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CONSULTANCY REPORT

INDO-US SUB-PROJECT

ON

CONVERSION OF BIODEGRADABLE ANIMAL WASTES FOR LIVESTOCK FEED

PROJECT No. 386-0000-C-00-5039-00

SUBMITTED BY

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TABLE OF CONTENTS

		Page No.
I.	SUMMARY	
	A. Technical Accomplishments	i
	B. Recommendations	ii
II.	INTRODUCTION	iii
III.	TECHNICAL SUMMARY OF SUBPROJECT : CONVERSION OF BIODEGRADABLE ANIMAL WASTES FOR LIVESTOCK FEED	
	A. Characteristics of the Biodegradable Animal Wastes	2
	1. Physical Characteristics	2
	2. Chemical Characteristics	3
	B. Processing of Biodegradable Animal Wastes	5
	1. Ensiling	6
	2. Urea Treatment	8
	3. Deep Stacking	10
	4. Solid State Fermentation	10
	C. Nutritive Value of Processed Animal Waste Products	11
	1. Slaughter House Waste Products	11
	2. Prawn Waste	12
	3. Large Animal Waste	12
	4. Poultry Litter	13
	5. Fungal Fermented Poultry Droppings	14
	D. Safety of Feeding Processed Animal Wastes	14
	1. Animal Health	14
	2. Pathogen Destruction	15
	3. Residues	16
	E. Application and Technology Transfer	16
	1. Recommended Uses	17
	2. Technology Transfer	18
	F. Publication of Research Results	19
	G. Recommended Follow-up	19
Literature Cited		21
TABLES :	1 and 2	
	3 and 4	
	5 and 6	
	7 and 8	
	9 and 10	
	11 and 12	

I. SUMMARY

As indicated in the Technical Summary, real accomplishments were achieved in the conversion of the wastes to animal feed. Processing of the wastes was an important part of the research due to the perishability of most of the wastes. Efforts were devoted to evaluating the nutritional value and safety aspects of the processed wastes and waste products.

A. Technical Accomplishments

The major technical accomplishments of the work in the Subproject were :

1. Development of effective methods of processing to destroy pathogens, stabilize the wastes, and enhance the palatability and nutritional value of the wastes. The methods require minimum inputs of fossil fuel and machinery, and can be used by Indian farmers.

2. Assessment of the nutritional value of the processed waste products.

3. Assessment of the safety aspects of feeding the waste products. Admittedly, the effort in this area was not extensive, but essentially no problems were encountered.

The research results are very promising and some farmers and industries are adopting some of the technologies which were developed.

B. Recommendations

1. The research has academic and applied value, and should be published in peer research journals.

2. Certain aspects should be addressed as follow-on activities to exploit the accomplishments of the past 5 years in the Subproject. The main areas which should be addressed are :

   a. Applied feeding experiments should be conducted with animals at different levels of production fed the waste products as part of the ration, followed by economic evaluation of feeding the waste products.

   b. Follow-up safety studies should be conducted, especially concerning toxic chemicals in the wastes and animal products from animals fed the waste products.

   c. Sound technology transfer programs should be developed for each of the wastes.

II. INTRODUCTION

The purpose of the assignment was to review the individual centers' reports and help in concluding the research work conducted at all CBAW Centers; participate in the discussions of the conclusions from all CBAW Centers in a final Workshop; and help in documentation of the research results presented at the CBAW Workshop. The consultant arrived in New Delhi on March 12, 1992.

The Workshop was held at the main headquarters of the Indian Council of Agricultural Research (ICAR) at Krishi Bhawan, New Delhi, March 23, 1992. Scientists from ICAR and participating Centers participated in the Workshop.

The main portion of the report is a Technical Summary of the progress of the subproject during the past 5 years. The information concerning the Subproject was summarized from the final reports submitted by the Centers. The report includes also a Summary and an Introduction.

III. TECHNICAL SUMMARY OF SUBPROJECT :

CONVERSION OF BIODEGRADABLE ANIMAL WASTES FOR LIVESTOCK FEED

Indian scientists working on the CBAW subproject studied different methods of processing biodegradable animal wastes for use as animal feed. At all locations emphasis was placed on development of low cost methods of processing which require minimum amounts of fossil fuel and equipment. The wastes were processed alone or combined with other ingredients. Scientists addressed the nutritional value and safety aspects of the processed waste products. Limited effort was devoted to technology transfer.

The centers concentrated efforts on the areas assigned upon implementation of the subproject. The areas of emphasis by the centers were as follows :

Indian Council of Agricultural Research (ICAR) Coordinating Unit.

Toxicological Studies - Central Toxicological Laboratory (CTL), Haryana Agricultural University, Hisar.

Slaughter House Wastes - Bombay Veterinary College (BVC), Bombay.

Large Animal (Cattle and Buffalo) Waste - Haryana Agricultural University (HAU), Hisar.

Aquatic Animal Wastes - Kerala Agricultural University (KAU), Trichur.

Poultry Wastes - Punjab Agricultural University (PAU), Ludhiana.

Reports of accomplishments by the Centers working on the different biodegradable animal wastes were prepared by the scientists responsible for the work at the respective Centers. These reports are on file at ICAR. The Technical Summary will briefly cover the work on all biodegradable animal wastes, organized as follows :

A. Characteristics of the Biodegradable Animal Wastes

B. Processing of Biodegradable Animal Wastes

C. Nutritive Value of Processed Animal Waste Products

D. Safety of Feeding Processed Animal Wastes

E. Application and Technology Transfer

F. Publication of Research Results

G. Recommended Follow-up.

A. Characteristics of the Biodegradable Animal Wastes

Physical and chemical characteristics of the wastes will be covered.

1. Physical Characteristics

Most of the wastes are high in moisture, hence, are quite perishable. Poultry litter from well-managed houses is not very high in moisture. With good management minimum processing is required to stabilize the litter. Aquatic wastes and blood are high in moisture, and are very perishable. Some of the aquatic wastes putrify within hours. The high levels of trimethylamine oxide, which may

be converted to trimethylamine, contribute to the spoiling problem. Cattle and caged poultry wastes are high in moisture, hence, must be processed frequently to prevent spoilage and loss of nutrients. Rumen contents are high in moisture, but do not spoil rapidly, due to the low pH of the material.

2. Chemical Characteristics

There is considerable variation in chemical composition of the biodegradable animal wastes (Tables 1 and 2). For example, crude protein varies from 8.4% for cattle rumen contents to 87.3% for blood, DM basis.

a. Slaughter House Wastes

Rumen contents and blood were used in the research at BVC.

1) Rumen Contents

Dry matter was lower in rumen contents than for any of the other wastes. The DM was similar for rumen contents from cattle, sheep and goats (average of 11.6%). The value for cattle rumen contents (11.8%) is slightly lower than the value of 13.3% reported by El-Yassin et al. (1991) and considerably lower than the value of 18.4% reported by Rao and Fontenot (1987). Crude protein and crude fiber concentrations were lower and ash and NFE were higher for rumen contents from cattle than from sheep and goats. Crude protein

values were lower than values of 18.4% and 14.4% DM basis, for cattle rumen contents, reported by Rao and Fontenot (1987) and El-Yassin et al. (1991), respectively, probably reflecting differences in the rations fed to animals prior to slaughter.

2) Blood

The CP of blood used at BVC was 87.3%, DM basis, similar to the values of 90.2% and 88.9%, DM basis, reported by Rao and Fontenot (1987) and El-Yassin et al. (1991), respectively.

b. Aquatic Waste

The prawn waste at KAU contained 41.8% CP, 29.0% ash (Table 1), 11.7% Ca and 1.9% P, DM basis. The CP and Ca concentrations in prawn waste are similar to the values of 45.3% CP and 12.7% Ca reported from crab processing waste (Samuels et al., 1991).

c. Large Animal Waste

The CP of cattle and buffalo dung (HAU) was 14.2% (Table 2), similar to the value of 13.2%, DM basis, reported by Lucas et al. (1975) for dried dung from cattle fed a 50% concentrate ration. In the HAU samples, cattle dung was lower in ADF and NDF than buffalo dung, perhaps reflecting differences in rations fed.

d. Poultry Wastes

Poultry litter which had accumulated on the floor of the poultry house for 11 months contained 14.7% CP, DM basis. This value is considerably lower than the previously reported average value of 31.3%, DM basis (Bhattacharya and Taylor, 1975). The high NDF value in the PAU litter indicates that the bedding materials made up major portions of the litters. The PAU scientists found similar chemical composition of litter containing rice husk or sawdust as bedding material.

Poultry droppings at PAU contained 24.4% CP and 20.5% ash (Table 1). These values are lower than previously reported values of 28% CP and 28% ash, DM basis (Bhattacharya and Taylor, 1975). The differences may reflect differences in dietary levels of CP and minerals.

B. Processing of Biodegradable Animal Wastes

Processing of animal wastes for use as animal feed is essential for destruction of pathogens, preservation/ stabilization, improvement of storage and handling characteristics, and maintenance or enhancement of palatability. Methods of processing which have been used are ensiling, deep stacking, urea treatment and solid state fermentation. Research was conducted at BVC on squeezing rumen contents to remove some of the moisture.

1. Ensiling

This processing method has been used extensively for preserving forages. Production of organic acids by anaerobic fermentation results in a decrease in pH. The ensiled mass is preserved for an indefinite period of time by the acid level.

a. Slaughter House Wastes

Experiments have been conducted at BVC on various aspects of ensiling slaughter house wastes and paddy straw. Rumen contents and blood (2:1 and 1:0) were ensiled with 40, 50 or 60% paddy straw and 5 or 10% molasses. The pH ranged from 5.4 to 5.8 and was not affected by proportions of ingredients. In a subsequent experiment different proportions of rumen contents and blood (1:0, 1:1, 2:1) were ensiled with 40, 50, 60 or 70% paddy straw. All mixtures contained 5% molasses and moisture was adjusted at 65%. The pH values ranged from 4.6 to 5.4. At 70% straw, pH values were highest, with no consistent differences among the other treatments. In previous work on ensiling of rumen contents, blood and wheat straw, with or without molasses, pH values of 4.4 to 5.0 were reported (Rao and Fontenot, 1987; El-Yassin et al, 1991).

b. Aquatic (Prawn) Waste

Mixtures of prawn waste and rice bran (1:1 wet basis) and prawn waste and paddy straw (1:1) were ensiled with 0, 10 or 20% tapioca flour or coconut cake at KAU. Poor ensiling was obtained when no additives were used. The pH values were 7.4 for prawn waste-rice bran and 8.8 for prawn waste - paddy straw. All prawn waste - rice bran mixtures with additives ensiled satisfactorily with pH values of 6.6 to 6.8. Adding 10 or 20% tapioca flour to prawn waste - paddy straw mixtures resulted in better ensiling than adding coconut cake. The pH values were 5.2 and 4.8 for mixtures with 10 and 20% tapioca flour, compared to 8.4 and 6.5 with 10 and 20% of coconut cake, respectively. In subsequent work with laboratory silos in which mixtures were ensiled for up to 42 days, it was found that good ensiling (pH of 5.4) was achieved after 7 days.

c. Cattle Waste

Experiments were conducted at HAU in which the wastes were ensiled with straw and mixtures of straw and green forage. Wheat and paddy straw were used as bedding for lactating cows for 2 weeks, then the bedding was ensiled with 0, 40 or 60% green oat forage and 0, 5 or 10% molasses. The highest pH was 6.1 for wheat straw bedding ensiled alone. Including green oat

forage or molasses alone did not substantially affect pH. The combination of green forage with 10% molasses resulted in the lowest pH values (4.2 to 5.0). In a subsequent experiment three levels of wheat straw were used as bedding for lactating cows. After 1 week the beddings were ensiled with 0, 40 or 50% maize fodder and 0 or 2% molasses. The pH values ranged from 5.2 to 6.7. Highest values were for silages with no maize fodder. Molasses was most effective in lowering pH when used in mixtures with 50% maize fodder. In these studies lactic acid concentrations were usually low.

Different proportions of cattle waste and wheat straw (75:25, 70:30, 65:35) were ensiled with 0, 10 or 20 parts of green fodder and 0 or 5% molasses. The pH increased with increased levels of green fodder, but molasses had the greatest effect in lowering pH. The effect of molasses was greatest at the lowest level of cattle waste. The pH value was less than 5.0 for this silage.

2. Urea Treatment

Urea treatment has been used to increase digestibility and CP concentration of crop residues. Since many of the biodegradable animal wastes are high in fiber, experiments were conducted on urea treatment.

a. Rumen Contents

At BVC squeezed rumen contents were treated with 4 or 5.3% urea, DM basis, with 0 or 10% molasses added before or after ensiling for 21 days. The CP was 9.9%, DM basis, for 4% urea and 10.5% for the 5.3% urea treated rumen contents. Small differences were seen in *in situ* DM digestibility between the urea levels. In unsqueezed rumen contents and paddy straw (1:1), treatment with 5.3% urea increased CP concentration from 3.9 to 11.4%, DM basis. Respective values for squeezed rumen contents and paddy straw were 3.3 and 10.8%. *In situ* DM digestibility was increased from 28.9 to 32.3% by urea treatment of the mixtures.

b. Large Animal Waste

Bedding prepared at HAU by putting 40 kg. wheat straw per lactating cow for 7 days was treated with 5% urea, DM basis, after wilting to 50% DM. Treating with urea increased CP from 8.4 to 11.6%, DM basis. An experiment was conducted with male buffaloes fed rations containing 66% oat hay and 34% sun-dried or urea-treated bedding. The *in vivo* DM digestibility, calculated by difference, was 30.0% for sun-dried bedding and 34.6% for urea-treated bedding.

3. Deep Stacking

a. Poultry Droppings

Different combinations of broiler droppings and wheat straw were stacked at 70% moisture for 9 days on a laboratory scale at PAU. The droppings were substituted for urea. At the higher levels of poultry droppings there were appreciable increases in CP, ash and lignin. An increase in cell solubles was recorded up to day 7. Deep stacking for 4 days resulted in lower loss of organic matter and NFE than 9 days.

b. Poultry Litter

Poultry litter was deep stacked at 35% moisture for 4 weeks at PAU. Temperatures, which were recorded daily, rose to above 60oC the first week, and remained above 60oC up to the third week.

4. Solid State Fermentation

Scientists at PAU studied solid state fermentation of poultry droppings to increase the protein value of the droppings for use in poultry feed. The droppings have been fermented with different fungal species. Three Coprinus species were quite effective in apparently converting uric acid to protein. However, it appeared that the fungi utilized soluble carbohydrates in poultry droppings for growth. In subsequent work, it was found that Aspergillus and Trichoderma reesei were very effective in apparently converting uric acid to protein.

C. Nutritive Value of Processed Animal Waste Products

The nutritive value of the products may refer to the value of the processed waste *per se* and the final product, which may include other ingredients in the final product. For example, the products may include deep stacked poultry litter or ensiled mixtures of rumen contents, blood, paddy straw and molasses. The ultimate measures of nutritive value is the performance of animals fed the waste products. However, most of the research has not progressed that far. Thus, measures of the nutritional value will usually include chemical composition, and digestibility (*in vitro*, *in situ*, *in vivo*).

1. Slaughter House Waste Products

Use of blood and rumen contents in ensiled mixtures resulted in silage of higher nutritional value than use of only rumen contents (Table 3). Crude protein content, and digestibility of DM, CP and crude fiber were higher for the silages containing blood. Adding molasses to squeezed rumen contents treated with urea increased *in situ* digestibility of DM, CP and crude fiber (Table 4). The increases were much larger if molasses was added after ensiling was completed. When rumen contents and blood were ensiled with 40 to 70% paddy straw, digestibility increased with increased proportion of blood in the mixture. Digestibility of ensiled rumen contents and paddy straw was decreased by squeezing the rumen contents (Table 5). *In situ* digestibility of DM, CP and crude fiber was increased by

treatment with 5.3% urea, DM basis, whether the rumen contents were squeezed or unsqueezed. In a subsequent experiment digestibility was higher for ensiled paddy straw and rumen contents, compared to paddy straw and water. This indicates that the rumen contents were higher in digestibility than straw. Treating straw or a mixture of straw and rumen contents with urea increased digestibility of DM and CP but did not affect crude fiber digestibility.

2. Prawn Waste

Addition of tapioca flour and coconut cake enhanced the nutritional value of the ensiled prawn waste and rice bran or paddy straw. The NDF of the silage was decreased by addition of tapioca flour (Tables 6 and 7) indicating higher available energy. Adding coconut cake increased the CP of the prawn waste - paddy straw silage. The digestibility of DM and CP of prawn waste - rice bran silage containing 10% tapioca flour was 61.7% and 80.6%, respectively (Table 8). These values are considerably higher than those reported for crab waste - wheat straw silage (Samuels et al., 1991).

3. Large Animal Waste

Adding green oat forage to ensiled wheat straw - cattle waste bedding at HAU increased IVDMD (Table 9). Adding molasses increased IVDMD only if green oat forage was not added. Similar results were obtained with paddy straw-cattle waste bedding. Digestibilities of DM and CP were higher for a ration containing urea-treated wheat straw-

cattle waste bedding, compared to sun-dried bedding (Table 10). Dry matter intake tended to be higher for cattle fed a ration containing urea-treated bedding than for those fed sun-dried bedding.

Substituting 20% of the DM of a wheat straw-concentrate ration with 5% urea (DM basis) treated cattle waste and wheat straw (2:1) tended to decrease digestibility of DM and fiber components, and daily gain in growing buffalo calves. When 30% of the urea-treasted mixture was substituted, digestibility of most components and daily gain were decreased.

4. Poultry Litter

A metabolism trial was conducted with adult male buffaloes fed deep stacked sawdust - based litter. The buffaloes were fed 3 kg. wheat straw, 2 kg. green sorghum forage, 30 g. salt and 3 kg. of the following supplements : 1) Poultry litter; 2) Poultry litter and 7% molasses; 3) Poultry litter, 7% molasses, 13% ext. rice bran; 4) Poultry litter, 7% molasses, 13% ext. rice bran and 5% uromol bran; 5) Poultry litter, 7% molasses and 13% ext. rice bran (pelleted). Daily DM intakes were 4.91, 5.39, 5.66, 5.64 and 5.72 kg. for buffaloes on treatments 1, 2, 3, 4 and 5 respectively. Thus, intake was increased by addition of molasses. Dry matter digestibility *in vivo* was similar for all rations (40.6 to 44.5%).

5. Fungal Fermented Poultry Droppings

Feeding fungal fermented poultry droppings to chicks at PAU resulted in a higher efficiency of protein utilization, compared to untreated poultry droppings, perhaps due to conversion of uric acid by the fungi (Table 11). In broiler growth studies, including fungal treated poultry droppings in the diets resulted in higher weight gains, compared to untreated droppings.

D. Safety of Feeding Processed Animal Wastes

There are potential hazards associated with feeding of biodegradable animal wastes. Pathogens may be present in some of the wastes. Thus, the wastes should be processed to destroy the pathogenic micro-organisms. The wastes may contain contaminations of heavy metals, pesticides, aflatoxins and medicinal drugs. If these should be present at objectionable levels, precautions must be used to prevent contamination of edible animal products. Some work has been conducted on safety aspects by Indian scientists working on the subproject.

1. Animal Health

There have been no animal health problems associated with feeding the processed animal wastes except for one instance at PAU. Adult male buffalo calves were fed rations consisting of green fodder mixed with deep stacked poultry litter, straw and molasses, which were changed later to deep stacked poultry litter, straw, molasses and rice polish.

Four animals died, but cause of death was not established. Clostridia were isolated from the litter. The scientists suggested that accidental wetness of the litter may have contributed to the presence of Clostridia. Health problems from feeding appropriately processed poultry litter have not been reported (Fontenot, 1990).

Blood samples obtained from buffalo calves fed 0, 20 and 30% silage composed of 2:1 (DM basis) of cattle waste and wheat straw plus 5% urea, DM basis, were analyzed for a number of parameters. After 120 days of feeding, generally, levels of blood components measured were higher for animals fed waste silage (Table 12). Levels were generally highest for the buffalo calves fed 30% silage. However, all the values were within the range of normal values. Trends for declines in the blood parameters were observed after the calves were removed from the cattle waste silages.

2. Pathogen Destruction

Rumen contents and paddy straw, treated with 5.3% urea, DM basis, and ensiled at BVC were free of coliforms and spore forming bacteria after 6 days. In previous research ensiled rumen contents, blood and straw (45:15:40) were free of coliforms, Shigella, Salmonella and Proteus (El-Yassin et al., 1991).

Ensiled prawn waste, rice polish and tapioca flour (45:45:10) at KAU was found to be free of pathogenic bacteria, such as Salmonella and Campylobacter.

Pathogenic micro-organisms, Salmonella, Klebsiella and E. coli were present during hot-humid and cold weather in poultry litter accumulated in poultry house pens at PAU, but these were not present during hot-dry weather. Deep stacking poultry litter at 35% moisture for 6 weeks at PAU destroyed E. coli and Klebsiella or these were not present initially. Salmonella was not present in the litter. Fungi were isolated from litter, but fungi were isolated from the feed also.

3. Residues

Samples of silage from HAU were analyzed by the CTL. Silages containing cattle waste, straw, green oat forage and molasses contained 35 to 65 ppb aflatoxin B1. There has been no evidence of problems of residues of heavy metals, myco-toxins, pesticides and medicinal drugs in animals fed animal waste if appropriate processing, management and withdrawal periods are used (Fontenot, 1990). Aflatoxin B1 (11 to 19 ppb) and B2 (19 to 28 ppb) were detected in prawn waste sent to the CTL by KAU.

E. Application and Technology Transfer

Research has progressed at all participating centers to the point that some of the technology developed can be used under farm conditions. Admittedly, only limited research has been done in which the processed animal waste products have been fed to producing animals. However, the work accomplished, plus results

which have been published previously, are sufficient to recommend application of some of the technology.

1. Recommended Uses

a. Poultry Wastes

Poultry wastes from layers can be fed to any class of animals with no withdrawal since layers should not be fed medicinal drugs. If layers are on bedding the poultry litter could be processed by deep stacking. The litter could be ensiled with high moisture ingredients such as oat or maize forage. The DM of the combination should not exceed 50% for good ensiling.

If the layers are in cages the waste could be dried or ensiled. Sun or heat drying is satisfactory. The wastes could be ensiled with straw or stover in such proportions to give a final DM of 50%.

Similar procedures could be used for processing litter or excreta from broilers as outlined for layers. The broiler litter or waste should not be fed to lactating dairy cows or laying hens since there is insufficient information on possible drug residues.

b. Cattle Waste

The waste can be ensiled with straw or other crop residues plus 10% molasses. The level of waste should be 50-60%, and the DM of the mixture should be 40-50%. The silages will be low in energy value, so should be

fed to animals at maintenance or at low levels to animals in production. The waste is best suited to feed ruminants.

c. Slaughter House Wastes

Rumen contents with or without blood can be ensiled with dry ingredients such as crop residue. Adding molasses may help ensiling. The DM should not exceed 50%. The silages will be low in energy value, so should be fed to ruminants at maintenance or in limited amounts to ruminants in production.

d. Prawn Waste

The research on ensiling of prawn waste has progressed sufficiently that this practice can be recommended. It can be combined with rice bran or straw in 1:1 ratio with 10% tapioca flour. It can be fed to ruminants.

2. Technology Transfer

Technology transfer programs should be initiated at all the centers. The consultants on technology transfer in 1990 and 1991 recommended specific approaches for application of the technology. Some activity in this area has begun at some centers. This kind of activity should be expanded at these centers and initiated at the other centers.

F. Publication of Research Results

Research has been conducted which has academic and applied value, nationally and internationally. The scientists should prepare manuscripts for submission to peer reviewed journals. There are excellent journals in India to which these papers could be submitted, such as the Indian Journal of Animal Nutrition and Indian Journal of Animal Science. Perhaps at least some of the papers should be submitted to international journals. Some suggestions are : Journal of Animal Science, Animal Feed Science and Technology, Journal of Agricultural and Food Chemistry, Canadian Journal of Animal Science.

G. Recommended Follow-Up

Considerable progress was made during the life of the subproject on conversion of biodegradable animal wastes for livestock feed. Solid basic research has been completed, defining characteristics of the wastes, development of low-cost and effective processing methods, and defining the nutritional value of processed animal waste products. However, the work has not progressed sufficiently to ensure widespread adoption of the technology. The main areas which have not been addressed sufficiently are conducting applied feeding experiments with animals at different levels of production; safety studies, especially residues of toxic substances in animal products; and technology transfer programs. It is recommended that these areas be addressed in follow-on activities.

For the applied feeding experiments each of the wastes would be processed by the method(s) found to be most feasible and practical. The processed waste product would be included at different levels in the rations of animals in production. The maximum level of the waste product would be determined for optimum production. This should be done with animals at different levels of production. Economic analyses should be conducted to determine the economy of feeding different levels of the waste products compared to conventional feeds.

Safety studies should include work on levels of toxic chemicals in the wastes and in animal products from animals fed the processed wastes. A critical area which needs to be addressed is the effect of feeding wastes from animals fed medicinal drugs to lactating animals on the presence of drugs and their metabolites in the milk. If the drugs are present, studies could be conducted concerning the effect of level of feeding the waste and processing the waste to prevent the appearance of residues.

Sound technology transfer prorams need to be developed for each of the wastes, based on the research conducted under the present subproject and the suggested new activites. The programs should be designed to be applied by typical Indian farmers and/or compound feed manufacturers. Some of the effort would include field demonstrations, followed by educational programs which would reach the appropriate clientele. Where applicable, publications should be prepared in laymen's language and distributed. In some cases, cooperation should be encouraged between public institutions and the private sector.

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TABLE 1 Chemical Composition of Biodegradable Animal Wastes

Item	Dry Matter	Crude Protein*	Crude Fiber*	Ether Extract*	Ash*	NFE*
	%	%	%	%	%	%
Rumen contents						
Cattle	11.8	8.4	28.0	1.4	17.3	45.0
Sheep	11.7	10.6	35.9	1.4	12.7	39.4
Goats	11.2	9.9	32.3	1.5	13.7	42.7
Blood	20.1	87.3	-	-	4.5	-
Prawn waste	-	41.8	-	-	29.0	-
Poultry droppings	-	24.4	19.7	-	20.5	-

*DM basis

TABLE 2 Chemical Composition* of Cattle and Buffalo Wastes (Dung) and Poultry Litter

Kind of waste	DM	CP	NDF	ADF	Cellu -lose	Ash	Lignin	Silica
	%	%	%	%	%	%	%	%
Cattle dung	14.7	14.2	61.0	44.3	19.5	-	16.7	8.1
Buffalo dung	15.2	14.2	65.4	54.9	27.4	-	14.3	13.0
Poultry litter**	-	16.7	54.4	-	18.4	29.5	-	-

*DM basis except for dry matter
**After 11 months accumulation, except 9 months for cellulose and 10 months for NDF

TABLE 3 Chemical Composition and In Situ Digestibility of Processed Slaughter House Waste Products*

Paddy straw	RC : blood	Crude protein	Crude fiber	Digestibility		
				Dry Matter	Crude Protein	Crude Fiber
%		%	%	%	%	%
40	1:0	5.2	29.0	40.0	37.7	46.7
40	2:1	8.8	26.5	51.0	43.5	51.8
60	1:0	5.5	28.5	46.2	32.8	52.9
60	2:1	7.4	30.5	51.1	48.7	57.2

*Mixtures contained 5% molasses

TABLE 4 Molasses Treatment of Urea Treated Squeezed Rumen Contents

Molasses treatment	Crude protein	Crude fiber	Digestibility		
			Dry Matter	Crude Protein	Crude Fiber
	%	%	%	%	%
None	10.5	31.8	25.6	50.1	23.3
10% before ensiling	10.9	31.8	31.9	59.4	30.7
10% after ensiling	11.2	30.9	39.3	72.9	41.4

TABLE 5 Effect of Squeezing and Urea-Treatment of Rumen Contents

Rumen contents	Urea treatment	Crude protein	Crude fiber	Digestibility		
				Dry Matter	Crude Protein	Crude Fiber
	%	%	%	%	%	%
Unsqueezed	0	4.0	28.7	32.6	34.5	29.2
Unsqueezed	5.3	11.5	28.5	39.2	50.2	44.5
Squeezed	0	3.5	29.1	29.1	31.4	27.3
Squeezed	5.3	11.1	31.3	33.2	47.3	30.9

TABLE 6 Chemical Composition of Prawn Waste - Rice Bran Silage

Component	Additives to prawn waste - rice bran, 1:1, wet basis				
	None (%)	Tapioca flour		Coconut cake	
		10%	20%	10%	20%
Dry matter.	47.8	48.7	50.2	48.7	47.5
Crude protein*	21.4	16.7	13.1	20.5	22.0
NDF*	30.5	24.9	18.0	24.1	21.8
Cellulose*	14.5	12.6	8.7	11.9	11.6
Lignin*	11.3	8.5	6.5	9.1	7.2
Ash*	18.5	15.0	11.5	14.8	13.0

*DM basis

TABLE 7 Chemical Composition of Prawn Waste - Paddy Straw Silage

Component	Additives to prawn waste - rice bran, 1:1, wet basi				
	None (%)	Tapioca flour 10%	Tapioca flour 20%	Coconut cake 10%	Coconut cake 20%
Dry matter	41.9	38.4	39.1	39.5	39.1
Crude protein*	15.8	15.9	14.3	22.9	24.0
NDF*	65.4	55.2	41.6	58.9	48.6
ADF*	46.5	39.3	31.6	42.1	35.5
Cellulose*	33.8	28.1	22.9	30.1	26.4
Lignin*	6.1	5.4	3.9	6.1	5.0
Ash*	18.8	16.5	12.9	18.2	14.1

*DM basis

TABLE 8 Chemical Composition and Digestibility of Prawn Waste - Rice Bran Silage*

Component	Chemical Composition	Digestion Coefficien
	%	%
Dry matter	50.5	61.7
Crude protein	17.2**	80.6
Crude fiber	11.0**	77.8
NFE	37.6**	36.8
Ash	17.1**	
NDF	25.0**	
ADF	24.6**	

*Prawn waste and rice bran, 1:1, plus 10% tapioca flour.
**DM basis.

TABLE 9 Chemical Composition and In Vitro Dry Matter Digestibility of Ensiled Cattle Waste - Wheat Straw Bedding and Green Oat Forage

Proportion		Molasses	Dry Matter	Crude Protein*	NDF*	IVDMD
Bedding	Green oats					
		%	%	%	%	%
1	0	0	34.8	9.4	59.2	30.8
1	0	10	33.8	10.6	57.2	34.6
0.6	0.4	0	27.3	9.7	59.4	32.9
0.6	0.4	10	26.8	9.6	61.4	35.1
0.4	0.6	0	21.5	10.1	58.1	35.1
0.4	0.6	10	21.5	10.4	64.0	33.5

*DM basis

TABLE 10 Digestibility and Intake of Rations Containing Sun Dried & Urea-Treated Bedding

Item	Ration		
	Oat hay	Oat hay plus urea-treated bedding	Oat hay plus sun-dried bedding
Digestibility			
Dry matter	67.6	49.4	45.5
Crude protein	56.6	39.9	32.0
Crude fiber	71.4	55.7	55.4
Dry matter intake, kg 100 kg BW	2.35	1.96	1.84

TABLE 11 Protein Utilization and Performance* of Chicks Fed Fungal Treated Poultry Droppings

Item	Untreated	Fungal Treated Aspergillus	Trichoderma reesi TR 9123	Trichoderma reesi TR 9414
Net protein utilization	9.10	11.70	11.66	10.40
Protein efficiency ratio	1.59	1.82	1.68	1.74
Gross protein value	8.50	17.13	14.92	18.02
Weight gain, g.	1018	1092	1046	1095
Feed intake, g.	2457	2600	2542	2578
Feed/gain	2.41	2.37	2.43	2.35

*2.6 weeks

TABLE 12 Blood Parameters in Buffalo Calves Fed Cattle Waste - Wheat Straw Silage

Item	Waste - straw silage, % 0	20	30
SGOT, Iu/liter	36.2	35.9	48.9
SGPT, Iu/liter	28.3	32.4	31.2
Alkaline phosphates, Iu/liter	127.3	224.9	307.5
Glucose, mg/dl	62.5	84.8	90.5
Cholesterol, mg/dl	198.3	219.2	294.6
Protein, g/dl	7.0	8.1	8.5
Urea, m/dl	12.3	20.2	24.4