## Lecture 4

### USE OF AGRO-INDUSTRIAL BY-PRODUCTS/CROP RESIDUES IN RUMINANT FEEDING

**Why this alternative?**

One of the principal limiting factors in ruminant production is **feed shortage**.

- Forages are known to form a greater proportion of the ruminant's diet but availability of these forages in quantity and quality all year round is limited. This is due mainly to seasonal fluctuations, overgrazing and increased land use by man.
- The high cost of conventional feed resources such as cereals and legume grains prohibit their wide-scale use, especially by small scale farmers.
- Furthermore, the competitive demand for these conventional feed resources as food between livestock and man on one hand and between monogastric animals and ruminants on the other hand limits the quantity of these conventional feeds available for ruminant feeding.
- Population pressure and urbanization, particularly in Africa, will further limit the quantity of grains available for animal feeding.
- In view of the limitations to the use of conventional feeds for livestock feeding, it is best to resort to the use of those feed resources, which are cheap, less competitive and which the ruminant animal can convert to useful products.

**What definition do we then give to the term "*Alternative feed resources*?"**

Alternative feed resources could be regarded as those materials arising from plant and animal origin which are cheap, not competitive and readily available which can be fed to livestock as to overcome problems of feed shortage and high production cost and at the same time ensuring the preservation of animal health, production yield and product quality. Alternative feed resources abound which can be used in the diet of ruminants. Most of the feeds available to both man and animals primarily come from plant sources. It is rare that a crop plant can be completely used by man, most do yield some residues and by-products which if properly processed may be consumed by farm animals. ***Crop residues*** are the left-over that result from the **harvesting of crops** while ***crop by-products*** are the resultant materials that arise from the **processing of crops**.

Crop residues and agro-industrial by-products have become an increasingly important way of feeding ruminants due to the scarcity of feeds particularly during the long dry season. The usefulness of these by-products often centres upon their being produced on or near to the farm and upon whether they are available at the right time of the year.

**Agro-industrial by-products?** Agro-industrial by-products are waste products arising from the processing of crops or animal product usually by an agricultural firm. The resultant products from these industries are considered as waste since they are of little or no nutritional importance to humans. Agro-industrial by-products in the tropics are abundant and varied and represent a substantial resource for increasing animal production. The use of these by-products for supplementary livestock feeding is justified when the forage supply is inadequate for the animals' needs, either in terms of quantity or quality. Agro-industrial by-products in Nigeria vary from primary processing of farm produce wastes to wastes form agro allied industries. Some of these wastes are left unutilized, often causing environmental pollution and hazard. Those that are utilized do not have their full potentials harnessed. Agro-industrial by products which can be of tremendous use in the livestock industry for feeding animals include brewers dried grain (BDG), palm kernel cake (PKC), maize offal (MO), wheat offal (WO) and cassava peels (CP). As grain production remains insufficient to meet human and animal feeding, the alternative is to employ feed ingredients which do not have direct human value. BDG, MO, and WO are by-products of sorghum, maize and wheat processing. They are of low protein and high crude fibre contents. These are two factors that limit their use in monogastric (poultry and pig) feeding. In contrast however, as due to their ability to digest low quality feeds and roughages, ruminants can utilize these products more effectively than monogastric livestock, and in doing so, they are not competing for human feed resources.

The supply of agro-industrial by-products is considerably high but their rate of utilization is dependent on the chemical composition and the species of livestock intended to be fed. Wheat bran/offals are considered the most common followed by fresh or wet brewers' grains.

**Classification of Agro-industrial by-products**

Agro-industrial by-products can be grouped according to the content of nutrients namely:

i. **Energy sources**: these are rich in fermentable carbohydrates and low in protein (containing less than 20% crude protein). The best example is molasses traditionally

used as a carrier for urea in ruminant feeding. Molasses is produced in the two sugar industries in Nigeria: Numan, in Gongola State, and Bacita and Jebba in Kwara State.

ii. **Protein sources:** Protein supplements refer generally to those ingredients that contain more than 20% crude protein. Agro-industrial by-products that serve as protein sources are mostly the oilseed cakes. Palm oilseed cakes are produced in the southern part of Nigeria and form the most abundant and least expensive oilseed cake available. It is however notorious for being gritty and unpalatable. Cottonseed and groundnut cakes are also important although the latter had declined drastically about three decades ago and is only coming up again with this spirit of looking inwards.

iii. **Miscellaneous by-products** supplying both energy and protein: by-products considered under this category are from cereal (wheat bran and other brans from traditional grains like sorghum, millet, rice and maize), brewery (brewers' grains), fruit and vegetable industries (citrus pulp, tomato pulp).

iv. **Mineral sources:** these primarily supply minerals and are commonly from animal by-products example is bone meal, oyster shell.

**Cereal by-products**

By-products from the milling of grains find extensive use in the feeding of livestock. The dry milling products generally include brans and offals.

**Cereal brans**

This is the outer covering of grains separated during processing. They are obtained from the milling of wheat, maize or rice. Wheat bran was the most important cereal bran in the country. However brans from traditional grains (sorghum, millet, rice and maize) are growing rapidly in quantity. Brans will normally contain 9 - 18% crude protein and 10 - 14% crude fibre. They have a laxative action in the gut and because of their high fibre content can be used as nutrient diluents for monogastric animals. Usually, the amino-acid profile of bran protein is superior to that of the whole grain. They are high in phosphorus but low in calcium.

**Cereal offals**

This is made up of a mixture of small particles of the bran, germ and part of the aleurone layer. They usually have less than 7% crude fibre with a protein content varying from 10 - 20% depending on the grain.

**By-products from brewery industries**

Most cereal grains go into the production of alcoholic beverages. The production of alcohol from these grains involves grinding, cooking and addition of enzymes to hydrolyze starch to simple sugars and then yeast to cause fermentation. After fermentation, the alcohol is removed and the residue is available for livestock feeding. If the residue is used wet, it is referred to as *brewer's wet grain* (BWG) but if used dried, it is referred to as *brewer's dried grain* (BDG). Most of the breweries originally produced wet grains that were available on request. As the usefulness of the grains in livestock feeding became increasingly clear, some of these breweries started to dry some of their grains for sale. These dried grains constitute only 5% of the total produced. The composition of the brewer's dried grain varies depending on the grain used for brewing. The average BDG has about 18% crude protein and about 20% crude fibre.

**By-products from roots and tubers**

Roots and tubers are wide spread in Nigeria. These include yam, cassava, potato, beets and carrots. Most of the tubers are produced for human consumption. However, the processing of some of these crops produces substantial quantities of by-products which go into livestock feeding. The most common of these tubers is cassava. Cassava when dried contains less than 3% crude protein, 1.3% fat, 85% NFE, ME of about 3,500 - 3,700 kcal/kg. Cassava peels are richer in crude protein (5 - 6%) and fat (6%) than the tubers. The major problem with cassava is that the raw tubers contain linamarin, a cyanogenic glycoside and prussic acid. In the presence of enzyme linase, the glycoside is converted to β-glucose, acetone and hydrogen cyanide. This makes raw cassava poisonous. There is greater concentration of the glycoside in the peels than in the tuber. Processing methods such as soaking in water, fermentation, sun-drying or moist cooking destroys the glycoside in cassava.

**By-products from sugar industry**

Molasses is an important by-product of the sugar industry. The production of molasses is dependent on the production of cane or beet sugar. Molasses has been used for many years as a **cheap source of energy** in the ration of farm animals. Molasses contain about **3.25% crude protein**. Molasses has been used in animal **feeding at levels of 5- 10%.** These levels are mostly

used as **(i) a carrier for urea** impregnation of poor quality roughages (ii) a **binder for commercial pelleted feeds** for the convenient and economic feeding of livestock and as (iii) **a sweetner for increasing the voluntary intake** of compounded feeds.

Bagasse is another by-product from sugar cane processing. Sugar cane is processed for its sugar which leaves two by-products, molasses and a fibrous residue termed *bagasse.* Bagasse is a high fibre, low protein product of very low digestibility which is sometimes mixed with the cane molasses for cattle feeding.

**Oil seed by-products (Cakes and meals)**

Oil seeds cakes and meals are the residues remaining after removal of the greater part of the oil from oil seeds. The residues are rich in protein and most are valuable feeds for farm animals. They often serve as protein supplements. Most oil seeds are of tropical origin, they include groundnut, cottonseed, soyabeans and palm kernel. Others plant protein sources that are less frequently used include coconut meal, rapeseed meal, rubber seed meal, sesame (Beniseed) cake.

Soyabeans is by far the most widely used oil seed protein and as such is assigned the standard against which other plant proteins are compared. The commonest form in which soyabean is fed is as soyabean meal after oil extraction by solvent or hydraulic method. Soyabean meal has about 40 - 48% protein depending on the efficiency of oil extraction and whether or not the beans were dehulled.

Groundnut cake (GNC) is the major plant protein supplement used in Nigeria. The availability of which depends on the production level of groundnut. The unextracted groundnut has about 26 - 30% protein and it mainly consumed by humans. The residue remaining from extraction of oil from groundnut either by solvent or hydraulic method is the groundnut cake. This has a protein content of about 38 - 47%. GNC is palatable. It is however, deficient in lysine, methionine and threonine.

Cotton seed cake (CSC) is obtained from cotton after the removal of the lint, followed by oil extraction from the seed. It has a protein content of 41- 45% depending on the efficiency of oil extraction. It is high in fibre containing about 10 - 13%. It is deficient in lysine, methionine, leucine and isoleucine. CSC also contains several anti-nutritional factors including gossypol. The nutritional value of CSC can be improved by (i) decorticating and dehulling, (ii) removal of gossypol by extracting the meal with a mixture of hexane, acetone and water, (iii) treatment of

the cake with phytase enzyme produced by *Aspergillus ficcum.* In Nigeria, most of the CSC is used in the feeding of ruminants and ruminants can utilize the CSC without dehulling.

Palm kernel cake (PKC) is a product of oil palm processing. It is obtained after oil extraction from Palm kernel. Protein content is between 18 - 25%. PKC is deficient in lysine, methionine, histidine and threonine. PKC is gritty and high in fibre content (at least 9%).

Sunflower meal is produced from sunflower seed following oil extraction by either solvent or mechanical methods. The protein content ranges from 41- 47%. It is highly deficient in lysine, tyrosine, methionine and cystine. It is high in fibre (11 - 13%). While decorticated sunflower meal can be fed to all classes of livestock, the use of undecorticated meal should be restricted to ruminants. Sunflower meal is high in calcium and phosphorus.

**By-products from Animal Origin**

By-products from animal origin supply protein or minerals. Most mineral sources are from animal origin. Animal proteins are derived from the processing of meat, fish and milk and products hatchery wastes. By-products from animals which supply minerals include; bone-meal, Oyster shells, Periwinkle shells, Snail shells and Egg shells.

Fishmeal is made of dried, ground whole fish or fish cuttings with or without oil extraction. Fishmeal varies in protein between 54 - 75% with about 10% fat, making it a high protein, high energy feedstuff. Fishmeal protein is high in biological value, supplying all the known essential amino acids. It is also an excellent source of minerals including calcium (3 - 6%), phosphorus (1.5 - 3%) and micro-minerals. It is rich in vit $B_{12.}$ The main constraint to its use is its high cost. High dietary levels of high fat fishmeal may lead to problems of rancidity in the diet.

Blood meal accounts for 7 - 9 % of the animal live-weight and so it can be harvested. Blood meal is essentially boiled and dried blood. The drying could be done naturally or artificially. Blood meal contains 80 - 82% protein and very little ash. The protein is very high in lysine but deficient in isoleucine. The processing temperature may affect the quality of protein. The protein contained in blood meal has a low digestibility. There is also the fear of disease transmission through the use of blood meal. Well processed blood is however safe for use. Blood meal should not be used beyond 8% inclusion level.

Meat meal is made up of trimmings that originate from the slaughter of animals. Meat meal should be devoid of hair, hoof, horn, manure and stomach content. The typical meat meal has 50 - 55% of high quality protein. The level of protein varies with the amount of bone contained

in the meal. If the phosphorus content of the meal is more than 4.4%, it is regarded as meat and bone meal and contains 45 - 50% proteins. Meat meal is used at about 7 - 10% dietary inclusion. It is however, virtually not in use in Nigeria as all parts of the animal are virtually consumed.

Feather meals have protein contents ranging from 85 - 95%. Feather meals can not be utilized by animals unless it is treated. Hydrolyzed feather results from heat treatment of this by-product under pressure. It is deficient in lysine, methionine and tryptophan. The protein is about 75% digestible. It should be used at low dietary inclusion levels. Other by-products from animal origin supplying proteins include hatchery waste, insect meal, milk and milk by-products.

Bone meal is a source of mineral. It is obtained by burning off the organic content of bone. Bone meal is a good source of both calcium (30%) and phosphorus (13%). Other minerals found in bone are also found in bone meal. It has the advantage of being available and can be produced by the local farmer.

Oyster/Periwinkle/Snail/Egg shells are all made of calcium carbonate with about 38% calcium. Oyster shell is predominantly used in most feed mills in the country. However, snail shell and egg shell are also excellent sources of calcium and could be used as a substitute for oyster shell.

**Constraints to the use of agro-industrial by-products.**

Constraints to the use of by-products and crop residues in livestock feeding systems include;

(i) bulkiness - high fibre content

(ii) their location in areas far from where they are needed (accessibility),

(iii) poor nutritive value and

(iv) unsuitability for direct animal use.

(v) Presence of some anti-nutritive/toxic materials that may be harmful to animals when used over a long period.

In Nigeria today, the issue of the bulkiness and location in areas far from those where the materials are needed has been partially solved by the development of a good network of roads and the opening up of the rural areas for development. As regards the poor nutritive value and non-suitability for immediate animal use, research results have shown that supplementation with molasses, non-protein nitrogen (urea and poultry excrete) and chemical (NaOH) and physical (grinding and pelleting) treatments improve the nutritive value and intake and hence the response of animals to some of these by-products. Physical treatment is considered more useful in

improving the nutritive value of these products and it is also a cheaper way of treatment compared to chemical treatments.

***Note as highlighted above,*** that the ways of improving the utilization of agro-industrial by products include:

- Use of **Chemical treatment** (e.g. NaOH). This is especially for cereal crop residues such as rice straws and maize stover
- **Physical treatment** (drying, grinding, pelleting)
- **Supplementation** with molasses, non-protein nitrogen (urea and poultry waste). Adequate supply of nutrients may improve the nutritive value of low quality feeds
- **Ensiling:** The process of conservation of forage under strict anaerobic conditions that would ensure fermentation process. In so doing the fibre in feeds would have been pre-digested thereby enhancing better utilization and release of nutrients.
- **Feed block technology:** this is mainly for those high in moisture content. Several agro-industrial by-products could be mixed together with urea, a binder such as cement and/or quick-lime, minerals and vitamins.