THE USE OF AGRO-INDUSTRIAL BY-PRODUCTS IN LIVESTOCK FEEDING DELIVERED BY

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WHAT IS A BY-PRODUCT?

By-Products can be divided into two broad groups namely, those of plant origin and slaughter house by-products. By-products of plant origin are usually cakes or meals obtained after extracting the oils from the seeds/fruits. They were formerly being referred to as waste-products because they were not put into any economic use. They were only of nuisance value. Development of livestock industry elevated their position from waste-products to by-products as they become essential inputs in livestock feeding. In these days of scarcity of virtually all raw materials the oil millers would rather prefer referring to these raw materials as joint-products instead of by-products.

By-products of animal origin (offals) are used to denote every part or particle which is not in the dressed carcass. Organs such as kidney, brain, liver, heart, tongue, extail, the intestinal tract, and gullet are edible by-products while ears, lips, snout, teeth, fetus, gall bladder, trimmings, hoofs, horns, hair are unedible by-products. Animals which die prior to slaughter or failed to pass meat inspection as fit for human consumption are also unedible. However, the basic factor making distinction between edible and inedible by-products is determined by the purchasing power of the consumer, his food habits, religion and customs.

The higher the income of the consumer, the higher the percentage of potentially edible offal which is used for inedible products. In U.S.A., for example, the whole

of the head, the feet, most of the tripe, and certain other parts are as a matter of routine converted into feed stock while in this country such parts as the lung, tripe, kidney, heart, head and even the hides and skins (Ponmo) are delicacy and even earn some premium over certain parts. Records from the Ministry of Trade show that exportation of Hides and Skins have continued to be on the decline. While the main reason for the decline may be the opening of Tanneries in the country, local consumption in form of "Ponmo" has also contributed in no small measure.

A study on by-products will not be complete without a brief review of the various processing techniques. The by-products of animal origin can be subdivided into two parts, viz: those of slaughterhouse and those derived from fish processing. The by-products of plant origin are mainly those of oil seeds, milling and brewing industries.

Slaughterhouse by-products include meat meal, meat and bone meal, burnt or steamed bone meal, blood meal and hydrolysed feather meal. Meat meal and meat and bone meal are not available in commercial quantity to justify installation of rendering plant for reasons which will be elaborated under factors limiting the use of agro-industrial by-products in animal feeds.

Hydrolysed feather meal and blood meal are very high in crude protein and other nutrients but have lower digestibility than other by-products of animal origin like meat and bone meal and fish meal. There are no large broiler processing

plants in the country to make available large quantity of feathers to convert to feather meal. Until recently dressed chickens have not been in great demand because most Nigerians prefer purchasing live birds to be slaughtered in their different homes. The demand for broiler meat has been on the increase, a factor that will encourage the establishment of large commercial broiler farms with feather meal as one of the by-products.

Burnt bone meal is the only by-product of slaughterhouse that is available in large quantity for inclusion in livestock feeds. It contains a high level of calcium and phosphorus which are essential for the physiological functions of the livestock (see Table 1 attached). Unlike raw meat meal, raw bone does not deteriorate as fast; it does not need any special handling. By the very method of processing (burning) all the harmful micro-organisms are eliminated.

Through the years we have found this product a very dependable source of calcium and phosphorus in all our rations. In recent times the supply has continued to dwindle due to increase in de-

mand. There is no processing plant for the manufacture of steamed bone meal. The major constraint is the large capital involved in setting up such a plant as compared to the simple art of burning involved in processing burnt bone.

Fish by-products include the tail, fins, head and the intestine. In this country, the fish is sold whole as fresh or in frozen form. It is therefore difficult and uneconomic to collect the fins, heads and intestines for processing as fish meal. The locally available smoked fish scrabs is a possible source of fish meal. This form is popularly called Chad Fish Meal because it is from Lake Chad area. This form of fish meal is low in protein both in terms of quantity and quality while it is high in fibre, oil, calcium, silica, and phosphorus.

The general belief is that the suppliers adulterate the product by adding sand and vegetable materials. Investigations were carried out to find out the method of processing in order to find out at what stage adulteration is carried out. Our investigations revealed there is no deliberate adulteration, rather the processing techni-

TABLE 1

II ANIMAL BY-PRODUCTS

		<i>Fish Meal (Imported)</i>	<i>Fish Meal (Local)</i>	<i>Blood Meal</i>	<i>Meat & Bone Mil Powder Meal</i>	<i>Bone Meal</i>
Crude Protein	%	65	20—40	45.0	33.0	—
Oil	%	4.5	8—12	1.0	8.0	0.5
Fibre	%	1.0	5—8	1.0	2.0	0.0
Calcium	%	6.1	9.0	0.28	10.0	1.25
Phosphorus	%	3.0	3.5	0.28	5.1	1.0
Lysine	%	4.5	1.5—2.5	6.9	2.2	2.5
Methionine	%	1.8	0.9—1.2	1.0	0.53	0.90
T.D.N.		70	—	61	63	85
M.E. Kcal/kg		2860	—	3080	2222	2506

que is responsible. When the fish is caught it is usually roasted by putting directly on a burning grass heap. It is then sun dired on the bare ground. The fish is thus contaminated with burnt grass and sand. It is a well known fact that the Chad whole fish obtained in this form has to be boiled and thoroughly washed to remove the sand before it can be cooked for human consumption. I must admit here that there were a few cases of good processing method with less foreign bodies.

The method of processing is largely responsible for the poor nutrient values of the locally available fish meal. Analysis reports have shown very wide variations in values. We have got samples with protein content as high as 50 per cent and those with values as low as 18 per cent. These wide variations in values coupled with poor keeping quality have made it impossible for use to include it in our formulation. We have to continue to use the imported brand of fish meal. The Ministry of Agriculture in the affected State(s) should initiate a programme to improve the processing technique in order

to harness this potential source of revenue.

The conversion of the slaughterhouse by-products into stock feed can be achieved by using simple methods that require less sophisticated equipments. The raw by-products undergo three main stages, i.e. sterilization by boiling to make the product safe for use as stock feed; reduction of the moisture to a minimum in order to create conditions unfavourable for bacteria growth; and recovering the fat from sterilised and dried meal which would otherwise cause rancidity.

The by-products of plant origin of greatest importance are the oil seed cakes, namely, groundnut cake, cotton seed cake, palm kernel cake, soya bean cake and others. These cakes are products of either expeller or solvent extraction methods. There are giant oil mills in Kano, Maiduguri, Zaria, and Gusau extracting the respective oils from the seeds. In all cases, the oil is the principal product while the cake is a secondary product.

Table II shows the purchase of groundnuts, cotton seed and palm kernel made

TABLE II
Purchases by Marketing Boards^{a/}
(⁰000 long tons)

<i>Year^{b/}</i>	<i>Groundnuts</i>	<i>Cotton seed</i>	<i>Palm kernel</i>
1965/66	933	85	449
66/67	1027	98	418
67/68	687	59	420
68/69	769	111	191
69/70	645	171	231
70/71	281	72	291
71/72	302	69	243
72/73	545	89	271
73/74	44	55	231
74/75	162	97	293

a/ Reported by Marketing Boards and Monthly Reports of Central Bank of Nigeria.

b/ For groundnut and cotton seed, crop year extends from October to October; for palm kernel, crop year equals? 4065/66 refers to 1965 only.

by the Marketing Boards. 1973/74 was the year of drought and the sharp drop from 545,000 tons previous year to 44,000 tons was responsible for the feed crisis of that year that forced most of the poultry farmers to close down. The price of groundnut cake rose from sixty naira a ton to three hundred naira per ton in less than three months. The situation was worsened by the fact that even at that exorbitant price, the cake was not available. The situation improved during the following year but the price level dropped but not to the pre-1973 year.

Between 1974 and 1976, we enjoyed the honeymoon and we had regular supply of groundnut cake even though at a relatively high acquisition cost. In 1976/77 there was the Marketing Board system review and Commodity Boards were created. These Boards were given wider powers on both the raw groundnuts and its products — oil and cakes. In 1976/77 season, the Groundnut Board was able to purchase only twelve thousand (12,000) tons of raw groundnuts as compared to one million and twenty seven thousand (1,027,000) tons purchased ten years earlier 1966/67.

The failure to purchase the groundnut was partly due to poor harvest and the pricing policy of the Board. The Board introduced toll crushing scheme in which the oil millers would be supplied the nuts for crushing in return for a fee. In return the oil millers will give back to the Board all the oil and the cake. This kind of scheme will, of course, generate a lot of heat. The oil millers on their part insisted that payment of crushing fee would not be attractive enough for them to re-activate their various mills that have been idle for months. The Board on its part insisted that the status setting it up confer ownership of all products/by-products of oil cakes on it. This state of impasse continued for several months while we watched the stock of groundnut cake dropped below the re-order level. Frantic efforts

were made by major feed millers to reconcile the two parties while importation had to be resorted to as a short-term measure. The adage that “when two elephants fight it is the grass that will suffer” could not be more than true in this case.

The price of groundnut cake rose from about one hundred naira (N100) per ton in February, 1977 to about two hundred and fifty naira (N250) per ton in September of the same year. The condition has continued to deteriorate and importation of groundnut cake on a permanent basis became the rule rather than the exception. With importation of groundnut cake added to those of maize, fish meal and additives more than 70 per cent of feed ingredients is imported. This dependence on imported feed ingredients has contributed greatly to the increases in prices of animal feeds.

It cannot be true that only 12,000 tons of groundnuts were harvested in Nigeria in 1976/77 season, poor harvest notwithstanding. The producer price of the groundnut should be fixed in such a way that it will not be attractive for the farmers to smuggle it across the boarder. The usual reasons adduced for buying the groundnuts below the market price are no more valid. The question of subsidising the price during the time of glut could be valid up to 1974 when about 90 per cent of the purchases of Marketing Boards were being exported. It is too soon to condemn the toll crushing scheme but it should be approached with more flexibility. Powers are given to the different government boards to create and not to destroy.

The cotton seed cake is high in protein and other nutrients but the presence of “Gosypol” which is poisonous to pigs and poultry has restricted its use in compound feeds. Over 90 per cent of the commercially available feeds are in the form of poultry and pig feed. Inclusion of as low as 5 per cent of cotton seed meal in pig ration has caused reduction in growth rate and other undesirable effects. Laying

flock fed 5 per cent of cotton seed meal in their diets have laid eggs with olive green yolk if stored for more than three days. The presence of gossypol in cotton seed meal has thus restricted its use to ruminant feeds. Attempts have been made to degossypolise the cotton seed meal by making the gossypol unavailable. These attempts have not met with great success because of the economic of degossypolising.

Soyabean is produced mainly in the middle belt of the country and it is an export crop. None of the oil mills process it and there is as yet no plan to process it locally. Soyabean meal is a very good source of protein which is higher in lysine than both the groundnut and cotton seed cakes. It is only surpassed in quality by protein of animal origin. During the 1973/74 crisis attempts were made to use the raw soyabean but owing to the high level of oil and antitryptic factor in the seed its use had to be removed from diets of poultry and pigs. Research results from mainly the U.S.A. and have proved conclusively that the "anti-tryptic factor" can be rendered harmless by passing the raw soyabean through an Extruder Cooker. Local use of soyabean and oil seeds will reduce the pressure on groundnut.

By-products of milling industry are mainly wheat offals and rice bran,

rice husk, rice polish and broken rice. Table V shows the present and future Flour Milling situation in Nigeria, and availability of by-products. 320,000 tons of wheat offal is estimated to be available in 1980 when all the mills start functioning. Wheat offal contains about 17 per cent protein and about 8% crude fibre. It is a fair source of energy. It is about the only by-product that is available in sufficient quantity in spite of the fact that about 70 per cent of it is exported in pelleted form. All the flour mills are located on the coastline except for the one set up in Kano. This situation made the use of this valuable raw material uneconomical in areas far away from the location of the flour mills as a result of high transportation cost.

The different components of the rice by-products are not easily available as individual products; rather a mixture of most of the products with a high content of the husk is made available as rice bran. The "rice bran" commonly available has fibre content as high as 30 per cent as against the expected 12.5 per cent. The main reason for this has been the method of processing. Except for the rice mills in Jos, Kwara and Ota/Ifo in Ogun State, most rice mills currently in use cannot separate the bran from the husk. The broken rice could not be used in the feed industry because its price is higher than

TABLE III

Nutrient Values of By-Products of Plant Origin

		Groundnut Cake	Soyabean Meal Ext.	Cashew Nuts	Palm Kernel Meal	Coconut Meal	Cotton Seed Cake
Crude Protein	%	48-52	46.0	20.0	18-20	20.0	42
Oil	%	6.0	1.0	38.0	6.0	6.0	37
Fibre	%	5.0	5.2	4.0	12.0	12.0	14.00
Total Phosphorus	%	0.6	1.0	0.45	0.48	0.60	.9
Calcium	%	0.20	0.21	0.05	0.21	0.20	0.15
Lysine	%	1.6	3.0	0.90	0.64	0.70	1.6
Methionine	%	0.48	0.63	0.30	0.39	0.31	0.55
T.D.N.	%	80	78.0	75	70	75	71
M.E. Kcal/kg		2640	2420	2860	2178	1870	1980

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TABLE IV

Nutrient Values of By-Products of Plant Origin

		<i>Wheat Offals</i>	<i>Rice Bran</i>	<i>Brewers Yeast +</i>		<i>Dried Bre- wers Grains</i>
Crude Protein	%	17.0	11.0	35—40	3.0	18—20
Oil	%	3.5	12.5	1.0	0.0	6.0
Fibre	%	8.5	12.5	3.0	0.0	20.0
Calcium	%	0.10	0.04	0.10	0.5	0.20
Phosphorus	%	0.90	1.42	1.4	0.05	0.05
Lysine	%	0.9	0.50	3.4	0.0	0.9
Methionine	%	0.25	0.24	0.70	0.0	0.40
T.D.N.		62	72	75	53	50
M.E. Kcal/kg.		1870	2860	2420	1950	1960

TABLE V

The Present and Future Flour Milling Situation in Nigeria, Showing By-product Availability

<i>Name</i>	<i>Name of Mills Local</i>	<i>Installed Capacity (tons)</i>	<i>Utilized Capacity (tons)</i>	<i>Estimated Present Availability of Wheat offals 1975 (tons)</i>	<i>Projected Capacity in tons (1980)</i>	<i>+ Estimated Potential availability of wheat offals in 1980 (Tons)</i>
Flour Mills of Nigeria Limited	Apapa, Lagos	630,000	630,000	176,400	630,000	176,400
Port-Harcourt Flour Mills	Port-Harcourt	40,320	40,320	11,290	90,000	25,200
Life Flour Mills	Sapele	60,000	45,000	12,600	180,000	50,400
Northern Flour Mills	Kano	60,000	45,000	12,600	75,000	21,000
Crown Flour Mills	Lagos*	—	—	—	105,000	29,400
Niger Best Flour Mills	Calabar*	—	—	—	—	7280
Johnson Consolidated Industries, Limited Flour Mills	Maiduguri*	—	—	—	39,000	10,920
TOTAL		790,320	760,320	212,890	1,145,000	320,600

those of most cereals.

BREWING AND MALTING BY-PRODUCTS:

Feed by-products of the brewing and allied malting industries are brewers grains, brewers dried yeast, malt sprouts and dried spent hops. Brewers dried grains are defined as the dried, extracted residuum of barley malt, alone or in mixture with other cereal resulting from the manufacture of wort. Dried brewers grains (DBG) and Dried Brewers Yeast (DBY) are the main by-products of brewing industry in Nigeria available for use in livestock feeding. Most breweries do not make these by-products available in the dried form for livestock feeding, rather they contract out the disposal of the wet products. However, for more than a decade Guinness Breweries at Ikeja and Benin has been making available the dried yeast and grain to the feed industry for inclusion in the rations.

Brewers Grains are intermediate in protein content ranking above rice bran. It is suitable for inclusion in dairy, beef cattle, sheep and goats and horses up to

25—30% while only between 3 and 6% should be included in pig and poultry feeds because of the high fibre content.

The composition of yeasts varies with strains and conditions of growth. Table shows composition of both dried brewers grains and yeast. Brewers yeast contain a high level of protein with a full complement of amino acids. It also contains carbohydrate, minerals and a high amount of the B vitamins. There are two types of yeasts in use in animal feed, namely, dried brewers yeast and to a lesser extent primarily yeast such as *Torulopsis utilis* grown specifically for feed purposes. In this country only the former is available for use while growing of yeast in commercial rate is yet to be developed.

Yeast is an excellent source of protein of high biological value for poultry, cattle, sheep, pigs, horses and lather animals. Yeast protein is intermediate in nutritive value between high value of good animal proteins and that of inferior vegetable proteins. It is however, deficient in methionine; this has reduced its replacement value for animal protein.

TABLE VI

Composition on Some Cereal and Cereal By-Products

Common Names	Number of Sample Analysed	Dry Matter	Crude Protein	Crude Fibre	Either Extract	Total Ash	Nitrogen-free Extract
Maize	(22)	84.94	10.42	3.14	3.82	2.14	80.84
Maize germ meal	/1/	89.00	13.00	4.10	12.50	3.60	55.80
Maize gluten meal	/1/	90.3	24.80	7.20	2.50	7.70	48.10
Brown rice	(6)	86.64	8.30	8.80	1.80	5.00	64.70
Rice bran I	(2)	90.34	4.99	26.42	1.67	34.97	22.29
Rice bran II	(3)	88.94	11.46	18.22	17.79	11.21	30.22
Rice bran III	(5)	88.43	11.66	18.56	19.58	12.23	26.40
Guinea corn	(10)	87.52	10.46	2.48	3.34	4.86	78.86
Millet	(9)	86.54	11.42	3.14	4.54	5.22	75.68
Wheat offals	(6)	87.94	16.82	11.24	4.54	6.31	61.09
Brewers dried grains	(4)	89.42	17.48	18.44	7.2	4.21	52.66

COMPOSITION OF COCOA NIBS, SHELL AND GERMS AND POD:

In recent times there have been a lot of reports on the use of cocoa pods in animal feed. It has been found that the cereal portion of sheep and goats ration can be replaced by 20—25 per cent dried cocoa pods while inclusion as high as 20 per cent dried cocoa pods may be included in the diet of poultry with a concomittant saving in feed cost even though progressive deceases in growth rate of birds were observed. The major draw-back in the commercial exploitation of the cocoa pods is that cost of gathering from individual farms is prohibitive.

Cocoa shells are unsuitable for human consumption because of the high fibre content neither are they used to any large extent as a cattle feed as only small fraction of the nitrogen is digestable. In addition some animals especially horses seem to be sensitive to the theobromine (3,7-dimethylxanthine) in the shells.

The by-product of cocoa and chocolate manufacture are cocoa shells and cocoa germs. Fermented cocoa consist of approximately 88 to 90% coty-ledon 0.7% germ and between 10 and 11 shell.

The limited use of dried fruit waste in animal feed has been due largely to non-availability of these product in the forms suitable for inclusion in animal feeds. The same applies to yam and cassava peels which are available mainly in the raw form. Yam peel is a by-product of the instant yam flour (POUNDO YAM) industry while cassava peel is a by-product of the garri processing plant. These two products are high in energy and could be used to substitute cereals in the rations of livestock.

Molasses and baggase are the two by-products of the sugar processing plant. The baggase is usually burnt as fuel in the sugar factory. Cane molasses is a good source of nutrients for cattle especially during the dry season. It is a major ingredient in the manufacture of protein block

for dry season feeding of cattle. Most of the molasses produced at Bacita is used by the alcohol manufacturing company adjacent to the sugar factory. This has considerably reduced the amount of molasses available for livestock feeding. However, vanase or slop, a by-product distillation of molasses is also a good source of nutrient for ruminant animals.

Benefits derived from the use of by-products are numerous. When available it can be used to reduce our dependence on imported feed ingredients which constitute a drain on our foreign exchange. Conversion of by-products of slaughterhouse helps to improve environmental sanitation. The by-products: blood, trimmings, fleshings, and condemned organs attract flies, rats and other vermin thus causing a public nuisance. In this country, the butcher is compelled by law to dispose of a condemned carcass or organ by burning or burying under the supervision of a meat inspector. This procedure tends to create hostility and destroy goodwill between the butcher and the meat inspector. If however, the butcher is able to convert the condemned carcass into animal by-products which will earn him some income the usual mistrust between the butcher and the meat inspector would have been considerably reduced.

By-products such as meat and bone meal, bone meal are good source of calcium, phosphorus, protein, vitamin B12 and essential amino acids such as lysine and methionine. Low grade fats and grease, unsuitable for human consumption, when mixed into poultry rations, will not only control dustiness but also assist in optimum feed conversion by acting as high calorific fuels with other foods.

The wasteful disposal of inedible offals needs little or no manpower while the conversion of these offals into by-products creates new employment opportunities not only at the place of produc-

TABLE VII

*Proximate Composition of Some Dried Fruit Wastes Usable as Animal Feeds**

Common Names	Number of Samples	Dry Matter		Crude Protein		Crude Fibre		Ether Extract		Total Ash		Nitrogen-free	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Orange pulp	(8)	92.6	91—94	4.3	42—48	12.1	11—15	1.23	1.0—1.9	4.7	4.3—5.2	77.7	76—78
Grape pulp	(8)	93.9	93—94	4.1	4.1—4.8	10.2	10—12	3.7	3.2—4.2	4.1	3.4—4.5	77.9	79—81
Pineapple pulp	(10)	90.5	89—92	3.0	2.0—3.6	9.6	10.3—11.9	3.8	3.2—4.4	3.9	3.4—4.3	79.8	79—81
Pineapple bran	(12)	90.2	89—92	3.2	3.2—4.3	15.1	14.1—16.8	1.2	1.1—1.6	4.4	4.1—4.8	76.1	75—78
Pineapple tops	(4)	92.1	91—93	6.1	6.6—6.8	19.8	19.7—20.1	1.5	1.2—2.4	6.5	5.4—6.9	66.2	65—67
Tomato pulp	(11)	91.5	89—94	18.3	17—19	16.8	16—18	6.5	6.2—7.0	9.9	9.3—10.4	48.6	46—51

Livestock Feed study report by the Study team Commissioned by the Federal Livestock Feed Department (PAGE 201).

TABLE VIII

Composition of Cocoa nibs, shell and germs and pod

Constituent	Fraction of Nibs (cotyledon)	Cocoa bean shells	Germs	Cocoa Pods
	%	%	%	%
Moisture	5.0	11.0	7.0	—
Fat	53.3	3.0	3.5	1.1
Crude protein	13.4	16.0	30.5	6.51
Tannins	5.8	9.0	—	—
Crude Fibre	2.6	16.5	2.9	30.25
Ash	2.8	6.5	6.5	—
Pentosans	1.5	6.0	—	—
Theobromine	1.4	0.7	3.0	—

tion but also in the secondary industries based on such raw materials. The provision of mobile processing plants could lead to the establishment of rural industries. By-products influence the price of the main products as the returns derive from the by-products may be used to cheapen the price of the main product.

The nitrogen, calcium and phosphate of the by-products, where they are found unsuitable for inclusion in animal feeds, can be converted into fertilizers to increase yield of field gardens and plantation.

The study team commissioned by the Federal Livestock Department has the following five reasons for the limited use of by-products in animal feeds:-

- (i) The unstandardized nature of several of the available by-products.
- (ii) The scattered facilities for the processing and handling of such by-products making large scale collection difficult.
- (iii) Their availability in forms unsuitable for direct utilization in animal feeds.
- (iv) A lack of information on their composition, and suitability as animal feeds and tolerable levels particularly in diets for simple stomached (mono-gastric) animals.
- (v) Lack of processing facilities for those by-products that require rendering and processing before use.

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