable count ($X 10^5$)	Differential count ($X10^5$)					
			E.coli	Klebsiella	Salmonella	Others	Fungi	
0	SD	26.5	1.5	0.5	-	-		
	RH	250	2150	20	-	Anthracoid	Aspergillus flavis	
1	SD	16000	30	20	-	-		
	RH	2	1	-	+	-	Penicillium sp.	
2	SD	-	1	-	-	Staph epidermide	Mucer sp.	
	RH	-	0.5	-	-	Anthracoid		
3	SD	-	-	-	-	As above	Sepedomin sp.	
	RH	-	-	-	-			
4	SD	-	-	--	**	Staph epidenudis	U.I.	
	RH	12.7	160	-	-	Anthracoid Dipthiroid	U.I.	

Note: 1. During 2 and 3 month the organism load was heavy and total viable plate count was not possible at 12 serial dilution. [illegible] $> 5 \times 10^{12}$/g litter

2. Solmanella sp. was qualitatively confirmed in the first month inrice husk litter and was suspected in 4th month (**) in saw dust litter.

SD = Saw dust

RH = Rice husk

UI = Unidentified

II) Fungal biodegrad. on of poultry droppings (PD):

Poultry droppings collected from cage house of growing broilers were oven dried and powdered to 40 mesh size. PD substrate (25 g) moistened with 57.5 ml of 0.13 N sulphuric acid in an Erlynmeyer flask (250 ml capacity) was sterlized at 121°C for 15 min. Then triplicate flasks were inoculated with a wheat spawn (5% fresh wt. basis) of each respectiv fungus (Table 4) for 20 days at an optimum required temperature. After incubation visual surface growth and mycelial penetration into substrate for each fungus was assessed and contents from flask were oven dried for individual chemical analysis.

Among the various fungi tested only 3 Coprinus sp. and Pleurotus ostreatus showed maximum surface growth with mycelial penetration on the PD substrate (Table 4). Because of alkalophilic nature the % decline in the uric acid and DM during 20 days with 3 Coprinus sp. was higher than with Pleurotus ostreatus. The Sporotrichum pulverulentum showed the least decline although growth and penetration of this fungus was close to that observed with Pleurotus Cermicopiae and Pleurotus hirsutus. Solient changes in chemical composition after 20 days were reduction in uric acid by 3 Coprinus sp, Pleurotus ostreatus and Pleurotus hirsutus than marginal reductions with Pleurotus cornicopiae and Sporotrichum pulverulentum when compared with control (Table 5). However, the increase in CP was not associated with the decline in the substrate CF content suggesting that all the fungi utilized soluble carbohydrates content of PD during 20 days growth. These results are inconclusive and further work is in progress.

Table 4: Relative growth, mycelial penetration and decline (%) in the uric acid and DM with fungal growth at their optimum temperatures in Poultry Droppings substrate

Fungus	Incubation temp °C		Visual observation		Decrease (%)	
	Range	Incubated	Surface growth	Mycelial penetration	Uric acid.	DM
Coprinus						
Sp. 1	30-33	30	++++	++++	36.0	24.5
Sp. 2		30	++++	++++	32.2	24.7
Sp. 3		30	++++	++++	37.5	21.8
Pleurotus Ostreatus		25	++++	++++	29.1	15.2
Pleurotus Hirsutus	25-30	25	+++	+++	27.6	24.1
Pleurotus Cermicopiae	25	25	++	++	21.5	22.3
Sporotrichum pulverulentum	37	37	+++	++	15.4	11.2

1. Incubation of flasks in triplicated was carried at respective temperature for 20 days.
2. Decrease (%) is calculated from uric acid DM content in poultry droppings before incubation.

Table 5: Chemical composition of the final poultry dropping substrate after 20 days incubation with fungi (% DM)

Fungus	Crude protein	Crude fibre	Uric acid	Total Ash
Coprinus sp. 1	27.1	21.6	2.53	27.1
sp. 2	25.6	20.7	2.68	27.2
sp. 3	27.2	19.8	2.47	26.2
Pleurotus ostreatus	27.7	21.6	2.60	24.2
Pleurotus cornucopiae	29.4	21.8	3.10	26.4
Pleurotus hirsutus	29.7	20.7	2.86	27.0
Sporotrichum pulverulentum	28.8	21.9	3.34	32.0
Control	24.4	19.7	3.95	20.5

1. Mean of 3 replicates for each fungi.

2. Control is the poultry droppings without fungal inoculations.

Suggestions for smooth working of the project:

1. Due to extreme climatic conditions proposed improvements in the laboratory facilities and shed for deep stacking are necessary. The isolation and pure culture work is hindered during summer and deep stacking of large quantities of crop residues in monsoon period.
2. For the isolation and culturing of pathogenic and non-pathogenic anaerobic bacteria and fungi import of CO_2 incubator is essentially needed.
3. For the smooth working the air conditioning of the previous where imported Atomic Absorption spectro photometer and micro-computer will be located is necessary. Besides acetylene gas is needed for mineral analysis to be carried out on Atomic Absorption spectrophotometer.

ANNEXE A - SECTION B

Technical Programs by Location, 1988

Bombay Veterinary College, Bombay

Haryana Agricultural University, Hissar

Kerala Agricultural University, Trichur

National Dairy Research Institute, Karnal

Punjab Agricultural University, Ludhiana

Bombay Veterinary College

1. The rumen contents from cattle, sheep and goats will be collected at weekly intervals for two months during each of the three seasons and their chemical composition will be compared after oven drying and sun drying. Drying will be studied with and without addition of straw or de-oiled wheat bran.

2. These samples will also be subjected to mechanical squeezing to reduce the moisture content and its effect will be studied on time required for drying (oven drying and sun drying), and loss of nutrients, if any.

3. On a laboratory scale, rumen digesta wil be incorporated with various levels of paddy straw, and blood at two levels of molasses in a factorial arrangement, and the various characteristics and chemical composition of these silages will be studied.

4. The nutritive value of the materials will be studied by nylon bag technique.

5. The squeezed rumen contents will be subjected to urea treatment at the level of 5.3%, and subsequently this material will be dried, and the effect on chemical compsition will be studied. The nutritive value of this material will also be studied in a digestion trial by using switch-over design, with negative control in sheep, goats or growing calves.

Haryana Agricultural University

1. Studies on chemical composition and IVDMD of bedding material:

Different quantities of bedding material (wheat straw) will be used in the pens of a fixed number of lactating cows. The bedding will be turned on alternate days and the samples will be taken on the 3rd and 7th days for evaluation.

2. Studies on the laboratory ensiling of bedding material:

The bedding material mixed with faeces, urine and feed residue will be removed from the pens on the 3rd and 7th day (as in expt. 1) and will be ensiled either alone or in combination with available forages/energy sources. The silages will be opened after six weeks and subjected to biochemical and chemical analysis to screen out better combinations.

3. Studies on the conservation of animal waste by sun drying and through urea (ammonia) treatment:

The bedding material containing various proportions of straw and waste will be either sun-dried completely or partially dried up to 40 to 50% dry matter, and then subjected to urea-ammonia treatment. After four weeks of stacking, the material wil be dried to ensure release of excess ammonia. The processed products will be fed to adult animals to determine their nutritional value.

Kerala Agricultural University

1. Screening of prawn waste, fish waste and frog meal will be done for microbial load, including clostrida and salmonella species.

2. Suitable microbial agent(s) capable of degradation of prawn waste will be identified and innoculation will be prepared.

3. Prawn waste, fish waste and frog meal collected from different centers will be analyzed.

4. Samll scale silages with different levels of straw and prawn waste will be prepared. The following parametrs are to be measured:

   a. ph
   b. Lactic acid
   c. Acetic acid
   d. Trimethylamine
   e. Ammonia
   f. Proximate composition
   g. Microbial population of the product
   h. In vitro-digestability

National Dairy Research Institute

1. Various types of animal organic wastes per se and after processing/treatment will be analyzed for pesticide residue, drug residues, and heavy metals.

2. Testing of the toxic material (identified under item 1 above) will be done for assessing the extent of toxicity, particularly with respect to the tolerance limits.

Punjab Agricultural University

A. On going current project

1. Monitoring of pathogen load and chemical composition of rice husk/sawdust based litter will continue until August, 1988. Hence, pooled sampling will be done from two pens each so that four representative samples are available for each litter every month.

2. Litter available in August, 1988 will be deep stacked and information on the nutritive value through acceptability and metabolism trials will be obtained.

3. Poultry dropping - straw deep starching at 35, 45 and 55% will be carried out at laboratory scale and final product will be evaluated through chemical analysis and in vitro/in sacco investigations.

B. Projects to be undertaken

1. The sawdust/rice husk based litter fermentation will be repeated after August, 1988 for quantifying the monthly changes in the chemical composition/pathogen load in the biomass available at the end by making modifications:

   a. The litter material spread in each pen will be weighed initially before spreading.
   b. The sawdust/rice husk containing pens will be randomly distributed on either side of the poultry house.
   c. Replacement of any wet spots by fresh litter material will be expressed on dry basis.
   d. Monthly sampling will be carried out in the pre-sterilized containers.

2. Pleurotus ostrealus

Caged broiler dropping treated with the fungus, Pleurotus ostrealus will be evaluated in broiler mashes at 10, 15, 20 and 25% levels.

C. Experiments at Laboratory scale under standardisation

1. Pure culture isolation and culturing on poultry dropping will be done with other suitable fungi in the incubation range between 25 to 37°C.

2. Cultivated fungal biomass with poultry dropping will be substituted as protein source.

ANNEXE B - SECTION A

Priority Listing of Equipment by Institution

PRIORITY LISTING OF EQUIPMENT

No.	Item	Institution				
		NDRI	HAU	KAU	PAU	BVC
BW1	Spectrophotometer, AA	1	6	1	1	3
BW2	Chromatography, HPTLC	2				
BW3	Chromatography, HPLC	3			4	
BW4	Calorimeter, oxygen	7	1			
BW5	Balance, electronic, analytical	9 (5)*	3	4		4
BW6	Balance, electronic, top loading	8 (4)	4		5	6
BW7	Incubator, CO_2			6	2	5
BW8	Spectrophotometer UV-Vis	4		2		8
BW9	Microscope, dissecting	6 (2)				
BW10	Cetrifuge, refrigerated, high speed			3		9
BW11	Freeze dryer			5		7
BW12	Shaker, rotary					
BW13	Polygraph	5 (3)				
BW14	Nitrogen analysis system		5			2
BW15	Fiber analysis system		7			
BW17	Laminar flow hood			7		
BW18	Press					1
BW19	NIR Analyzer	(1)				
BW20	Culture laboratory fermenter				3	
BW21	Anaerobic chamber		2			

*( ) Priority if NIR is purchased.

ANNEXE B - SECTION B

Performance Specifications of Equipment

BW-1

ITEM: Atomic absorption spectrometer and accessories

INTENDED USES: This equipment will be used for quantative measurement of elements in waste materials and animal tissues.

REQUIREMENTS:

The equipment is to be installed and determined operational in India by manufacturer trained personnel.

Training, on-site service and repair is to be provided in India.

The equipment is to be covered by a warranty of at least one year from the time of installation that includes parts, labor and travel.

Power 220 volts, 50 Hz with power cords for India.

Automated atomic absorption spectrometer with the following features and specifications:

Double beam spectrometer with integrated visual display, keyboard and software for instrument control and data management

Manually operated turret to hold four hollow cathode lamps prealigned for automated operation

Monochromator, grating system with spectral range 190 to about 900 nm. Resolution settings of 0.2, 0.5 and 1.0 nm or similar slit ranges.

Photomultiplier of double beam, AC system. Selectable to 50mA. UV transmitting windows

Deuterium background corrector synchronously modulated with source emission alternately passed through sample and around sample for corrected measurement

Interlocked gas controls that are manually selected for air or nitrous oxide and acetylene. System contains individual pressure, flow control and metering for fuel and oxidants. Change-over valve for changing from air to nitrous oxide which is interlocked with burner. Interlocks continually monitor burner type, spray chamber bungs, burner shield and liquid trap level. Flame ignitor that operates only on air-based flames with push-button control

Burners for air and nitrous oxide operation that are non-corrosive (titanium). Burner to be adjustable for vertical, horizontal and angular directions. Nebulizer to be non-corrosive and adjustable

Display and software for methods and information retrieval on all elements determined by atomic absorption techniques. Keyboard with keys, and disk drive with 360K bytes storage. Measurements will be made using multiple integration, height or peak areas. Calibration will be stored and displayed in absorbance and concentration.

Printed copy of operational, maintenance and techniques manual must be included.

Tubing, connectors, fittings, tools and spare parts for operation and routine maintenance to be provided

Single hollow cathode tubes for the above atomic absorption system to be provided for the following elements:

- Arsenic
- Cadmium
- Calcium
- Chronium
- Cobalt
- Copper

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- Iron
- Lead
- Magnesium
- Mercury
- Potassium
- Selenium
- Sodium
- Zinc

Regulators adequate to meet above performance specifications with pressure guages for handling compressed air, acetylene and nitrous oxide to be provided

Replacement parts for two years.

QUANTITY: Five (5)

ESTIMATED COST: $32,000.00

SHIPPING WEIGHT: N/A

SOURCE: 1. Perkin-Elmer Corp. (203)762-1000

2. Varian (415)193-4000

BW-2

ITEM: HPTLC

TLC SCANNER II

REQUIREMENTS:

Must have automatic tract scanning in any sequence.

Must have automatic peak location and optimization.

Must have automatic spectra recording.

Must have multi-wavelength scanning.

Must have background subtraction.

Must have an approprite selection of integration and evaluation methods.

Must be able to scan objects up to ±200x200 mm/sec.

Scanning speed must be selectable between 0.1 mm/sec and 20 mm/sec.

Must have automatic zeroing: before each tract or only before the first.

POWER: 220V/50Hz with power cords and connectors for India

QUANTITY: 1

ESTIMATED COST: $23000.00

CATALOG NO: 027.6610

SOURCE: Camag Scientific

ACCESSORIES AND REPLACEMENT PARTS:

Spare Mercury Lamp

Quantity: 3

Estimated cost: $335.00 ea

Catalog no: 027.7640

Source: Camag Scientific

Spare Deuterium Lamp

Quantity: 2

Estimated cost: $751.00 ea

Catalog no: 027.6641

Source: Camag Scientific

Spare Tungsten Lamp

Quantity: 25

Estimated cost: $4.00 ea

Catalog no: 027.6642

Source: Camag Scientific

Owner's Extended Service Kit

Quanity: 1

Estimated cost: $1,580.00

Catalog no: 027.6693

Source: Camag Scientific

TLC Integrator (SP4290, 220V)

Quantity: 1

Estimated cost: $2650.00

Catalog no: 027.6654

Source: Camag Scientific

Printer/plotter paper for SP4290 (cs/10 rolls)

Quantity: 10

Estimated cost: $150.00 ea

Catalog no: 985.0035

Source: Camag

Spare TI-print had for SP4290

Quantity: 1

Estimated cost: $80.00

Catalog no: 935.0065

Source: Camag

NANOMAT II

REQUIREMENTS:

Must quarantee trouble free spotwise application fo quanitative and qualitative samples on HPTLC plates or sheets, precisely positioned without damage to layer.

Must consist of a Pt-Ir tube of calibrated lenth sealed in a glass holder.

Must act as a fixed volume pipette.

Repeatability of sample dosage: better than ±1%

POWER: 220V/50Hz with power cords and connectors for India

QUANTITY: 1

ESTIMATED COST: $719.00

CATALOG NO: 022.4700

SOURCE: Camag Scientific

ACCESSORIES AND REPLACEMENT PARTS:

Capillary Dispenser System

Quantity: 1

Estimated cost: $347.00

Catalog no: 022.4700

Source: Camag Scientific

Dispenser Magazine, 0.5 ul

Quantity: 5 pk of 10

Estimated cost: $200.00/pk

Catalog no: 022.7796

Source: Camag Scientific

Dispenser magazine, 1.0 ul

Quantity: 5 pk of 10

Estimated cost: $200.00/pk of 10

Catalog no: 022.7797

Source: Camag Scientific

Twin trough tank, 10x10 cm, SS lid

Quantity: 2

Estimated cost: $63.00 ea

Catalog no: J22.5155

Source: Camag Scientific

Twin trough tank, 10x10 cm, w/o lid

Quantity: 2

Estimated cost: $51.00 ea

Catalog no: 022.5156

Source: Camag Scientific

Twin trough tank, 20x10 cm, SS lid

Quantity: 2

Estimated cost: $115.00 ea

Catalog no: 022.5254

Source: Camag Scientific

Twin trough tank, 20x10 cm, w/o lid

Quantity: 2

Estimated cost: $95.00 ea

Catalog no: 022.5251

Source: Camag Scientific

Linear developing chamber, 10x10 cm

Quantity: 1

Estimated cost: $446.00 ea

Catalog no: 022.8510

Source: Camag Scientific

Conditiong tray

Quantity: 1

Estimated cost: $57.00 ea

Catalog no: 022.8515

Source: Camag Scientific

Spare glass strips for 022.8510, pk of 24

Quantity: 1 pk of 24

Estimated cost: $26.00

Catalog no: 022.8511

Source: Camag Internationl

VISUALIZATION EQUIPMENT

Chromatogram immersion device

Quantity: 1

Estimated cost: $1309.00 ea

Catalog no: 022.6602

Source: Camag Scientific

Spare dip tank for 022.6602

Quantity: 1

Estimated cost: $89.00 ea

Catalog no: 022.6620

Source: Camag Scientific

Reagent spray, all glass

Quantity: 2

Estimated cost: $59.00 ea

Catalog no: 022.6100

Source: Camag Scientific

UV Cabinet, 220V

Quantity: 1

Estimated cost: $850.00

Catalog no: 022.9064

Source: Camag Scientific

HPTLC PLATES

Merck silica gel 60 plates F254, 10x10, pack of 100

Quantity: 10 boxes of 100

Estimated cost: $275.00/box

Catalog no: 034.5629

Source: Camag Scientific

Merck silica gel 60 plates F254, 20x10 cm, pack of 50

Quantity: 20 boxes of 50

Estimated cost: $215.00/box

Catalog no: 034.5642

Source: Camag Scientific

BW-3

ITEM: High pressure liquid chromatography (HPLC) equipment and accessories

USE: This equipment will be used for analytical sample preparation, separation and quantitation of organic components in fresh and processed fruits and vegetables. Examples of components to be measured are sugars, oligosaccharides, organic acids, phenolic substances, fatty acids, lipids, proteins, peptides, pigments, vitamins and polyamines.

REQUIREMENTS:

1. The system must include on-site installation and start-up of the HPLC by trained representatives employed by the manufacturer, and factory trained service representatives of the manufacturer must be available for on-site service of the equipment in India for the full warranty period.
2. The system must be covered by a full one year warranty on all nonconsumable parts and include travel and labor in India. The warranty must not begin before installation and start-up are completed.
3. A complete training school package must be included at no additional charge that covers HPLC theory, technique and preventative maintenance. The training package should include tuition, travel and accomodations for the participants in India.
4. The HPLC components are to be modular to facilitate addition of various detectors for conductivity, separate use of pumps, column change and maintenance.
5. The HPLC must be capable of providing solvent gradients with a high degree of accuracy and reproducibility.
6. All materials that will be exposed to solvents are to be inert and noncorrosive when in contact with organic and inorganic solvents.
7. Manuals must be provided for each HPLC component that includes instructions on operation, maintenance and repair.
8. Spare parts and repair supplies must be included for operation of each HPLC component for a period of two years.

HPLC COMPONENTS:

1. Solvent Gradient Delivery System consisting of two HPLC pumps and gradient controller or equivalent system.

   Specifications:

   a. Flow rates: 0.01 to 10.0 mL/min in increments of 0.01 mL/min with digital flow rate selector.
   b. Flow rate accuracy: ± 1% of setting with ± 0.1% precision.
   c. Display: LCD pressure indicator to continuously monitor operating pressure with pressure transducer.
   d. Output pressure: 100 to 6000 psi.
   e. Pressure protection: Independent high and low limit adjustment.
   f. Solvent compressibility: Automatic compensation for changes in solvent compressibility to insure accurate flow rates.
   g. Solvent mixing: Mixing of solvents in volumes of 100 microliters or less.
   h. Compositional accuracy: ± 1.5% or better.
   i. Compositional control: Control of solvents from 0-100% for two or more different solvents.
   j. Draw-off valve: Solvent draw-off valve to facilitate rapid solvent change-over and pump priming.
   k. Additional controller capabilities:
      1. Simultaneous flow rate and solvent compositional gradients.
      2. CRT that continuously displays operating parameters and status.
      3. Keyboard with function and numeric keys for operator input with help or explain key for assistance.
      4. Eleven or more preprogrammed linear, concave and convex gradient curves that can be linked to 35 or more different segments of the eleven gradient curves.
      5. Storage for at least ten different gradient tables and ten timed events tables.
      6. Safe memory battery power backup for all stored data.

2. Sample Injector.

   a. Sample injector must be a stand-alone instrument with the capability to load and inject from 1 microliter to 2mL of sample without changing sample loops or interrupting solvent flow.

   b. The sample loop must be continuously swept by mobile phase during the analysis to prevent sample carryover.

   c. Ability to operate at pressures from 100 to 6000 psi without interrrupting solvent flow.

   d. Automatic signal to chart recorder or integrator when injection of sample is completed.

   e. Septumless injection port.

3. Variable Wavelength Detector: UV-visible dual beam absorbance detector with the following specifications.

   a. Wavelength range: 190 to 600 nm.

   b. Bandwidth: 5 nm.

   c. Wavelength accuracy: $\pm$ 2 nm minimum.

   d. Reproducibility: $\pm$ 0.5 nm.

   e. Absorbance ranges: 0.0025 to 2.56 AUFS.

   f. Flow cell: 12 microliters, 10 nm path.

   g. Maximum pressure: 1000 psi.

   h. Time constant: selectable for 0.15, 1 and 4 seconds.

   i. Noise: Less than $\pm 2 \times 10^{-5}$ at 254 nm.

   j. Drift: Less than 1×10^{-3} AU/hour.

   k. Autozero: Pushbutton assembly for automatic zeroing and remotely by contact closure.

   l. Display: LED display and selector switch for monitoring sample absorbance, background absorbance, power supply and lamp energy checks and transmission in the sample and reference cells.

   m. Signal outputs: 10 mV attenuated and 1V unattenuated electrical signal output.

   n. Optical signal: Concave holographic grating.

   o. Source: Deuterium or xenon lamp.

4. Refractive Index Detector

   a. Light source: Infrared light-emitting diode.

b. Temperature control: Selected controls by setpoints between 30 and 50°C with ± 0.1°C precision.

c. Solvent refractive index range: 1 to 1.75 RIU.

d. Noise: Not more than 2×10^{-8} RIU.

e. Measurement range: 5.0×10^{-3} to 5.0×10^{-8} RIU full scale.

f. Drift: Less than 2×10^{-7} RIU/hour.

g. Linear dynamic range: 5×10^{-3} to 5×10^{-9} RIU.

h. Flow rate: 0.03 to 20 mL/min.

i. Flow cell: 8 to 10 microliters, sample and reference chambers

j. Cell pressure: 100 psi maximum with protection pressure relief valve.

k. Autozero: Automatic microprocessor controlled zero operation.

l. Display: LED display of RIU, sensitivity, and time constant.

m. Power cord, recorder cable and integrator cable.

5. <u>HPLC Column Heater</u>

a. Operating range: 10°C above ambient to 99°C.

b. Reproducibility: ± 1°C.

c. Stability: ± 0.5

d. Accuracy: ± 0.5°C.

e. Column capacity: At least two columns 15 or 30 cm long, 1/4 or 3/8 in. diameter.

6. <u>Integrator/Recorder.</u> An integrator/recorder is required that is designed for use with HPLC systems. It must plot and print data, store data from previous analyses, print peak identity and retention time, store at least ten different methods, perform calculations by methods of area percent, internal standard, external standard, and include correction factors. It must be able to automatically subtract baselines, skim peaks on tails, integrate partially resolved peaks and automatically calibrate response factors from analyses of standard samples.

a. Operating temperature: 5 to 40°C.

b. Input voltage: -5mV to 1V.

c. Dynamic range: one microvolt/sec.

d. Linearity: Better than ± 0.1%.

e. Measuring sensitivity (A/H): 1 microvolt sec/count.

f. Retention time storage maximum: 7000 minutes per file.

g. Maximum number of peaks integrated: 800 with 180 identification peaks.

h. Peak recognition speed: 6 peaks/sec.

i. Memory protector: Long-life battery backup.

j. Paper: 150 meters of integrator paper must be included.

k. Spare pens for two years of normal operation.

7. Solvent Clarification System. A system must be provided to filter solvents for removing particles of 0.25 microns or larger. The system must be complete for operation and consist of funnel, holder, clamp, tubing, vacuum pump, reservoir and filters for aqueous and organic solvents. 200 replaceable filters must be provided for organic and aqueous solvents.

8. Sample Clarification System. A system must be provided to filter samples of 10 mL volume for removing particles of 0.5 micron or larger. The system must be complete for operation and consist of holders, syringe and filters for samples in organic and inorganic solvents. 500 replaceable filters must be provided.

9. Analytical and Guard Columns. The following columns composed of stainless steel and the indicated or equivalent packing material with fittings and holders must be provided.

a. Resolve C_{18}, 5 micron, 3.9 mm x 15 cm analytical column. Four are required.

b. uBondapak C_{18}, 10 micron, 3.9 mm x 30 cm analytical column. Six are required.

c. uBondapak Phenyl, 10 micron, 3.9 mm x 30 cm analytical column. Two are required

d. uBondapak NH_2, 10 micron, 3.9 mm x 30 cm analytical column. Four are required.

e. Carbohydrate Size Separation Column, 8 mm x 30 cm, 5,000 to 250,000 M.W. separation. Two are required.

f. Precolumn Filter, 2 micron porosity filter with holder connector and adaptors. Ten replacement filter frits are required.

g. Guard columns with uBondapak C_{18}, uBondapak Phenyl, uBondapak NH_2 and Resolve C_{18} or equivalent packing materials must be provided. Holder, connector and adaptors must be included. Five of each type are required.

10. Syringes - three of each must be provided with each system.
    a. 10 mL Hamilton or equal Gas Tight Syringe with 3 packages of replacement needles.
    b. 25 Microliter Syringe.
    c. 100 Microliter Syringe.
    d. 10 Microliter Syringe.
11. Other Parts - Include the following standard kits:
    a. Tubing cutter.
    b. Tool kit for HPLC general maintenance.
    c. Assortment of compression screws, ferrules and nuts for HPLC fittings and connectors.
    d. Tubing 25 ft of stainless steel and 25 ft of plastic for connnecting HPLC columns, detectors and other components.
    e. Standard replacement and repair parts for solvent delivery system, sample injector, absorbance detector, refractive index detector, column heater and integrator.
12. Power: 220 V/50 Hz with power cords and connectors for India.

QUANTITY: One (1)

COST: $40,000 each

SHIPPING WEIGHT: N/A

SOURCE:

1. Waters, Millipore Intertech, Maple Street, Milford, MA 617-478-2000

BW-4

ITEM: Oxygen calorimeter

USE: To determine the heat of combustion of any solid or liquid biological material.

REQUIREMENTS:

I. A self-contained, water-jacketed oxygen calorimeter with automatic adiabatic controls, electric valves, ignition indicator and automatic temperature return system, consisting of:

1. Jacket
2. Bucket
3. Thermometer supports
4. Ignition circuit automatic temperature control system
5. Double valve oxygen bomb
6. Oxygen filling connection
7. Bomb clamp
8. Bomb cover support stand
9. Matched 24 to 30 C Parr certi
10. Matched thermistor probes (2 each)
11. Thermometer reading lenses (2 each)
12. Overflow hose
13. Fuse wire
14. Sample capsules (6 each)
15. Vial of 10 standard benzoic acid pellets
16. Extra gaskets and rings
17. Instructions

Power: 220 V/50 HZ with power cords and connectors for India.

(Fisher catalog numbers are given for reference)

Parr 1241 or equal. Cat. no. 04-349-2

II. Replacement parts:

1. Oxygen reaction vessel (1 each)
   Catalog no. 04-392-1
2. Calorimeter thermometers (6 each)
   Range: 75 to 86 F (24 to 36 C)
   Subdivision: 0.01 degrees
   Length: 585 mm
   ASTM: 117 C
   Catalog no. 04-362
3. Benzoic acid, primary standard, crystal
   Quantity: 3 cases of 6 x 30 g
   Catalog no: A68-30

QUANTITY: Two (2)

COST: $7,325

WEIGHT: 200 lbs.

SOURCE: Fisher Scientific

BW-5

ITEM: Electronic analytical balance

USE: Weighing of materials

REQUIREMENTS:

Capacity: 160 g/30 g

Taring range: 0 to 160 g/0 to 30 g

Readability: 0.1 g/0.01 mg

Precision: + 0.1 mg/+ 0.02 mg

Linearity: + 0.2 mg/+ 0.03 mg

Stabilization time: ~3 sec/~5 sec

Variable integration: Selectable

Stability indicator: Standard

Pan diameter: 3.5" (8.9 cm)

Weighing chamber (LxWxH): 6x7.25x10.2"
(15.2x18.4x25.9)

Pan clearance: 10" (25.4 cm)

Housing dimensions (LxWxH): 17.5x7.5x13.3"
(44.4x19x33.8 cm)

Shipping weight: 25 lb (11.4 kg)

Operating temperature range: 10 to 40 C
50 to 104 F

Electrical requirements: 220 Volts/50 Hz with power cords and connectors for India

ESTIMATED COST: $3,595.00

SOURCE: Ohaus - Fisher Scientifice (p 52)

QUANTITY: Four (4)

BW-6

ITEM: Electronic top loading balance

USE: Weighing of materials

REQUIREMENTS:

Capacity: 0 to 4000 g

Taring range: 0 to 4000 g

Readability: 0.1 gm

Reproducibility: ± 0.05 gm

Linearity: ± 0.1 gm

Stabilization time: ~ 2 sec

Weighing pan: 6.65" dia (16.9 cm)

Electrical requirements: 220 V/50 Hz (must come with power cord and plug)

SHIPPING WEIGHT: 12 lb

ESTIMATED COST: $1,495.00

SOURCE: Ohaus - Fisher Scientific (p 41)

BW-7

ITEM: Incubator, CO_2

REQUIREMENTS:

Multiplex gas control system must provide the following:

Control capacity: CO2 and O2; or CO2 alone.

Control sensors: gas percentages must be time multiplexed.

Control setpoints: direct digital set to 0.1% resolution for each gas in normal operating ranges. Setpoint range from 0 to 99.5% for each gas.

Control accuracy: proportional mixing to within 0.1% for each gas.

Flow rate: adjustable from 0 to 2 liters per minute.

Atmosphere exchange: must have continuous fresh exchange at desired flow rate to maintain optimum environment.

Gas recovery: automatic.

Air supply: built-in instrument grade air pump with pre-filter.

Gas filters: disposable, autoclavable, for each gas.

Temperature control system must provide the following:

Temperatue range: 3 C above ambient to +60 C.

Temperatue Control: ±0.2 C

Safety alarm systems: monitors interior chamber temperature. Must include automatic independent adjustable overtemp safety limit control adjustable to within 0.1 C of setpoint. Activates audible and visual warning.

Temperature display: LED digital thermometer, resolution to within 0.1 C. Independent probe mounted in chamber.

Humidificaton: to 98% at +37 C operating temperature.

Construction:

Must be stainless steel interior and exterior.

Must have triple wall construction which provides additional insulation around water-jacket to protect

against ambient temperature fluctuations.

Inner door must be tempered glass, to seal against radiant heat to glass to minimize condensaton. Door heater must be adjustable from main control panel. Outer door gasket seals against cabint.

Leveling feet must have adjustable, non-skid design. Must allow for installation on 24" front-to-back laboratory bench.

Shelves:

Must have stainless steel, perforated, precision milled flat shelves with adjustable shelf brackets to prevent tipping. Shelves, brackets, and supports must be removable without tools for cleaning and chamber decontamination.

Must have capacity for up to 18 shelves per chamber. Four shelves should be supplied. Total useable shelf space must be 47.5 sq. ft.

Shelf dimension must be 19.5" (50 cm) sq.

Chamber dimension:

Working interior: 20" (50.6 cm) wide x 20" (50.8 cm) front-to back x 22.5" (57.1 cm) high. Net working volume should be 5.1 cu. ft. (144 liters).

Overall interior: 21 (53.3 cm) x 20" (50.8 cm) front-to-back x 24" (61 cm) high. Overall interior volume should be 5.83 cu. ft. (165 liters).

Exterior dimension:

Exterior base: 20.5" (52 cm) front-to-back x 22" (52 cm) wide.

Exteriro dimension: 24-11/16" (62.7 cm) wide x 25-3/8" (64.5 cm) front-to-back including outer doors x 70-1/2" (179 cm) high including 1" (2.5 cm) allowance for adjustable leveling feet.

Gas connectons: 3/16" (4.76 MM) tubing connections.

Gas input pressure: 8 to 20 PSIG (.56 to 1.5 kg/cm sq) input pressures required. Two stage gas regulators from CO_2 or other cylinders required.

Water jacket fill and drain: ports located on front of chamber.

Net weight filled: 476 lbs (215 kg)

Electricl requirements: 220V/50Hz

Model no: 2721

Estimated cost:

Shipping weight: 596 lbs.

Source:

ACCESSORIES:

Shelves:

Quantity: 15

Catalog no: SHE-1107

Source:

CO_2 Regulator:

Quantity: 1

Catalog no: REG-1003

O_2 Regulator:

Quantity: 1

Catalog no: REG-1005

Replacement filter:

Quantity: pk of 6

Catalog no: QIA-1005

COST: $ 6,000 ea

SHIPPING WEIGHT: 600 lb.

SOURCE:

Fisher Scientific	800-527-5920
Labconco Corporation	816-333-8811
American Scientific Products	800-527-6230

QUANTITY: Three (3)

BW-8

ITEM: Spectrophotometer UV-VIS

REQUIREMENTS:

Type: Split-beam

Wavelength range: 190 to 950 nm

Readout: Digital, installed printer

Photometric presentation: 0 to 2000% T, -9999 to +9999 conc., 0 to +3.000 A

Slitwidth: 2 nm

Wavelength accuracy: ± 0.005A at 1A

Photometric linearity: ± 0.25%

Photometric accuracy: ± 0.005A at 1A

Stray light: <0.05T @ 220 nm

Source lamp: Deuterium, quartz, halogen

Detector type: Silicon, photomultiplier

Power: 220V/50 Hz with power cords and connectors for India

Must include: 20 column thermal printer and battery backup/expanded memory board, serial interface, wavelength scanning software, disk operating system, color graphics, color monitor, asynchronous communication adapter, proprinter, parallel adapter, parallel printer cable and null modem cable.

Must be 220-240V/50Hz with power cords and connectors for use in India.

ESTIMATED COST: $13,678.50

CATALOG NO: 07-703-27

SOURCE: Fisher Scientific, p 992, 993

QUANTITY: Three (3)

REPLACEMENT PARTS:

Cuvets (polystyrene)

Optical characteristics: 340 nm

Variance: + 3% T

Dimensions: 10 mm square, 44 mm high

Quantity: 4 cases of 500

Estimated cost: $51.30/case

Catalog no: 14-386-20
Source: Fisher Scientific

BW-9

ITEM: Dissecting Microscope 7X-30X
Phase 10X, 20X, 40X, 100X

REQUIREMENTS:

DIN optics for higher resolution and flatter fields

Phase-equipped for low contrast subjects

Bright-field capabilities.

Must have one 4X bright field scanning objective and 10X, 20S, and 40X (retractable) phase objectives.

Eye pieces: 2 eyepieces DIN standard 10X wide field with removable pointer in one eyepiece.

Head: Trinocular head (360 rotable, 45 inclined), interchangeable with monocular tube. Must include centering telescope.

Nosepiece: Quadruple nosepiece rotated by easy to use knurled ring.

Stage: Research-quality graduated mechancial stage. 130X135 mm stage with spring loaded stage clip

Focus control: Low position, coaxial coarse and fine focus controls engraved in micron gradation.

Condenser: Phase contrast turret condenser.

Light source: Low voltage, high-output 6V, 20W halogen lamp with solid state continuously variable light intensity control.

ESTIMATED COST: $1895.00

CATALOG NO: S19555-3FAZ

SOURCE: Fisher Scientific, p 633
QUANTITY: One (1)
REPLACEMENT PARTS:

Fluorescent illuminator with power supply

Must be 220V/50Hz with power cords and connectors for use in India.

Estimated cost: $245.00

Catalog no. S19700-F1

Illuminator Lamp

6V 20W halogen lamp

Estimated cost: $9.95 each

Catalog no: S19534A

ACCESSORIES:

Camera

35 mm chinon SLR

Must be fully automatic

Estimated cost: $344.00

Catalog no: 04-442

Source: Fisher Scientific

Lens

50 mm F/1.9 standard

Settings: F/1.9 to F/22

Focus: up to 18"

Estimated cost: $76.00

Catalog no: 04-42-1

Source: Fisher Scientific

Adapter T-mount

Adapts microscope for use with 35 mm camera

Estimaed cost: $15.00

Catalog no: S19530-13

Source: Fisher Scientific

T-Ring

Pentax K am M Chinon

Estimated cost: $8.00

Catalog no: S19530-18

Source: Fisher Scientific

Eyepiece

Wide field, compensated for planachromatic objectives

Power: BWK 10X

Estimated cost: $59.00

Catalog no: S1955-10CE

Source: Fisher Scientific

BW-10

ITEM: Benchtop Refrigerated Centrifuge

REQUIREMENTS:

Capacity: 4 x 750 Ml

Maximum tube size: 98 x 135 MM

Maximum speed: 5800 rpm

Maximum force: 5060 x G

Speed control: Digital

Timer: Range of 1-59 with 1 min. resolution

Refrigerator system: 0 to 39C in 1 min resolution

Rotors: Angle, horizontal

Dimensions: 23W x 30D x 17.25H

Power: 220V/50 Hz with power cords and connectors for India

Catalog No. 05-112-93

QUANTITY: Two (2)

COST: $5,980.00

SHIPPING WEIGHT: 229 lbs

SOURCE: Fisher Scientific

Accessories:

Swinging bucket rotors - Catalog No.05-103C

Quantity: 1

Estimated cost $1,380.00

Swinging bucket adaptor - Catalog No.05-112-68

Tube capacity: 40-52 ml

Places per adaptor: 7

Quantity: 4

Estimated Cost 2/$91.80

Swinging bucket adaptor - Catalog No.05-112-64

Tube capacity: 10 to 19 ml

Places per adaptor: 19

Estimated cost: 2/$102.10

Quantity: 4

High speed polycarbonate tubes

Capacity: 15 ml

OD x L: 16 x 116 mm

Quantity: 5 cases of 100

Estimated cost: $116.00/case of 100

Catalog No.05-528-E

High speed polycarbonate tubes

Capacity: 50 ml

OD x L: 28.5 x 103 mm

Quantity: 5 cases of 100

Estimated cost: $131.00/case of 100

Catalog No. 05-528

Source: Fisher Scientific

BW-11

ITEM: Freeze Dryer

REQUIREMENTS:

Floor model, stainless steel with drying chamber, 13" diameter with 18 ports with shell dryer

6 liter condensate capacity

0.5 hp refrigeration unit

Direct drive, gas ballasted 190 liter/minute vacuum pump

Operating temperature -40°C to +65°C

Temperature control ± 0.5°C

Corrosion resistant cabinet with removable side panels, on 2 in. swivel casters

Spare parts for two years normal operation

Instruments: Panel mounted temperature indicator -85°C to +25°C; vacuum guage 1 to 5000 microns

Power: 220 V/50 Hz with power cords and connectors for India

QUANTITY: Two (2)

COST: $10,000.00

SHIPPING WEIGHT: 500 lbs.

SOURCE: Labconco (914)255-5000

Drying Chamber: The chamber must be manufactured for mounting to the freeze dryer and include all tubing and connectors necessary for installation. The tray dryer must consist of a 1/4 hp refrigeration system built into the cabinet for cooling to -40°C, built-in heater to provide input to 43°C, temperature controller, and monitors for temperature, vacuum release valve and clear viewing top. The chamber must have capacity for freeze drying at least four liters of water per day.

Vacuum Pump: The vacuum pump must be at least 0.75 hp with direct drive, capable of 10^{-4} torr vacuum, free air displacement of at least 150 liters/min and 600 rpm. It must have built-in oil pump, permit continuous operation at high pressure and allow control of vented exhaust and air. An exhaust filter-smoke eliminator or an equivalent system to prevent exhaust fumes and smoke must be included. Vacuum tubing, clamps, adaptors and four liters of vacuum oil must be provided for installation and operation with the freeze dryer. Adaptors must be included to allow remote viewing of pump oil level from the front of the freeze dryer cabinet.

Recommended spare parts and maintenance supplies for at least two years of operation to be provided with each component.

BW-12

ITEM: Rotary shaker

REQUIREMENTS:

Must include memory function that preserves last set point and restarts shaker if power fails.

Must be operated by microprocessor - controlled magnetic drive system.

Must have visual and audible malfunction indicators.

Shaking frequency: 40 to 400 rpm

Shaking orbit: 1" dia (25 mm)

Overall Dimensions: 20.5" L x 19" W x 4"

Shipping weight: 88 lb (40 kg)

Electrical requirements: 220V/50Hz with power cords and connectors for India

CATALOG NO: 14-257

ESTIMATED COST: $[illegible]429.00

SOURCE: Fisher Scientific (p 974)

ACCESSORIES:

Universal tray (1)

Size E 16.5x16.5" (42x42 cm)

Cat. no. 14-257-1A

Estimated cost: $326.00

Universal tray (1)

Size F 31.5x16.5" (80x42 cm)

Cat. no. 14-257-1C

Estimated cost: $605.00

Erlenmeyer flask clamps

Flask size - 250 ml (15)

Cat. no. 14-257-1G

Estimated cost: $18.00 each

Flask size - 500 ml (15)

Cat. no. 14-257-1J

Estimated cost: $23.00 each

Tilting test tube rack (1)

For test tube diameter: 4/5" (20 mm)

Cat. no. 14-257-1T

Estimated cost: $282.00

BW-13

ITEM: Polygraph

REQUIREMENTS:

Two operating axes, x (beam movement) and y (pen movement)

Input ranges: 8

Timebase ranges: 12

Number of channels: single

Accuracy for both axes: ±0.1% full scale for 1 to 50 mV/in and ±0.2 full scale for 100 to 5000 mV/in.

Accuracy for x axis time base: ±0.5% full scale for 1 to 50 sec/in and ±1.0% full scale for 100 to 200 sec/in.

Response: 1/3 sec full scale both axis

Must have electrostatic platen to accomodate 100' rolls of paper

Must include:

electric pen lift
snap in pen installation
automatic pen up and return to zero at end of timebase sweep
one-100' roll of chart paper
two red and two black pens
two 10-pin conectors
two fuses, 1A and .5A

POWER: 220V/50Hz with power connections for use in India

ESTIMATED COST: $2295.00
QUANTITY: One (1)
CATALOG NO: 13-940-785

SOURCE: Fisher Scientific

REPLACEMENT PARTS:

Fuses: 1A

Quantity: 12

Fuses: 0.5A

Quantity: 12

Recorder pens

Quantity: 12 red/12 black

Estimated cost: 4/12.50

Catalog no: 13-940-811

Chart paper

Quantity: 100x100 ft (30 m) roll

Source: Fisher Scientific

BW-14

ITEM: Automatic Kjeldahl Analyzer

REQUIREMENTS:

Alkali pump

Steam generator

Condenser

Titration vessel

Feed water tank

Adapters

Pair of electrodes

POWER: 220V/50Hz with power cords and connectors for India.

SHIPPING WT: 86 lb (39 kg)

ESTIMATED COST: $12,995.00

CATALOG NO: TC-1030-002

SOURCE: Fisher Scientific

ITEM: Digestion System for Automatic Kjeldahl

REQUIREMENTS:

20 positon block

20 tube carrying tray

Heat shields

Thermometer

20 straight 250 ml digestive tubes

POWER: 220V/50Hz with power cords and connectors for India.

SHIPPING WT: 55 lb (25 kg)

ESTIMATED COST: $3495.00

CATALOG NO: TC-1015-011

SOURCE: Fisher Scientific

ITEM: Manifold Exhaust System for Automatic Kjeldahl Analyzer

REQUIREMENTS:

Exhaust Manifold

Tubing

Water Suction pump

Stand

Drip pan

POWER: 220V/50Hz with power cords and connectors for India.

ESTIMATED COST: $1215.00

CATALOG NO: TC-1005-034

SOURCE: Fisher Scientific

ITEM: Printer for Automatic Kjeldahl Analyzer

REQUIREMENTS:

Complete with connecting cable

3 rolls of blue paper

POWER: 220V/50Hz with power cords and connectors for India.

ESTIMATED COST: $1100.00

CATALOG NO: TC-1030-016

SOURCE: Fisher Scientific

REPLACEMENT PARTS:

Digestive tubes

Volume: 250 ml

Quantity: 10 pk of 20

Estimated cost: $210.00 pk of 20

Catalog no: TC-1000-0158

Source: Fisher Scientific

Printer paper

Quantity: 20 rolls

Estimated cost: $14.00/roll

Catalog no: TC-1566-0015

Source: Fisher Scientific

Electrodes

Quantity: 4

Estimated cost: $70.00/pk of 2

Catalog no: TC-1000-0676

Source: Fisher Scientific

Tube stands

Must be stainless steel

Must hold 20 tubes

Quantity: 4

Estimated cost: $206.00 ea

Catalog no: TC-1000-0082

Source: Fisher Scientific

Kjeltab MT catalyst

Formulated to contain 3.5g K_2SO_4-0.4g $CuSO_4$

Quantity: 10 pk of 1000

Estimated cost: $63.00/1000

Catalog no: 13-159D

Source: Fisher Scientifc

QUANTITY: Two (2)

BW-15

ITEM: Semi-Automated Crude Fiber Extaction Unit

REQUIREMENTS:

Hot extraction unit consisting of:

- Hot extractor
- Reflector
- Two reagent bottler with holders
- Rinsing bottles with holders
- Vacuum trap
- Spray bottles
- Special valve tool
- Tubing
- Drain trough
- Spare parts kit
- Antifoaming agent
- Allen key

Cold extraction unit consisting of:

- Cold extractor
- Spray bottle
- Tubing
- T-tubes
- Spare parts kit

Sample size: 0.5 to 3 g

Measuring range: 0.1 to 100%

Capacity per batch: 6

Reproducibility: Better than ±1% relative at 1 to 30% fiber

Accuracy: 0.1% relative

Preheating time: 10 to 12 min

Power: 220V/50Hz with power cords and connectors for India

SHIPPING WT:

Hot extraction unit: 178.5 lb (81 kg)

Cold extraction unit: 31 lb (18 kg)

ESTIMATED COST: $17,950.00

CATALOG NO: TC-1010-001

QUANTITY: One (1)

SOURCE: Fisher Scientific

BASIC ACCESSORIES:

Stand for 6 crucibles

Quantity: 3

Catalog no: 1000-1079

Holder for 6 crucibles

Quantity: 1

Catalog no: 1000-1080

Crucibles, porosity P2 (40-90 microns)

Quantity: 10 sets of 6

Estimated cost: $151.00/pk of 6

Catalog no: 1000-1172

Source: Fisher Scientific

REPLACEMENT PARTS

Boiling column with water condenser

Quantity: 1

Catalog no: 1000-1003

Crucible seal

Quantity: 18

Catalog no: 1000-1005

Sealing ring for crucibles (hot extraction unit)

Quantity: 12

Catalog no: 1000-1006

Sealing ring for crucibles (cold extraction unit)

Quantity: 6

Catalog no: 1000-1567

Boiling element

Quantity: 4

Catalog no: 1000-1097

Filter mesh

Quantity: 12

Catalog no: 1000-1157

Sealings for water nozzle

Quantity: 1 set

Catalog no: 1000-1193

Sealing kit for 6 valves (set of 72)

Cylinder seal for boiling column

Quantity: 12

Catalog no: 1000-1307

Indication lamp

Quantity: 6

Catalog no: 1565-0004

Fuse 2A

Quantity: 10

Catalog no: 1564-0013

Fuse 8A

Quantity: 10

Catalog no: 1564-0033

Fuse 15A

Quantity: 10

Catalog no: 1564-0028

Membrane for air pressure pump

Quantity: 1

Catalog no: 1577-0014

Membrane for vacuum pump

Quantity: 2

Catalog no: 1577-0018

Plastic strap

Quantity: 50

Catalog no: 1569-0010

Tubing 6/12 mm

Quantity: 4 m

Catalog no: 1582-0023

Tubing · 2/4 mm (for CEU)

Quantity: 4 m

Catalog no: 1582-0027

BW-17

ITEM: Laminar Flow Hood

REQUIREMENTS:

Must isolate virtually all vibration from filter/blower console to the work surface

Class 100 environment must utilize HEPA filtration (99.99% efficient to 0.3 ul)

Must have solid stae speed control for adjusting air flow velocity from 40 to 110 PPM

Must have welded metal cabinet with corrosion resistant polyurethane enamel finish

Must have perforated aluminum diffuser screen

Must have non-glare plastic laminated work surface

Must have fluorescent light fixture providing 150 foot candle at work surface

Must have 1/2 hp motor

Must operate at 3000 BTU/hr

Overall dimensions: 75"W x 65"H x 44"D
Work area: 73"W x 30"H x 24"D

Must supply replaceable parts for 2 years

POWER: 220V/50Hz with power connections for use in India

SHIPPING WT: 800 lb

ESTIMATED COST: $4296.00

CATALOG NO: L5316-6 Mfr. no: 10554

SOURCE: Scientific Products

QUANTITY: One (1)

BW-19

ITEM: Infrared Analyzer

REQUIREMENTS:

Scanning Spectrophotometer

Must be able to measure: protein, acid detergent fiber, fat, dry matter, potassium, calcium, magnesium, phosphorus, sulfur, heat damaged protein, and other parameters of feed material.

Scanning size: 2 grams

Sample illumination area: 3.5 C^2 (on center rotation)

Scan time: 2 sec

Scans per reading: 64 averaged

Typical analysis time: 70 sec

Wavelength range: 220nm-2500nm (first order)

Wavelength precision: 0.015nm S.D. of repeat scans

Wavelength accuracy: $\pm$.5 nm

Spectrum bandwidth: 10nm $\pm$ 1 nm

Power: Must have 220V/50Hz with power connections for use in India.

Shipping wt: 80 lb

Model: 6250 System

Source: Pacific Scientific

Computer

Must act as instrument controller

Accumulate spectra

Transform spectra to select optimized measurement wave length

Perform regression analysis necessary for development of calculation equations

Stores calibration equations and displays information

to the operator on command

Must contain:

256 KB RAM
10 MB hard disk
360 KB floppy disk drive
8087 Co-processor
Graphics card with parallel port
Serial port
Monochrome port
DOS 3.0 or 2.1

Power: Must have 220V/50Hz with power connections for use in India

Shipping wt: 55 lb

Model: 6250 System

Source: Pacific Scientific

ACCESSORIES:

Cyclone sample mill/grain top

Catalog no: 03-2706

Estimated cost: $1850.00

Power: 220V/50Hz

Forage top for cyclone mill

Catalog no: 560-200-0367

Estimated cost: $195.00

High fat adapter for Udy mill

Catalog no: NR4265

Estimated cost: $500.00

Forage/grain cup kit consisting of:

sample rack
20 sample holders
200 disposable sample holder backs
back removal tool/scapula and sample packing tray

Catalog no: 690-200-0002

Estimated cost: $800.00

Forage/grain sample holder with sealed in (airtight) quartz window plus sealable back kit

Catalog no: 690-200-0003

Estimated cost: $90.00

Forage/grain sample holder with bonded-in quartz window

Catalog no: 090-200-0001

Estimated cost: $32.00

Sample packing tray

Catalog no: NR-4283

Estimated cost: $50.00

Sample brush

Catalog no: 40-0028

Estimated cost: $3.00

Forage/grain sample holder rack

Catalog no: 690-200-004

Estimated cost: 73.00

Forage/grain sample holder quartz window

Catalog no: 690-200-005

Estimated cost: $17.00

Forage/grain sample drawer insert

Catalog no: 690-200-0011

Estimated cost: 120.00

Forage/grain disposable sample holder backs (bag of 100)

Catalog no: 690-200-0007

Estimated cost: $9.50

Forage/grain back extraction tool/scoopula

Catalog no: 690-200-0003

Estimated cost: $27.00

Forage/grain sealed reference sample holder with hay

Catalog no: 690-200-0009

Estimated cost: $125.00

REPLACEMENT PARTS:

Lamp for scanner

Quantity: 2

Catalog no: 23-0084

Estimated cost: $100.00 ea

Sample brushes

Quantity: 12

Catalog no: 40-0028

Estimated cost: $3.00 ea

BW-20

ITEM: Culture Laboratory Fermenter

REQUIREMENTS:

Top driven magnetically-coupled with permanent magnet DC motor

Three 6-bladed turbine type impellers

Feedback control for stable speed over wide range of viscosities

Range: 50 to 1250 rpm

Temperature control:

- Proportional solid state electronic control with RTD sensing probe and recirculation system
- Range of 5°C above water supply to 60°C
- Accuracy: ± 0.2°C throughout operating range
- Panel mounted 4 digit LED display

Aeration:

- Inlet air sparger delivery
- Range of 1-20 liters per minute, panel-mounted variable area flow meter
- Autoclavable hydrophobic 0.2 micron filters

Vessel specifications:

- Total volume capacity - 7.5 liters
- Working volume - 1.5-5.0 liters
- Flask diameter: 6"
- Flask height: 18"
- Borosilicate glass

Stainless steel headplate with 19 penetrations and "O" ring seal

Five liquid addition and sampling tube assemblies

Removable baffle assembly

Innoculation port with septum

Inlet air filter

Exhaust air outlet and filter

Heat exchanger with quick disconnect fittings

Panel mounted temperature recorder

Power: 220 V/50 Hz with power cords and connectors for India

QUANTITY: One (1)

ESTIMATED COST: $8,000.00

SHIPPING WEIGHT: 90 lbs.

SOURCE: Virtis

SPARE PARTS AND ACCESSORIES:

1 7.5 liter culture vessel (borosilicate gloss)

10 Bacterial air filters (0.3 microns)

5 Innoculation septums

40 Stainless steel port plugs

Siligon rubber Tubing

3/10" ID x 3/8" OD - 50 ft.

1/8" ID x 1/4" OD - 50 ft.

1 Digital pH control module (1)

Estimated Cost: $3,000.00

BW-21

ITEM: Anaerobic Chamber

REQUIREMENTS:

Unheated

Positive pressure atmosphere maintainable below 5 ppm

Chamber size: 84 x 32 x 40"H

Flexible vinyl chamber (20 mil pressed polished) with 10 mil frosty vinyl bottom extending 2" on all sides

1 12" entry lock

2 unheated catalyst boxes (six trays)

1 gas regulator set up

Atmosphere control system (electronic)

Vacuum pump

Vacuum/pressure guage

Power: 220 V/50 Hz with power cords and connectors for India

QUANTITY: One (1)

ESTIMATED COST: $6,000.00

SHIPPING WEIGHT: 500 lbs.

SOURCE: COY Laboratory Products, Inc.

OPTIONS:

1 Forced air incubator with sliding glass doors, solid state proportional temperature control (± 0.1°) with digital readout. Temperature range from 30 to 45°C. Size: 69.9cm (L) x 91.4cm (W) x 29.2cm (D)

Estimated Cost: $1,200.00

1 Aluminium shelf assembly for chamber

1 Incandescent flooring device

Estimated Cost: $250.00

ANNEXE C

Schedule and Location for Training Program for 1988

TRAINING PROGRAM FOR 1988

Name	Starting Date	Institution	Field of Training	Suggested Institution/ Scientist
Dr. P.M. PUNTAMBEKAR a/	April 1	Bombay Vet. Coll.	Processing and feeding of slaughter house wastes	Washington State Univ., Pullman (Dr. J.R. Males)
Dr. A.N. MULBAGAL a/	July 15	Bombay Vet. Coll.	Microbio. (pathogenic) aspects of feeding slaughter wastes	Auburn Univ., Auburn, AL (Dr. Thomas A. McCaskey)
Dr. K.R. YADAV	Sept. 1	Haryana Agr. Univ.	Processing and feeding large animal wastes	Purdue Univ., Lafayette, IN (Dr. Allan Sutton)
Dr. K. SINGH a/	April 1	Haryana Agr. Univ.	Ensiling cattle wastes	VPI & SU, Blacksburg (Dr. J.P. Fontenot)
Dr. D.C. SANGWAN	May 1	Haryana Agr. Univ.	Growing pure cultures of micro-organisms	Univ. of Ill., Urbana (Dr. Bryan White)
Dr. E. SIVARAMAN	July 15	Kerala Agr. Univ.	Processing of seafood wastes	VPI & SU, Blacksburg (Dr. J.P. Fontenot)
Dr. (Mrs.) A.D. MERCY	July 15	Kerala Agr. Univ.	Feeding of seafood wastes	VPI & SU, Blacksburg (Dr. J.P. Fontenot)
Dr. P.C. JAMES	July 15	Kerala Agr. Univ.	Microbiological/pathogenic aspects of fish wastes	Auburn Univ., Auburn, AL (Dr. Thomas A. McCaskey)
DR. T.V. VISWANATHAN	July 15	Kerala Agr. Univ.	Transfer of tech. concerning feeding seafood wastes	VPI & SU, Blacksburg, (Dr. John Gerken)
Dr. K.S. SANDHU	Sept. 1	Punjab Agr. Univ.	Microbiological/pathological aspects of poultry wastes	Auburn Univ., Auburn, AL (Dr. Thomas A. McCaskey)
Dr. V.K. GUPTA b/	May 1	Punjab Agr. Univ.	Growing pure cultures of micro-organisms	Univ. of Ill., Urbana (Dr. Bryan White)
Dr. P.M. LANGAR	July 15	Punjab Agr. Univ.	Processing of poultry wastes	VPI & SU, Blacksburg (Dr. J.P. Fontenot)

a/ Subject to nomination by institution
b/ Subject to acceptance by Dr. Bryan White