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OPPORTUNITY STUDIES FOR THE PRODUCTION OF BONE MEAL
FOR ANIMAL FODDER

XP/ZAM/90/037/11-54

ZAMBIA

Technical report: Processing of slaughterhouse waste
for animal feed*

Prepared for the Government of Zambia
by the United Nations Industrial Development Organization

Based on the work of A. W. A. Burt, expert in technical aspects
of animal fodder production

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* This document has not been edited.

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ABSTRACT : XP/ZAM/90/037/11-54

This report results from a 20 day mission to Kenya, Zambia and Malawi in November/December 1990 to carry out the technical component of a feasibility study: (a) of adding an animal byproducts processing plant to the Zambia Pork Products (ZAPP) operation; (b) of transferring the small scale technology used by an entrepreneur in Kenya to encourage native entrepreneurs to develop similar bone processing in Zambia; and (c) of carrying out a preliminary assessment of the relevance of the Zambian situation to that in Malawi.

Since the present and likely future output of byproducts by ZAPP are unlikely to be sufficient to support economic operation of the smallest modern byproducts processing plant, the available animal and poultry byproducts in the area of Lusaka were surveyed and estimated. Particular attention was given to the existing byproducts plant in the neighbouring ZAMFRIG plant which with appropriate rehabilitation would have ample capacity to process all the byproducts currently available from local animal and poultry operations and already has experienced management and operatives in place.

A short visit to Malawi revealed: (a) the concentration of animal and poultry byproducts around Lilongwe and Blantyre; (b) the existence of very old and dilapidated byproducts processing plants at abattoirs in both areas badly in need of rehabilitation; and (c) two substantial sources of poultry feather and blood

A project to rehabilitate the Malawi plants and examine the feasibility and relevance of a collection service is recommended.

It is recommended that this rehabilitation of this plant be undertaken and a regular byproduct collection service be established. The same plant is already buying and burning bone to produce bone ash for animal feed use and it is recommended that this be continued, and no action taken to transfer technology from Kenya to Zambia.

INTRODUCTION

This report results from a mission by Dr A.W.A. Burt to Nairobi, Lusaka and Lilongwe between November 16th and December 6th 1990. The objective was to put together the technical component of a feasibility study on the production of blood and bone meals (processing of animal offals) in Lusaka.

The original mission proposals (Job description - Annex I) envisaged the following:-

- (i) Visit and inspect the technology being used by an entrepreneur in Nairobi to collect and process bones into bonemeal with a view to transferring this technology to native entrepreneurs in Zambia. The consultant was then to make a preliminary evaluation of the possibility of extending this operation to Malawi.
- (2) To evaluate a proposal to add an animal byproducts processing plant to the ZAPP operation in Lusaka.

In the event, the mission took a very different direction for the following reasons:-

- (1) It proved impossible to contact the entrepreneur in Nairobi or to visit the relevant bonemeal plant in the first stage of the mission. This, together with other factors discussed in this report, led to the omission of this part of the mission.
- (2) It rapidly became apparent that the total byproduct output of ZAPP was insufficient to support a modern processing plant of the smallest capacity normally available.

The mission therefore took the following form:-

- (1) An evaluation of the total available supply of byproducts for processing in the Lusaka area.
- (2) Consideration of the possibility of rehabilitating an already existing and partially operating byproducts plant in Zambia Cold Storage (ZAMFRIG) adjoining the ZAPP plant.

(3) A brief assessment of the availability of byproducts and current processing facilities in Malawi.

This report therefore discusses some of the basic problems of animal and poultry byproduct processing, and deals with the specific areas mentioned above. The principal persons with whom discussions were held are listed in Annex II.

It is true that Zambia, Malawi and other African countries suffer chronic shortages of proteins for use in animal feeds, and require supplies of phosphate sources for animal feeds. It might therefore be expected that processing animal byproducts could make a useful contribution to feed supplies. While the general objective of turning noxious waste into valuable animal feed is highly desirable, this report sets out reasons why this may not be easy in the developing countries in Africa and discusses some of the practical difficulties which have to be overcome to achieve a successful byproducts operation.

I. PROCESSING ANIMAL BYPRODUCTS

A. General

The animal byproducts industry worldwide processes the byproducts of the slaughter of animals and poultry for human food, into usable animal feed. The process generally involves heat to sterilize the products and then to dry them, and particle size reduction to meal form.

The products processed consist of -

- (1) Condemned carcasses and scrap and spoilt meat
- (2) Intestines and other organs
- (3) Blood
- (4) Feathers
- (5) Bone.

The most common products are meat meal, meat and bone meal, poultry offal meal, blood meal, feather meal, steamed bone meal or bone ash, low grade tallow/pig fat for soap making or other chemical industry use.

The smallest plants commercially available operate a batch process and generally have capacities of 1 to 1½t/charge and a cycle time of 2½ to 4h/charge. This means that sufficient material must be available to provide reasonably full operation if such plants are to operate economically.

The nature of the material being processed governs the precise nature of the plant, but in general for meat and bone meal, the process includes prebreaking to reduce the material to a size which will cook reasonably quickly and thoroughly before charging the cooker which cooks and sterilizes and dries the material. Upon discharge it may be centrifuged to remove fat and broken again to reduce bone to a size suitable for grinding and bagging off as meal. Processing conditions and the use of ancillary equipment depend upon the product being ground. For example, adequate breakdown of the protein in feathers require higher temperature and pressures than are generally used for meat and bone and blood meals.

B. Supply of Animal Byproducts

In Zambia, as in many other developing countries, the intake of animal protein per head of the population is extremely low. Meat is a luxury item, hence the poorer classes of the population make every possible use of the offals from cattle, sheep, pigs and poultry slaughter, including animal bones. This is illustrated by the prices currently charged for such materials by two of the biggest meat suppliers in Lusaka (Table 1). This table does not include blood, some of which is processed into blood sausages of various kinds. In consequence, the total supply of material for processing to animal feed relative to the tonnage of animals and poultry slaughtered is far less than in the developed world. The principal byproducts available are:-

(1) Large animal bone - after cooking, making broth or excess to market requirements, i.e. collected by agents or surplus at meat processing plants (slaughter houses).

(2) Blood - can be used in blood sausages, but substantial excess remains in units which do not make such products. Use in human food really requires collection by the hollow knife technique which is not always available. Some of this excess is currently chemically treated, boiled/sundried for use in local cattle feeds.

(3) Poultry feathers - little use is made of these. If sufficient quantities can readily be collected, they could be made into feather meal for use principally in cattle feed, and, if adequately processed, in poultry feed.

(4) Condemned carcasses and offals - condemned by meat/veterinary inspectors. The supply of these at slaughter houses is a small percentage of total output and is irregular. At present they are collected and dumped by the Council as a service to the slaughterhouses, and are a human health hazard because they are often stolen or illicitly traded as an item of human diet.

(5) Small amounts of minor offals - rectum, testicles, etc., not generally consumed.

(6) Small amounts of trimmed fat - can be rendered to tallow A from large cattle slaughtering operators.

It will be apparent that compared with the developed world. the Lusaka area offers relatively little in the way of animal byproducts for processing and that these consist largely of blood and poultry feathers, with some bone, and that there is very little material capable of producing the quantities of meat/meat and bone meal which are a familiar feature of the European animal feed industry.

Table 1 Retail value of Byproducts in Lusaka (K/kg)

	<u>ZAPP</u>	<u>Galaun</u>
Shin	31	
Backbone	61	
Ham bone	36	
Shoulder bone	20	
Head bones	15	
Liver	82	
Tripe/casings	26	26
Lungs/Spleen	31	
Hearts	71	
Tongues	66	
Trotters	87	
Kidney	87	
Snouts		2
Jattle Bible/Tripe		60
Pigs Heads		140 each
Ox heads		75 each
Cow heels		20 each
Poultry offal		15
Bones (Beef)		22

C. Animal and Human Health

Health and hygiene are supremely important considerations in the meat processing industry. The basic requirements are -

- (1) Proper inspection of slaughter animals and carcasses to ensure that material not fit for human consumption is condemned and properly removed from the human food chain.
- (2) That this material and all other byproducts must be adequately sterilized to destroy all human or animal pathogens before the product is used in animal feed.
- (3) The layout and mode of operation of the plant must be such that material cannot be recontaminated after processing, but must be kept dry and clean, prior to its despatch.

The difficulties involved in ensuring that these criteria are truly met are illustrated by recent experiences with Salmonella in poultry in the U.K and elsewhere in the world, and in the occurrence of Bovine Spongiform Encephalopathy in the U.K., apparently transmitted to cattle by meat and bone meal derived from sheep infected with Scrapie. The latter happened in spite of closely controlled processing plants, apparently due to a relatively minor change in operating conditions.

It follows that operations in the developing countries must be planned to meet these criteria. It is clear that substantial improvement is needed in Lusaka in all three areas. There is clear evidence of inadequate meat inspection, and failure to prevent condemned material finding its way into the human food supply. Some of the inadequacies of the processing facilities for animal byproducts are the subject of this report.

It must be the intention and resolve of the Government of Zambia and those of other developing countries to raise standards of their meat and offal processing industries to the highest levels at the earliest possible moment.

D. Critical Quantities of Animal Byproducts

Because wet animal byproducts are very perishable, regular collection and processing must be envisaged if product quality is to be properly maintained.

In the climate of Lusaka, or indeed anywhere, in reasonably temperate conditions, twice weekly collection will be necessary. Some of the slaughter houses will probably only supply small quantities of condemned carcasses or any other class of offal at any one time. Lack of a full load greatly increases the cost of transport ($\frac{1}{2}$ load = double cost /unit transported).

Similarly at the plant operating level, a full charge of a particular raw material is required for maximum efficiency. e.g. If blood awaits processing in a quantity which amounts to a half cooker charge and has to be processed because no more is likely to be available then the processing cost per unit must rise.

The efficiency of operation is critically dependent upon such factors. Management in scheduling of transport and batching in the plant is a critical factor in effective operation. In the end, if byproducts are only available for processing in intermittent small quantities, plant operation becomes grossly uneconomic and/or the products become a jumbled and variable mess of mixed materials, some of which will be spoilt before processing and others improperly processed.

In the area covered by this report, this is likely to be a major factor in increasing costs of transport and reducing the effectiveness of plant operation.

3. Alternative Technology

(i) Extrusion

Apart from the normal technology of cooking, drying and grinding, other ways of processing these offals into animal feed ingredients are available, but do not appear to offer a realistic practical alternative in the circumstances of this project. One alternative system consists of mixing the offal with a large amount of dry meal so that the moisture content of the mix is 22 - 25% and then extruding the mixture thus generating substantial heat and pressure. The heat generated sterilizes the mixture and excess moisture flashes off after extrusion so that the final product has a moisture content of 9 - 12%.

This process can be used for blood, feathers, guts and carcass trimmings. However the following disadvantages are apparent:-

(1) A substantial amount of suitable dry animal feed material must be available to be co-processed with the animal offal, for instance blood could only be included at about 15% in the mix. This supply is not readily available in the countries concerned.

(2) The particle size of the materials must be reduced before extrusion to 3 mm, thus gut/waste meat must be minced.

(3) Other preprocessing is needed:-

Blood - anticoagulant applied at collection - then stabilized by addition of alkali to pH 10.

Feather - centrifuged to remove excess water acquired during slaughter, ground to sufficiently small particle size, enzyme treated to hydrolyse the protein (or digestibility of the product will be very poor).

(4) The process is obviously unsuitable for bone or offals containing bone.

(5) Close careful control of the moisture content of the mix and the processing temperature and time are necessary to ensure adequate sterilization. This may be difficult to achieve in the locations covered in this report.

Such plants can be supplied by Inotec International, Parc Industriel d'Encarville, 27101 Val de Reuil, France, - Phone 402711 (Export Sales Manager - Alan Haythornwaite, 45 Church Road, Warton, Preston, Lancs PR4 1BD, U.K. (0722 634456).

A Budget price for a plant to process poultry feathers, blood and offal would be £250,000 (U.S \$ 475,000). This would have an output of about 3t total product/hour, including about 500kg wet offal. It would thus handle about 4t of wet poultry byproducts per 8h shift. The 3t output/hour would include only about 100 to 120 kg of material derived from offals, the remainder (about 2900 kg) would be dry animal feed (maize, grain offals, soya, etc) for co-processing.

The plant would consist of:-

Centrifuge - for removal of excess water from feathers.

Wet offal grinder

Dry meal grinder

Ribbon mixer (mixing offal with carrier)

Extruder

Conveyor

Cooler/drier

Elevators, electrical controls etc.

In addition, tanks would have to be provided for pretreatment and holding offals such as blood and feather, while carcass meat would have to be minced.

Generally speaking, the application of such a process to large animal operations seems unlikely to be effective. Its only possible relevance in Zambia and Malawi appears to be with large scale integrated poultry processing operations which also prepare their own feed and would thus have a suitable supply of materials for co-processing and a direct use for the finished product. Generally higher standards of management in this part of the industry would also encourage one to examine the possibilities of this process in more depth.

(ii) Acid treatment

A further alternative is the treatment of soft offals or blood with controlled quantities of formic acid solution. Application of the appropriate quantity of acid sterilizes the material and upon standing the structural proteins hydrolyse to form a soluble amino acid solution. However, this process would require

- (a) Importation of expensive acids.
- (b) Very careful control of quantities of acid applied.
- (c) Great care to avoid cross contamination of the product or vessels by fresh material.
- (d) Haulage of substantial quantities of liquid to animal feeding units which could make use of it - e.g. pig units
- (e) Substantial space and handling equipment to handle the tanks required.

For these reasons it does not appear to be practicable for application to the situations described in this report.

II ZAMBIA - LUSAKA

A. General

This section deals with the proposal to add an animal offal processing plant to the ZAPP pig slaughter and meat processing operation. It examines the raw material supply likely to be available from ZAPP operations and other raw materials and processing facilities in the area of Lusaka, and recommends that an alternative approach be adopted; that is that the neighbouring ZAMFRIG plant be rehabilitated, when it could readily handle all the animal and poultry byproducts likely to be available for processing in the area of Lusaka.

B. Future production of pigs in Zambia and throughput of ZAPP

The pig population of Zambia is fluctuating around 220,000 (FAO estimate 1987). It is estimated that in that year 166,000 pigs were slaughtered. It seems that restrictions caused by feed availability and its quality and price have allowed practically no expansion in production since that date. The present annual slaughter by ZAPP is some 12,000 pigs/year. Taking into account other operations, e.g. King Farm Products (5000 pigs/year) in the Lusaka area, slaughter in that area amounts very approximately to somewhat over 10% of the total slaughter. Since Lusaka probably contains about 10% of the population of the country these estimates look reasonable.

They do not hold out any prospect of a very substantial rise in the numbers of pigs slaughtered by ZAPP in the foreseeable future. The situation postulated in the draft financial report on this project, wherein pigs slaughtered by ZAPP would rise from 50/day (the approximate current level) to 160/day over the next five years appears to be extremely unlikely. One can postulate neither production push nor demand pull to support such an assumption. The safest assumption appears to be that slaughtering by ZAPP will fluctuate around their current levels for the next five years.

This situation has been exacerbated by recent rises in feed prices. National Milling, the Parastatal that commands 70% of animal feed production increased its prices by 25% on November 1st and by a similar amount on December 1st. These increases appear to be more related to the financial requirements of National Milling than to the cost of raw materials.

Supply of commercial pig feeds is difficult and reports suggest that their quality is generally low. Coupled with their high price, this suggests that any increase in pig production in the foreseeable future is only likely to come from commercial producers purchasing or producing feed materials and mixing their own feed. The overall production of feed ingredients and competition for them for poultry production suggests that any such increase is likely to be very limited.

Furthermore, the total slaughtered by ZAPP has only recently risen to its present level (Table 2), and this rise may have more to do with cash flow problems elsewhere in the industry affecting payments to producers than to any noticeable increase in total pig production.

C. Present output of offals by ZAPP available for processing.

The total throughput of pigs by ZAPP recently has been:-

Table 2

Recent numbers of pigs slaughtered at ZAPP

1987/88	5372	in 11 months	Average carcass weight			67 kg
1988/1989	8554		"	"	"	68 "
1989/1990	9231		"	"	"	74 "
<u>1990/91</u>						
April	639		"	"	"	66 "
May	966		"	"	"	70 "
June	778		"	"	"	67 "
July	949		"	"	"	69 "
August	1062		"	"	"	71 "
September	1116		"	"	"	67 "
October	1312		"	"	"	70 "

This illustrates the rise that has taken place in recent months to a throughput of around 12,000 pigs/year (July to October 1990 - Average 1109/month)

Condemned pigs and condemned meat (two separate items) which provide part of the supply of material for processing to animal feed were as follows:-

Table 3. Weight of pigs and offal condemned at ZAPP

	<u>1989</u>			<u>1990</u>				
	<u>No.pigs</u>	<u>Weight of pigs (kg)</u>	<u>Wt of Meat (kg)</u>	<u>Total kg condemned</u>	<u>No.pigs</u>	<u>Wt of pigs</u>	<u>Wt of meat</u>	<u>Total condemned</u>
January	9	637	932	1569	18	1388	4746	6134
February	-	-	301	301	24	1644	766	2410
March	2	133	366	499	5	373	2292	2665
April	1	68	1159	1227	8	524	472	996
May	4	260	515	775	15	1049	292	1341
June	5	356	198	554	17	1144	1154	2298
July	7	461	344	805	22	1516	716	2232
August	3	237	4754	691	33	2307	710	3017
September	2	159	3347	3506	28	1879	1342	3221
October	23	1808	3285	5093	24	1716	4774	6460
November	12	994	850	1844	-	-	-	-
December	28	2172	1761	3933	-	-	-	-

gcs condemned (Table 3) in April to October 1990 amounted to 147 or 2.15% pf intake totalling 10,135kg. In the same period meat condemned amounted to 19,565 kg. The latter figure includes portions of carcasses condemned and spoilt meat and processed products associated with difficulties with the refrigeration system in the plant. The total of approximately 30 tons over 7 months, two thirds of which is condemned part carcasses and spoilt processed products is therefore probably somewhat excessive, but can be used as an indication of the amounts of material available from this source for processing. This amounts to around 200 kg/working day or 1t/week or 50t/year.

Blood.

The supply of blood can be estimated at about 4.5 kg wet blood/pig. This amounts to about 54t blood/year from 1000 pigs/month.

Other Offal

Very small amounts of other offal are available from the plant, consisting of parts of large intestine, scrotum, etc., and odd amounts of offal not sold. These amounts are very small and can be included with the estimated of condemned meat above which is excessive for long term operation.

Bone.

Most bone is sold, but some residue remains unsold and is available for processing as fresh bone. This amounts to approximately 1t/month.

Thus, the total byproducts available for processing from ZAPP can be estimated as follows (Table 4).

Table 4 Total byproducts available for processing from ZAPP
(at 1000 pigs/month) (t)

	<u>per week</u>	<u>per month</u>	<u>per year</u>	<u>Annual product</u>
Blood	1	4.5	54	11t blood meal
Condemned carcass	0.35	1.4	17)	20 t M & B meal
Condemned offal & meat etc.	0.70	2.8	34)	
Unsold bone	0.25	1	12)	
			—	
		Total	117	

This calculation shows that the total amount of raw material available for processing from the ZAPP operation amounts to some 110 - 120 t/year at present rates of throughput giving finished product outputs of just over 30t/year, mostly meat and bone and blood meal. The amount available / week amounts to about 2.3 t, or 2 harges/week in the smallest plant available. The total available amounts to about 9 - 10 kg/pig slaughtered producing 2.5 - 3 kg saleable product/pig slaughtered.

These amounts cannot hope to support the capital investment involved in installing even the smallest available modern processing plant. At the prices discussed later in this report, the total value of the estimated outputs from ZAPP byproducts would amount to 1.5 to 2.0 M Kwacha annually, whereas the capital cost of a new package plant would probably exceed 20M K. (see Annex III). It was therefore decided to examine other possibilities, including the use of the existing plant at ZAMFRIG, across the road from ZAPP and to estimate the total supply of currently unprocessed slaughter wastes in the area.

D. Zambia Cold Storage (ZAMFRIG) byproducts processing plant.

This plant is partly operational and handles the byproducts arising from the slaughter of around 500 cattle per week. The plant was manufactured by Atlas, Denmark. It consists of a prebreaker to break down condemned carcasses, fallen stock etc., and a pneumatic system for loading the dry melters (2 x 3000 l capacity). One of these is set up for processing blood and is connected to a vacuum system, and the other is set up for carcass meal production leading to a settling tank and centrifuge for fat separation, and a grinder.

Carcass meal, blood meal (of unsatisfactory quality owing to breakdown of the vacuum system) and low grade tallow are being produced. Power and steam are provided by the main plant boilers. A crusher for breaking carcass material after cooking and prior to grinding is already on site and requires installation. A third dry melter (Iwell) has been replaced at the Livingstone plant of this Company and there is a proposal to install this at Lusaka, because its direct feed would allow processing to continue when the prebreaker and pneumatic feeding equipment are out of action due to breakdown.

The Zamfrig production manager is fully experienced in the operation of byproducts plants and is a former FAO consultant on byproducts processing. The plant has experienced operators and is presently in partial operation. The site has an operating quality control laboratory.

This plant properly repaired and in full operation on a single shift basis could probably handle between 2000 and 2500 t wet slaughter wastes per year, and even more if the additional cooker were added. At present (see below) it processes about 15% of its potential throughput. The plant production is summarized below:-

Table 5. ZAMFRIG Production and processing of byproducts.

	<u>/week</u>	<u>/year</u>	<u>Product/year</u>
Cattle slaughtered	500	25,000	
Total carcass weight	75 t	3,750 t	

Blood	4.5 t	225 t	45 t
Condemned carcasses, meat and offal	1.5 t	75 t	25 t + Tallow 2 t
Total processed	6 t	300 t	
Bone ex plant and delivered in		120 t	

Processing bone

The ZAFRIG plant has a substantial area around it as yard space, part of which is currently used for the collection of bone. Bone from this plant and that collected elsewhere in Zambia is left to dry and then burnt to bone ash which is sold for use in animal feed. Collectors are paid 8K/kg bone delivered to plant. The amount burnt currently amounts to about 10t/month. The product is currently sold for 23K/kg.

E. Other sources of animal byproducts currently unprocessed.

By making visits and telephone calls it was possible to roughly survey and make an estimate of byproducts currently available for processing from other plants in the Lusaka area. The results were as follows (Table 6):

Table 6. Other sources of animal byproducts - Lusaka

<u>Source</u>	<u>Blood</u>		<u>Condemned carcass and offal etc.</u>		<u>Bone</u>	
	<u>/year</u>	<u>/½ week</u>	<u>/year</u>	<u>/½ week</u>	<u>/year</u>	<u>/½ week</u>
King Farm (Pigs)	20 t	0.2 t	10 t	0.1 t	Sold elsewhere	-
Bucaneer (pigs and cattle)	13 t	0.13 t	4 t	0.04 t	-	-
Twiketane (cattle & pigs)	-	-	16 t	0.16 t	-	-
Kyindu (some pigs - principally cattle)	46 t	0.46 t	15 t	0.15 t	75 t	0.75 t
TOTAL	79	0.79	45	0.45	75	0.75

The total of animal offal available from these sources is about 124t/year with an additional 75 t bone. This is a very rough estimate but gives an idea of the order of magnitude of additional material available. It should be noted that a substantial amount of this total is provided by Kyindu Ranch which is some 30 km from downtown Lusaka.

The figures per $\frac{1}{2}$ week are an indication of the amounts to be obtained per collection and thus have an impact on the size of vehicle required and the cost of collection. It should be noted that the weight of any total collection from one plant is well under 0.5t in total with the exception of Kyindu where it amounts to about 1.4 t (most of which is bone).

Poultry byproducts

In view of the limited amounts of animal material available, the availability of poultry byproducts was assessed with the following results (Table 7)

Table 7. Availability of Poultry Byproducts - Lusaka

(t)

	<u>Blood</u>		<u>Wet feather</u>	
	<u>/year</u>	<u>/$\frac{1}{2}$ week</u>	<u>/year</u>	<u>/$\frac{1}{2}$ week</u>
Galaun	20	0.2	77	0.77
Tomba Farms	11	0.11	41	0.41
Poultry Processing Co.	44	0.44	173	1.73
Total	75	0.75	291	2.91

In this case the concentration of products from 3 local broiler processing plants and the amounts available/collection would allow a more economic collection operation than that likely to be possible for animal byproducts.

F. Total Animal and Poultry Byproduct Supply - Lusaka

The total amount of material available for processing from the adjacent plants of ZAMFRIG and ZAPP and the other plants listed amounts to the following -

Table 8. Total Supply of Material/year (t) - Lusaka

	<u>Blood</u>	<u>Carcass/Offal</u>	<u>Bone</u>	<u>Feather</u>
ZAMFRIG	225	75	Already burnt	
ZAPP	54	51	12	-
Animal product available for collection	79	45	75	
Poultry products available for collection	75	-	-	291
Total	433	171	87	291

Gross total 982 t.

Accepting that there are large errors in some of these estimates, these are likely to be unimportant, since the potential capacity of the ZAMFRIG plant is such that it could handle twice the amount of material with appropriate rehabilitation.

G. Present disposal.

The present system of disposal is that each plant pays the municipality to take away its waste and dump them. The cost to ZAPP of this procedure is some 8000K/month. This is unsatisfactory because it is suspected that some condemned offal and carcasses find their way into the human food supply. Such material is often stolen from the plant

compounds. This method of disposal is not only dangerous but wasteful, as this material could add to the supply of protein for use in animal feed, although the amounts involved are relatively small.

H. Environmental problems.

At the moment there is clear evidence of animal blood finding its way into local drainage systems and appearing in open ditches in the industrial area. Proper processing would eliminate this problem.

Processing animal wastes creates smell and therefore in the longer term it is likely that the operators of both ZAMFRIG and ZAPP will move to sites out of town and away from the industrial area. This tendency is already apparent among private sector slaughter houses.

In the long term, therefore, it is likely that byproduct processing will move out, possibly to a separate site or in association with a new slaughterhouse facility. It is significant that a new slaughterhouse being built by Chibote Farms, E. of Lusaka, includes its own byproducts plant. However the present location of the ZAMFRIG plant is not unfavourable, being next door to ZAPP and within very easy reach of the Poultry Processing Co., the two major sources of additional byproducts for processing.

I. Outline proposal.

The obvious answer to the disposal problem for the next 10 - 15 years is therefore to rehabilitate the ZAMFRIG plant and develop its operation to become the processing centre for any byproducts in the Lusaka area, which are not currently being utilized. This solution is indicated and supported by:-

- (1) Better utilization of an existing plant and experienced labour force
- (2) Management with relevant experience.

To achieve this, the plant would need rehabilitation and additional investment in transport for collection.

J. Management problems

Although slaughter plants currently have to pay for the removal of byproducts as waste, it became apparent from conversations with experienced local management that payment, even if nominal, would be expected for material removed to a central processing point. This should not be a problem, if payments are small and regular, or if the environmental standards are tightened to an extent which allow no other economic route for disposal. One would prefer to see any problems in this area left to the good sense of the managements concerned.

The second problem concerns the real commitment of ZANFRIG to such a proposal. This organisation is a Parastatal, already receiving substantial aid to rehabilitate its slaughtering and meat processing facilities in Lusaka and elsewhere and like many organisations in Zambia is experiencing some financial difficulties. However, conversations with the senior management of ZANFRIG and its owner ZIMCO revealed no objection to the proposal that the plant be rehabilitated and used for processing collected offal.

Finally, the organisation and operation of collection of the different materials involved and their existing batch processing to the different products requires experienced management and good flexible control for it to be successful, because the material is very perishable. In this respect, the presence of such experience in ZANFRIG is a considerable asset. Also the organisation can already handle excess bone by collection, drying and burning.

K. Marketing of Byproduct meals and their value.

Difficulties are apparent in both these areas. Firstly the amounts produced will be relatively small. Secondly, National Milling controls 70% of the compound feed production of Zambia. It is likely that disposal will be primarily ^{to} pig and poultry producers mixing their own feed, as the quantities available will probably be too small to interest National Milling. The small tonnes of fat produced are likely to be sold for soap and chemical production.

With rapidly escalating prices of animal feed and raw materials in Zambia it is very difficult to assess the commercial value of these products. Nevertheless some assessment will be attempted. The following table shows some comparative prices.

Table 9. Price/t of various feed ingredients (K)

	<u>Zambia</u>	<u>Current U.K</u> <u>(ask equivalent)</u>
Soya cake	15,000	10,500
Full Fat Soya	19,500	14,500
Sunflower (23%)	9,500	? 6,500
Meat (carcass) meal	35,000	11,745 (meat & bone)
Dicalcium Phosphate (17% P)	16,200 (yr old price)	16,200
Bone Ash (15% P)	23,000	
Bone meal (15% P)	13,000	
Feather meal	-	
Blood meal	60,000	
Low grade tallow	32,000	10,700

The local price of protein sources (obtained from National Milling) is generally higher than the world prices as represented by the U.K. This merely reflects the lack of production within Zambia and the chronic shortage of such raw materials. The relative value of the feed materials produced by any such processing plant will continue to reflect this situation until there is a substantial increase in the output of vegetable proteins. The price of dicalcium phosphate differs less from international values, but this price is historic. The noticeable higher value of bone ash more truly reflects the local value of material supplying nutrient P.

The values of products from processing to be used in the valuation of the output of this plant may be derived as follows, principally from the above:-

Table 10. Value of outputs.

	<u>K/kg</u>
Blood meal	60
Carcass/meat and bone meal	40 (48 - 50% Protein)
Feather meal	40 (80% Protein but low grade protein)
Tallow	32
Bone ash	23

These values are very approximate and highly unstable. The original values assessed in the provisional financial analysis of the project were 52 K/kg for Blood meal, which we have increased to reflect current values for blood meal sold from the ZAMFRIG plant. The value of carcass/meat and bone meal has been decreased from 48K to 40K/kg since this is currently sold from ZAMFRIG at 35K/kg.

Table 11. Potential Annual Output of ZAMFRIG Plant and its value.

	<u>t/year</u>			
	<u>Wet</u>	<u>Dry product</u>	<u>Value/kg (K)</u>	<u>Total value (K)</u>
Blood	433	85	60	5100,000
Carcass/offal	171	60 +5 tallow	40 32	2400,000 160,000
Feather (wet)	291	73	40	2920,000
	—	—		—
Total	895	223	K	10,580,000
	—	—		—

Using the values given in Table 10 and the total quantity of material available, (Table 8), one can derive an estimate of the maximum value of the annual produce of the plant assuming that all the material available is properly collected and processed. This is shown in Table 11. The annual value of the output is about 10.5 million K, of which 49% is derived from processing blood, and a further 28% from feathers. Of these total quantities around 50% of the blood available and 44% of the carcass/offal is already processed by the ZAMFRIG plant.

L. Rehabilitation of the ZAMFRIG Plant

Time did not allow a proper assessment of the costs of rehabilitation of this plant to put it into full operation. These should be examined in more detail, but they should be considerably less than the cost of building a new plant as the infrastructure and much of the equipment are already in place. Since the total amount of wet material likely to be available for processing in the Lusaka area is less than 1000t/year and since this plant with 2 x 3000l cookers has a single shift capacity of over 2000t slaughter wastes/year, upgrading its capacity to cope does not appear to present any tremendous practical difficulty, given the managerial will and the necessary finance.

The ZAMFRIG meat processing facility is currently being rehabilitated/ upgraded with aid from DANIDA. The Danish Engineer on site gave an off the cuff estimate of 2 to 5 M Danish Kroner (14.5 - 36.4 M K) as the sum likely to be involved. This is in the range of the cost of the machinery for a new package plant from Denmark of about one third capacity of the existing plant, and seems to be excessive.

The items that need attention are:-

1. Install existing Iwell Cooker ex Livingstone (350,000 K ?)
(Plus some rehabilitation of same - (Iwell cookers now handled by Douglas Rowson, India Road, Gloucester, GL1 4DR, England - 0452 29455, Fax 0452 307951)
2. Install cooker already on site for meat and bone meal production.
3. Replace 1 boiler (also used for main plant)
4. Repair Feed Blower for carcass meal.
5. Spare motor and reduction gear for cooker
6. Vacuum plant condenser for blood meal.
7. Installation to remove blood meal from cooker.
8. Install new centrifuge for fat extraction, already on site.

To these might have to be added storage hoppers and feeding device for feathers.

To establish a collection system a dedicated vehicle or vehicles would be needed - say a 5t truck with blood tank and appropriate pumping equipment, plus 2 men.

It is difficult to see why these improvements, repairs and amendments should begin to approach the cost of a new plant.

The principal increased operating cost would be running and manning the collection vehicle. The plant rehabilitation could be undertaken with the knowledge of its likely ultimate throughput, which is well below its potential capacity.

Some estimate of plant capital and running costs for a new plant with a single shift capacity of about 1000 t wet material/year are given in Annex III.

M. ZAMBIA - Conclusions and Recommendations

1. There is already ample potential processing capacity in the ZAMFRIG plant to cope with the total animal and poultry byproducts available for processing in the area of Lusaka.
2. The plant should therefore be rehabilitated and a collection service instituted to allow appropriate operation, as an experienced management and work force is already available.
3. It will probably be necessary to make some small payment for offals collected and this payment must be regular, as must be the operation of the collection service, e.g. twice weekly collection from all locations.
4. This same plant is already collecting bone and burning it to bone ash. Further collections of fresh bone can therefore either be handled in this way or small amounts of bone added to carcass meal to make meat and bone meal. There seems to be little need to process bone in any other way.
5. Standards of meat inspection, and of environmental control generally, should be tightened up. The Zambian Government should consider making meat inspection the responsibility of the Veterinary Department rather than Municipal authorities.
6. Encouragement should be given to the increased use of blood collection systems and development and sale of processed blood products for human food.

7. UNIDO should encourage the management of ZAMFRIG, ZIMCO and the Zambian Government to seek a proper aid package to put this plant rehabilitation and collection service into effect.

III MALAWI

A. General

In view of the changes already made in the structure of this project, the consultant devoted his 3½ days in Malawi to attempting a preliminary survey of the present supply of animal offals, concentrating on the area of Lilongwe. While conducting this survey, efforts were made with some success, to gather information about the situation at the other major centre of population at Blantyre/Limbe. These two major centres of population also include the only sizeable animal abattoirs, poultry processing plants, broiler production units and feed mills in Malawi.

B. Cattle Slaughtering.

Commercial cattle slaughtering is in the hands of the Cold Storage Co.Ltd., which has abattoirs at Lilongwe (visited by the consultant) and Blantyre. The Lilongwe plant apparently kills 100 - 250 cattle/week. (Average say 450/month). Pig slaughter is occasional because of the depredations of African Swine Fever, say 50/month. Cold Storage has a similar plant at Blantyre which kills about the same number of animals. Both plants are equipped with 30 year old processing plant which produces meat and bone meal, tallow and low quality blood meal from blood, condemned carcasses and offal and excess bone. These meals are sold principally to large scale poultry producers mixing their own feed. Condemnations at the Lilongwe plant are high (1 - 2% of cattle slaughtered), principally due to Tuberculosis. Meat inspection in these two abattoirs is carried out by the Veterinary Department, and meat is processed and sold from the plant. There is a slaughter house

at Mzuzu, but this slaughters only for private butchers, handling smaller numbers of animals with no facilities to handle byproducts. Some condemned offal at Lilongwe and Blantyre is already used for the production of petfood.

C. Poultry

Central Poultry, Lilongwe, produce broilers and slaughter about 8,500 birds/week. They have about two thirds of the market. The intestines are sold for human consumption. Blood and feathers, crop gizzard and other wastes are burnt. This organisation produces its own feed.

Near Blantyre, Press Poultry slaughter about 10,000 broilers/week which amounts to about $\frac{7}{8}$ of the market in that area.

D. Quantities of available Byproducts

The following tables set out the estimates of production of byproducts.

Table 12. Estimated Animal Offal available - Lilongwe Abbatoir

Slaughter - 5400 cattle/year @ ? 300 kg liveweight.

Condemned - say 100/year = 28 t material

Condemned Offal = 12 t

Blood = 48 t/year

is already

Most condemned offal and some blood/used in pet food.

Hence Availability of material:-

Condemnations + bones = 90t = 36 t High ash meat and bone meal

+ 10 t Tallow

Blood - 48 t = 10 t Blood Meal

Table 13. Estimated Poultry Offal available - Central Poultry, Lilongwe

Slaughter - 425,000 birds/year.

Total Liveweight say 700t/year, producing approximately:-

80 t wet feathers and minor offals = 20 t Feather meal

19 t Blood = 4 t Blood meal.

Assuming that this operation has two thirds of the market, the following additional quantities are available elsewhere in the Lilongwe area:-

40 t Wet feathers and minor offals = 10 t Feather meal

9 t Blood = 2 t Blood meal

The total quantities of poultry offals available in the Lilongwe area are therefore:-

120 t Wet feathers and minor offals

28 t Blood.

Similar calculations for the Blantyre area are summarized in

Table 14.

Table 14. Estimated quantities of animal and poultry offals available in the Blantyre area (t/annum).

1. Blantyre Abattoir (as Lilongwe)

		<u>Potential Product</u>
Condemnations	40 t)	36 t high ash meat and bone meal 10 t Tallow 1) t Blood meal.
Bones	50 t)	
Blood	48 t)	

2. Press Poultry

		<u>Potential Product</u>
Wet Feather and Minor Offals	100 t	25 t Feather meal
Blood	23 t	5 t Blood meal

3. Other Poultry

Wet feather and Minor Offals	12 t	3 t Feather meal
Blood	3 t	0.5 t Blood meal.

E. Discussion and Recommendations - Malawi.

In the case of Malawi, the distance between the Lilongwe and Blantyre areas is such that a common central processing unit is not feasible. Furthermore, the poultry offals are produced in privately owned plants as part of integrated operations which also produce their own feeds. One of these operations is already buying an extrusion unit to heat and process whole soya for feed use. It is therefore possible that the use of such equipment will ultimately extend to coprocessing blood and feather with dry ingredients as described in Part I above, to recycle these wastes as poultry feed on site, unless the rehabilitation of the Parastatal abattoir byproducts plants includes the institution of a proper collection and processing service such as that envisaged for Lusaka.

With regard to rehabilitation required, it is clear that the plant at Lilongwe was extremely old and considerably dilapidated although still working, any spare parts being manufactured locally. We understand that the plant at Blantyre is in a similar condition. We recommend that consideration be given to their replacement with updated smaller plants, and that a proper feasibility study be conducted on this, including consideration of whether or not a collection service should be established to process poultry feathers and blood in the same plant, or whether it is better to leave the processing and use of this material to the poultry producers.

IV DISCUSSION

This report amply illustrates the difficulty of achieving satisfactory processing of animal and poultry byproducts for use in animal feeds in developing countries in Africa, although this may be highly desirable as a means of turning potentially noxious wastes into valuable feed materials. These difficulties have two main origins:-

1. Modern byproducts processing plant is very expensive in terms of capital cost because of the complexity needed to ensure proper control of the process, because of the standard of construction needed to ensure safe operation with steam at high pressure, and because of the mechanical force needed to e.g. break down and process condemned carcasses. The result is that smaller scale plant offers little saving in capital cost, i.e. the capital cost/t processed rises substantially at lower levels of throughput.

2. The supply of material in a developing country, short of animal protein, with the human population making good nutritional use of material regarded as waste in the developed world, with few slaughter points with even moderate throughputs of animals or poultry, make it very difficult to arrange an adequate and consistent throughput of material to support economic operation of even the most modest processing plant. Add to this the difficulties of management and the cost of transport, and the present situation is not surprising.

For these reasons alone, it cannot be sensible to do other than to build on the expertise, equipment and existing practice, such as it is, in both the countries covered by this report, until such time as alternative technology appropriate to mini-scale operation in Africa becomes available. Perhaps UNIDO should consider supporting efforts, e.g. at NRI to improve such technologies.

For these principal reasons we recommend that the ZAMFRIG plant in Lusaka be rehabilitated and a collection service set up, and that the present operations in Malawi be looked at in more detail to see if they can be improved. Collection and burning of bones to ash should continue as it is relatively safe, simple and cheap, and produces a usable end product.

V. RECOMMENDATIONS

1. That no further action be taken by UNIDO regarding the transfer of bone processing technology from Keyna to Zambia.

2. That a project be established using aid funds to appropriately rehabilitate the ZAMFRIG Byproducts processing plant in Lusaka and to institute a collection service to collect available animal and poultry offals, and bone from other locations. Action - UNIDO, Government of Zambia, Managements of ZIMCO and ZAMFRIG, and ? DANIDA or other aid agency.

3. It is suggested that the Government of Zambia should consider the transfer of responsibility for meat inspection from the municipalities to the veterinary authorities. Action - Government of Zambia.

4. Since properly collected and processed blood is a nutritionally valuable human food, every encouragement should be given to its appropriate collection and use for this purpose, and the enlargement of the market for such produce. Action - Managements of all slaughter plants.

5. That a similar package be the subject of detailed assessment for Malawi covering (a) minimum rehabilitation of existing byproduct processing plants, (b) consideration of a collection service for poultry feathers and blood to be processed in the same plants, or (c) encouragement for poultry processing plants to incorporate these particular byproducts in their own feed. Action - UNIDO, Government of Malawi, Cold Storage Co.Ltd, management, Private Poultry plant managements.

ANNEX I. JOB DESCRIPTION

XP/ZAM/90/037/11-54/ J 14101

Post title International Expert in Technical Aspects of Fodder Production.

Purpose of project To evaluate the technical, economic and financial viability of the development of an industry producing bone meal for animal fodder in Zambia. The project will take full advantage of the positive experience gained in bone meal production in Kenya and assess the applicability of the Zambian results to Malawi.

Duties In close co-operation with the following Government counterpart authorities, the Ministry of Commerce and Industry, the National Commission for Development Planning (NCDP), the UNDP office in Zambia and the other members of the international team, the expert will specifically be expected to carry out the following duties:

- To carry out a technical analysis of the production of bone meal in Zambia, with particular reference to the relevance of the Kenyan experience;
- To critically examine the aspects of the establishment of a blood and bone meal factory related among others to the technology employed, product engineering generally, raw materials supply, manpower skills and environmental impact;
- To prepare a technical report containing the technical component of the pre-investment analysis, together with conclusions and recommendations to the Government for future action.
- The expert will also provide to the team leader (the financial analyst) all data and information required for drafting the final report. He or she will also be required to provide all data required for the COMFAR calculations.

ANNEX II Itinerary and List of Discussions 1990

November 18th Arrive Lusaka
" 19th UNDP and Mr Ngoma, Buyer, National Milling Corporation
" 20th ZAPP, Mr Walmsley
" 21st " " and colleagues.
" 22nd " Mr Michael Galaun, Lusaka Cold Storage Co.
" 23rd ZANFRIG - Mr Saidi, Production Manager, Kyindu Farms, Mr Irwin.
" 26th ZAPP
" 27th UNDP, ZANFRIG, National Milling - Dr Chako, Commercial Farmers Bureau, Mr Hudson
" 28th Kyindu Farms - Mr Risbey, ZANFRIG - Mr Popopo
" 29th ZAPP, Lusaka Veterinary Admin. - Dr Songolo ZIMCO, - Mr Libakeni
" 30th ZAPP, ZANFRIG. - Mr Nielsen (DANIDA). Poultry Processing Co., - Mr Chambeshi NDCP - Mr Patrick Nkanza
December 1 Patrick Nkandu - UNIDO
December 2nd Lilongwe.
3rd UNDP. Mr Chris.Kichiza - Ministry of Trade, Industry and Tourism
4th Mr Khulewa, Cold Storage Corporation
Mr Chizombe - Grain and Milling Ltd.
Mr T. Barrett - British Development Division, Phone: Mr Leech UNIDO Hides & Skins project.
5th UNDP Ms A. Schuckler FAO
Phone - Deputy Chief Veterinary Officer - Dr Msiska
Mr Leon Swart - Central Poultry Lilongwe
Dr M.C.N. Jayasuriya, FAO Crop Residues and agro-industrial wastes project
6th UNDP, and depart.

ANNEX III Capital Costs of Modern Byproducts Processing Plant (Zambia)

Type - Lildahl MINIPAC 2500 (Package unit, including boiler)
(ex J. Lildahl A/S. P.O Box 26, Gl. Hobrovej 114
DK - 8900 Randers Denmark. Phone +45 6433355
Fax. +456 415171)

Throughput - 4 t wet raw material/day in one 9 hour shift.

<u>Cost.</u>	Ex Randers	2,700,000 D.Kr.	(19,656,000 K)
	Transport to Lusaka		(405,000 K)
	Erection/Installation		(500,000 K)
	Local civil works (base & building)		(1,000,000K)
	Crane hire		(20,000 K)
	Training Supervisor and operatives		(250,000 K)
			<hr/>
		TOTAL	21,821,000 K
			<hr/> <hr/>

To this must be added the cost of a prebreaker and crusher for handling carcass and bones.

Similar plants are available from Haarslev Machinfabrik A/S Bogensevej 85, Haarslev P.O Box 65, 5400 Bogense Denmark, Phone +45 64831225, Fax +45 64831229

For Collection Service

1 x 5 t Truck	K 4,000,000
Ancillary equipment tanks/pumps etc.	50,000
	<hr/>
	K. 4,050,000
	<hr/> <hr/>

Direct running costs at 80% of rated throughput

<u>Labour</u>		<u>K/year</u>	
1 Supervisor		60,000	
2 Drivers		90,000	
2 Lorry Mates		70,000	
2 Machine Operators		88,800	
2 Labourers		70,000	
		—	
Total Labour		378,800 K	
		—	
Plant Electricity	270 Units/d	20,000	
Oil	315 l/d	1,844,600	
Truck Diesel	(50l/week)	75,000	1,939,600 K
		—	—
Water	6000 l/day	?	
<u>Maintenance and repairs</u>			
2% of capital cost		450,000	
Overheads (Office/phone etc) say		40,000	
TOTAL:		<u>K 2,808,400</u>	

or 2,808 K/t. wet material processed/year
at 1000 t/year.

Plus cost of purchase of offal from outside suppliers.