PM Formalization of

Micro Food Processing Enterprises Scheme

HANDBOOK
OF
POULTRY FEED

AATMANIRBHAR BHARAT

Indian Institute of Food Processing Technology
Ministry of Food Processing Industries
Pudukkottai Road, Thanjavur, Tamil Nadu 613005
Website: http://www.iifpt.edu.in
Email: info@iifpt.edu.in
Call: +91 4362 228155

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INTRODUCTION

1.1. introduction

Animal feeds are the food given to animals which are domestic often refers to fodder in course of care and management of farm animals by humans for profit. Supply of quality feed ensures the health of animals. Animal wellbeing is highly dependent on feed that reflects well-balanced nutrition. Some modern agricultural practices, such as fattening cows on grains or in feedlots, have detrimental effects on the environment and animals.

Compound cattle feed is an important constituent of ration, considering the fact that dairy animals in India have limited access to cultivated green fodder and grasses. Most of the macro and micronutrients to meet animals' requirements are provided by compound feed, especially on crop residue-based diets. It is possible to formulate balanced rations for growing and lactating animals only if the feed used conforms to the laid down specifications, for energy, protein, minerals, vitamins, etc.

In order to provide animals with necessary nutrients to meet their requirements for maintenance, growth, pregnancy, and production of milk, to reduce the risks of animal health and to minimize excretions and emissions into the environment, the chemical composition of cattle feed used in the diet has to be precisely known.

The animal feed market in India is segmented on the basis of product into:

- Cattle
- Poultry
- Aqua

1.2. Poultry feed

Poultry feed is food for farm poultry, including chickens, ducks, geese, and other domestic birds. Before the twentieth century, poultry was mostly kept on general farms, and foraged for much of their feed, eating insects, grain spilled by cattle and horses, and plants around the farm. This was often supplemented by grain, household scraps, calcium supplements such as oyster shells, and garden waste. As farming became more specialized, many farms kept flocks too large to be fed in this way, and nutritionally complete poultry feed were developed. Modern feeds for poultry consists largely of grain, protein supplements such as soybean oil meal, mineral supplements, and vitamin supplements. The quantity of feed, and the nutritional requirements of the feed, depending on the weight and age of the poultry, their rate of growth, their rate of egg production, the weather (cold or wet weather causes higher energy expenditure), and the amount of nutrition the poultry obtain from foraging. This results in a wide variety of feed formulations. The substitution of less expensive local ingredients introduces additional variations. Healthy poultry requires a sufficient amount of protein and carbohydrates, along with the necessary vitamins, dietary minerals, and an adequate supply of water. Lactose-fermentation of feed can aid in supplying vitamins and minerals to poultry. Egg-laying hens require 4 grams per day of calcium of which 2 grams are used in the egg. Oyster shells are often used as a source of dietary calcium. Certain diets also require the use of grit, tiny rocks such as pieces of granite, in the feed. Grit aids in digestion by grinding food as it passes through the gizzard. Grit is not needed if the commercial feed is used. Calcium iodate is used as a supplement to iodine. The feed must remain clean and dry; contaminated feed can infect poultry. Damp feed encourages fungal growth. Mycotoxin poisoning, as an example, is "one of the most common and certainly most under-reported causes of toxicoses in poultry".Diseases can be avoided with proper maintenance of the feed and feeder. A feeder is a device that supplies the feed to the poultry.[8] For privately raised chickens or chickens as pets, the feed can be delivered through jar, trough, or tube feeders. The use of poultry feed can also be supplemented with food found through foraging.[9] In industrial agriculture, machinery is used to automate the feeding process, reducing the cost and increasing the scale of farming. For commercial poultry farming, feed serves as the largest cost of the operation.

1.3. Terms related Poultry

- **Mash:** Mash refers to nutritionally complete poultry feed in a ground form. This is the earliest complete poultry ration.
- **Pellets**: Pellets consist of a mash that has been pelletized; that is, compressed and molded into pellets in a pellet mill. Unlike mash, where the ingredients can separate in shipment and the poultry can pick and choose among the ingredients, the ingredients in a single pellet stay together, and the poultry eats the pellets whole. Pellets are often too large for newly hatched poultry.
- **Crumbles:** Crumbles are pellets that have been sent through rollers to break them into granules. This is often used for chick feed.
- **Scratch:** Scratch grain (or scratch feed) consists of one or more varieties of whole, cracked, or rolled grains. Unlike other feeds, which are fed in troughs, hoppers, or tube feeders, scratch grains are often scattered on the ground. Hence, large particle size is desired. Because they consist only of grains, scratch grains are not a complete ration and are used to supplement the balanced ration.
- **Chicks:** A baby chickens
- **Poult:** A baby turkey
- **Pullet:** A female breeder chicken under 20 weeks old
- **Hen:** A female chickens or turkey over 20 weeks old
- **Roster:** A male chicken
- **Broiler:** A chicken raised for meat.
- **Layer:** A chicken raised to produce eggs

Chick

Poult

Pullet

Hen

Rooster

Tom

Broiler

Layer

1.4. Requirement of poultry feed

In order to provide Poultry with necessary nutrients to meet their requirements for maintenance, growth, to reduce the risks of Poultry health and to minimize excretions and emissions into the environment, the processed Poultry feed required.

1.5. Energy sources of poultry feed

These are described under the following categories:

- Grains and seeds
- Milling by-products
- Molasses
- Roots and tubers

1.5.1. Grains and seeds

Grains are seeds from cereal plants, members of the grass family called Gramineae. Cereal grains are essentially carbohydrates, the main component of the dry matter being starch, which is concentrated on the endosperm. All cereal crops are annuals (Kharif). By-products of harvested grains as chaff, Stover, and straw are utilized as low-quality forages for ruminant Poultry. Moreover, many of the grains are milled or processed in some manner thereby creating additional by-products that can be fed to livestock with varying degrees of nutritive values. In India except for poultry, swine, and lactating dairy animals, grains are not usually fed for livestock production, because of high cost due to high demand by human beings.

- **Nutrient composition of grains**

The name cereal is given to those members of the Gramineae which are cultivated for their seeds. The dry matter content of grain depends on the method of harvesting and storage conditions but is generally within the range of 80-90%. Protein constitutes 85-90% of the nitrogenous compounds. The protein occurs in all tissues of cereal grains, but higher concentrations are found in the embryo and aleuronic layer than in the starchy endosperm pericarp and testa. The protein content of grain though variable normally ranges from 8-12%. The lipid content of cereal grains also varies with species, normally ranges from 1-6%. Maize and oat contain 4-6% oil, while sorghum 3-4% and wheat, barley, and rice 4 contain 1-3% oil. The embryo or germ contains more oil than the endosperm. Cereal oils are unsaturated, the main acids being linoleic and oleic and because of this, they tend to become rancid quickly.

Cereal starch consists of about 25% amylase and 75% amylopectin, although waxy starches contain greater proportions of amylopectin.

The major grains are used as Poultry feed are

- **Maize *(Zea mays):*** Maize contains about 70% starch, 85-90% TDN, 4% oil and about 8-12% protein.
- **Sorghum (*Sorghum bicolor*):** Sorghum contains about 65% starch, 80-85% TDN, 2-3% oil and about 8-12% protein.

- **Wheat (*Triticum aestivum*):** wheat is a good source of energy containing 75-80% TDN, crude protein content ranges from 8-14, Lysine, threonine and methionine are the major limiting amino acids in wheat grain.
- **Barley (*Hordeum vulgare*):** The crude protein varies from 11-16% and TDN from 78-80%. The lipid content of barley grain is low; usually less than 2.5% of dry matter.
- **Oat (*Avena sativa*):** Oats of high hull content are richer in crude fibre and have a lower metabolisable energy value than low hulled oats. The soft physical nature of the hull and high oil content contribute to the high palatability of oats. The crude protein content ranges from 8-12% and TDN 70-73%.
- **Rice *(Oryza sativa):*** Unprocessed rough rice contains about 8-10% crude protein, 9% rude fibre, 1.9% ether extract and 6.5% ash. The TDN content varies from 78-82%.
- **Rye (*Secale cereale*):** Protein content of rye varies from 10-14% and TDN 75- 80%. It is regarded as the least palatable of the cereal grains.

1.5.2. Milling by-products

- **Wheat bran:** The crude protein ranges from 13-16% and TDN from 65-70%. The bran has amino acid balance superior to that of wheat.
- **Wheat middling:** It has 96% of the energy value of barley and 91% of the energy value of corn. Midds are palatable feedstuffs and can be included in the grain mixture at high levels.
- **Rice bran de-oiled:** The crude protein ranges from 13-16% and TDN from 55-65%. It is a good source of proteins, vitamins and minerals.
- **Rice polish /raw rice bran:** The oil content of rice polish varies from 13-19%. The crude protein ranges from 13-16% and TDN from 70-90% depending on the oil content.
- **Chunies:** Generally they are high in CP and low in TDN value than that of the parent pulse grain. The CP value of different chunies varies from 15-20% and TDN value ranges from 55-65%.

1.5.3. Molasses

- **Cane molasses:** Cane molasses is a by-product during manufacture of sugar from sugarcane. From each ton of sugarcane approximately 25-50 kg of molasses are

produced. Cane molasses must contain at least 43% sugars and have a density of not less than 79.5^{o} brix.

- **Beet molasses:** Beet molasses is a by-product during manufacture of sugar from sugar beet. Beet molasses contain about 48-53% sugars and have a density of not less than 79.5o brix.
- **Citrus molasses:** Citrus molasses is produced from the juice of citrus wastes. Citrus molasses contain about 41-43% sugars and have a density not less than 71.0o brix. Moisture content is higher ranging from 27-30%. The crude protein ranges from 10-14% and TDN from 65-75%.

1.5.4. Roots and tuber

- Turnips (*Brassica rapa*)
- Cassava root (*Manihot esculenta*)
- Potato (*Solanum tuberosum*)
- Sweet potato (*Ipomoea batatas*)
- Carrot (*Daucus carota*)

1.6. Advantages of pelleted feeds

- Compound Poultry feeds are composed of a variety of ingredients. Pelleting helps in disallowing the ingredients to segregate. It does not allow sorting out certain ingredients and rejecting others.
- It reduces the wastage of feeds.
- Pellets are less subject to infestations by insects and molds.
- Pelleting preserves vitamin A potency and ensures fewer storage losses and prevents disintegration of nutrients after the feed is mixed.
- It reduces the possibility of adulteration of feeds with undesirable substances.

- It is easy to handle.
- Pelleting kills bacteria like Salmonella and E. coli if any happen to be present in the feed due to exposure to high temperature.
- Increases palatability and digestibility.
- Reduces to a certain extent, the microbial degradation of the protein.

1.7. Statistics

1.7.1. Global scenario

The global poultry feed market is projected to register a CAGR of 4.1% during the forecast period (2020-2025). The increasing demand for poultry meat products is the major factor driving the market. The increasing industrial livestock production and the increasing demand for organic feed are two other factors augmenting the growth of the market studied. As poultry requires 60% protein, 13% fat, and 3% calcium, the required nutrient content is met majorly by poultry by-products and fish meal. Approximately 50% of the live market weight of ruminants and 30% of poultry is the by-product. These by-products are rendered, ground, and available as a feed source for poultry. Poultry meat is a growing trend on the global front, and it increased from 119,205.21 metric ton in 2018 to 120,884.63 metric ton in 2019 (OECD, 2020). Thus, the demand for compound feed is projected to increase over the forecast period to meet the specific feed requirements.

1.7.2. Scope of poultry Feed sector

The world's population is projected to grow from about 7 billion in 2012 to 9.6 billion people by 2050. More than half of this growth is expected in Sub-Saharan Africa (SSA); China and India. In addition to population growth, per capita, meat and milk consumption is also growing especially in China and India, and is projected to remain high in the European Union, North America, Brazil, and Russia. These foods are more resource-intensive to produce than plant-based diets. As the cities are urbanizing and the population is migrating in search of better living standards; there is the double impetus for food in these magnets of growth. An increase in consumption of eggs, meat, growing demand for other products, and an increase in oilseed production factors are driving the global animal feed industry these trends will lead to higher requirements for processed dairy, aqua, and poultry products; in turn leading to a trigger for higher feed requirement. With foreign multi-national companies eyeing to enter the lucrative Indian markets, the animal feed industry in India will have to increase their capacities keeping in mind the quality issues to leverage on the growing demand for compound feed.

CHAPTER 2

PROCESSING OF POULTRY FEED

2.1. Product uses

Poultry feeds are special food for domesticated Poultry that keeps their body healthy and improves the quality of their products. Each type of poultry has its own category of feed which contain all the essential nutrients required for their wellbeing. Birds, just like humans, have various systems in place inside their body that protects them from all kinds of diseases and keeps them healthy. And just like how humans have special dietary needs to keep their body functioning well at all times, chickens too have their special requirements when it comes to food. This becomes all the more crucial when we are consuming products that are derived from poultry, such as eggs, and meat. In this case, it must be necessary that we take very good care of the poultry as their health directly affects the quality of the products which we consume. Any product from an poultry that is in poor condition or is affected by any kind of disease causes great danger to the health of the people who consume products from such Poultry. Nutrients feeds are specially designed to provide all the vital nutrients to chickens so that their body functions well and their health remains in great condition. This not only keeps them away from diseases but also enhances the quality of the products derived from them. But one should remember that each type of poultry requires a different type of feed. There are many varieties of feeds in the market today all of which offer a range of benefits and are meant for certain types of poultry based on their utilization.

2.2. Types of Poultry feed

Different types of fees are produced by the feed milling plant, variation in feed formulations are also necessary due to availability of different basal feeds in different season.

The requirement of poultry feed

Requirements for Chicken Feeds (BIS 1992) (on dry matter basis)

	Broiler Starter Feed	Broiler Finisher Feed	Chick Feed	Growing Chicken Feed	Laying Chicken Feed	Breeder Layer Feed
Moisture, percent by mass, Max	11	11	11	11	11	11
Crude protein (NX 6.25) percent by mass, Min	23	20	20	16	18	18
Lysine, percent by mass, Min	1.1	1.0	0.9	0.6	0.65	0.65
Methionine, percent by mass, Min	0.50	0.35	0.3	0.25	0.30	0.30
Metabolizable energy (Kcal/kg), Min.	2800	2900	2600	2500	2600	2600
Crude Fibre, percent by mass, Max	6	6	7	8	8	8
Calcium (as ca) Percent by mass, Min	1.2	1.2	1.0	1.0	3.0	3.0
Available phosophorus, percent by mass, Min	0.5	0.5	0.5	0.5	0.5	0.5
Acid insoluble ash percent by mass, Max	3.0	3.0	4.0	4.0	4.0	4.0

10. Salt (as Nacl) percent by mass, Max	0.6	0.6	0.6	0.6	0.6	0.6
11. Calorie/ Protein Ratio	122	145	130	156	144	144

Requirements for Minerals, Fatty Acids, Amino Acids and Vitamins in Chicken Feeds (BIS 1992)

Characteristic	Broiler Starter Feed	Broiler Finisher Feed	Chick Feed	Growing Chicken Feed	Laying Chicken Feed	Breeder Layer Feed
1. Manganese, mg/kg	90	90	90	50	55	90
2. Iodine, mg/kg	1	1	1	1	1	1
3. Iron, mg/kg	120	120	120	120	75	90
4. Zinc, mg/kg	60	60	60	60	75	100
5. Copper, mg/kg	12	12	12	12	9	12
6. Vitamin A, IU/kg	6000	6000	6000	6000	8000	8000
7. Vitamin D, IU/kg	600	600	600	600	1200	1200
8. Thiamin, mg/kg	5	5	5	5	3	3
9. Riboflavin, mg/kg	6	6	6	6	5	8
10. Pantothenic acid, mg/kg	15	15	15	15	15	15
11. Nicotinic acid, mg/kg	40	40	40	40	15	15
12. Biotin, mg/kg	0.2	0.2	0.2	0.2	0.15	0.20
13. Vitamin B12,mg/kg	0.015	0.015	0.015	0.015	0.01	0.01
14. Folic acid, mg/kg	1.0	1.0	1.0	1.0	0.5	0.5
15. Choline, mg/kg	1400	1000	1300	900	800	800
16. Vitamin E, IU/kg	15	15	15	15	10	15
17. Vitamin K, IU/kg	1.0	1.0	1.0	1.0	1.0	1.0
18. Pyridoxine, mg/kg	5	5	5	5	5	8
19. Linoleic acid, g/100g	1	1	1	1	1	1
20. Methionine+/ cystine,g/100g	0.9	0.7	0.6	0.5	0.55	0.55

Nutrient Requirements of Leghorn Type Chicken as Percentage or Milligrams or Unit per kg Diet (Ranjhan, 1998).

Nutrient	Starter	Grower	Layer Over	Breeder over
	0 -8 weeks	9 - 20 weeks	20 weeks	20 weeks
Energy (ME Kcal/kg)	2,500	2,500	2,500	2,500
Protein (%)	22	16	18	18
Lysine (%)	0.80	0.60	0.65	0.65
Methionine (%)	0.30	0.25	0.30	0.30
Linoleic acid (%)	1.0	1.0	1.0	1.0
Calcium (%)	1.0	1.0	3.25	3.25
Phosphorus (Available %)	0.4	0.4	0.4	0.4
Sodium Chloride (%)	0.4	0.4	0.4	0.4
Manganese (mg/kg)	80	50	50	80
Zinc (mg/kg)	50	40	60	80
Iron (mg/kg)	80	60	60	80
Iodine (mg/kg)	8	6	6	8
Copper (IU/kg)	0.3	0.3	0.3	0.3
Vitamin A (IU/kg)	4,000	4,000	10,000	10,000
Vitamin D_3 (IU/kg)	400	400	400	400
Vitamin E (mg/kg)	20	10	10	10
Vitamin K (mg/kg)	1	1	1	1
Thiamin (mg/kg)	4	2	2	2
Riboflavin (mg/kg)	5	3	5	8
Pyridoxine (mg/kg)	4	4	4	6
Pantothenic acid (mg/kg)	15	15	10	15

Nicotinic acid (mg/kg)	35	20	20	20
Folic acid (mg/kg)	1	0.5	0.5	1
Biotin (mg/kg)	0.25	0.15	0.15	0.25
Vitamin B_{12} (mg/kg)	0.01	0.005	0.006	0.006
Choline (mg/kg)	1,300	900	1,300	1,300

2.3. Processing technology

RAW MATERIAL

- Grains: Wheat, Maize, oats, sorghum, rice, barley, millets, ragi, etc.
- Brans: rice polish, De-oiled rice bran, wheat bran, maize bran, etc.
- Protein meals/cakes: Rapeseed meal/cake, soybean meal, cottonseed meal/cake (decorticated and un-decorticated), groundnut meal/cake, coconut meal/cake, palm kernel meal/cake, sesame cake, linseed cake, maize germ oil cake, maize gluten meal, sunflower meal, safflower meal, guar meal, etc.
- Chunnies: Guar, tur, urad, moong gram & chunnies of other locally available pulses.
- Agro-industrial by-products: Molasses, babul chunni, tamarind seed powder, mango kernel extraction, tapioca waste, etc.
- Minerals and vitamins: Mineral mixture, calcite powder, common salt, di-calcium phosphate, vitamins A, D & E.

Manufacturing process

- The different feed ingredients are taken in a batch mixer from the raw material storage godown in accordance with feed formulation.
- After mixing all raw materials is ground to a uniform particle size of 1-2 mm. The ground material is further mixed.
- The material used in feed formulation in similar quantities such as vitamins, minerals, urea, calcite powder, common salt, etc. are mixed in ribbon mixture using proper diluents and storage in one of the storage bin.

- Ground material and molasses are mixed simultaneously in a twin-screw type mixture. Usually, molasses are added at the rate of 10% in the Poultry feed.
- However, if the cost is very high some sweetening agents could be used in place of molasses.
- Molassed feed is mixed with the dry steam before pelleting.
- Steam acts as a conditioner to the feed and it helped to killing some pathogens.
- The temperature of steam feed is in the range of 75 to 80 degrees centigrade.
- Now, the steamed feed is converted to pallets by pressing it through a cylindrical die and press roller.
- Usually, 1-2 mm die used for is used for the production of pelleted feed for Poultry.
- Pelleted feat thus produce is passed through pellet cooler before packaging in HDPR or gunny bags.

FLOW CHART OF ANIMAL FEED PREPARATION

Raw material are procured from market and stored in storage

↓

Raw material testing for toxicity and other parameters

↓

Raw materials are mixed in a definite proportion

↓

Grinding of raw material in 1 mm size

↓

Grounded Raw material are mixed with minerals in a definite proportion

↓

Now the feed are mixed with molasses @ 10-12 %

↓

Treat the feed with steam before pelleting at 70-80^{o} c

↓

Pelleting the feed at size of 2 mm

↓

Testing the feed for (temperature and binding of Pellets)

↓

Filling and packaging

2.4. Equipment involved

- **Batch mixer:** Batch mixing is the more preferred mode of mixing for raw material and applications producing in small to medium capacities.

  In batch operation, all ingredients are loaded into the mixer together or in a pre-defined sequence and mixed until a homogenous material is produced and discharged from the mixer in a single lot. The output of a batch mixer is measured in kg/batch.

  The continuous mixer on the other hand is generally dedicated to a single high-volume product. Ingredients are continuously charged into the mixer in accordance with the formulation. The mixing takes place as the material travels from the charging port to the discharge nozzle, from where it is continuously discharged. The output of a continuous mixer is measured in kg/hr.

- **Grinder**: Poultry feed grinder is the necessary equipment in an animal feed processing plant. the grinder is mainly used for grinding grain products on the definite shape that are to be made into livestock feed pellets or poultry feed pellets.

- **Screw Conveyor:** Screw conveyors in modern industry are often used horizontally or at a slight incline as an efficient way to move semi-solid and solid materials. They usually consist of a trough or tube containing either a spiral blade coiled around a shaft, driven at one end and held at the other or a "shaftless spiral", driven at one end and free at the other.

- **Pellet Making Machine**: These machines are used to make the pellets. This machine helps in reducing nutrition losses, enhance the protein content, reduce feed wastage, and help Poultry to digest their fodder properly and easily. In this process, fatty ingredients are added to the materials in order to raise the nutritional value of the feed. The feed obtained from the mixer is blended with molasses. Assorted animal feed that is crushed into fine particles is further formed into pellets by a Poultry feed pellet mill.

- **Packing Machine:** The Automatic Weighing and Packing Machine support the process of precise weighing and packaging of animal feed pellets. The machine weighs the product with accurate measures and fills these in gunny bags.

2.5. PROJECT COMPONENTS

2.5.1. Land

The required land for Animal feed is estimated to be around 2000-3000Sq.ft.

Civil Work

- **Workshop Are**a- This area includes the space for processing, cleaning, sorting and, processing, packaging processes and laboratory. Total workshop area is approx. 1500 Sqft.

- **Inventory Area-** This area includes the storage space for all the raw materials and storage space and finished goods. Total inventory area is approx. 1000 Sqft.
- **Office Area –** This space includes staff working region. Total workshop area is approx. 500, Sqft. (Land and building requirement may vary depending on the size of project)

2.5.2. Misc. Assets

- Water Supply Arrangements
- Furniture
- Computer and Stationary
- Laboratory for testing

2.5.3. Power Requirement

With semi-automatic machines and equipment with manual handling, the Power Required is about: 15-20 kW, to operate this plant. (It is also depend on Project size and machines specification)

2.5.4. Manpower Requirement

Men and women both are involved in this. For a small unit to begin with around 8-10 people can work.

CHAPTAR -3

PACKAGING PRACTICES OF POULTRY FEED

3.1. Introduction of Poultry feed packaging

Animal feeds are a rich source of nutrients and rodent attacks, microbial spoilage, and pilferage may occur during storage. Hence, proper and safe storage methods need to be provided till they are marketed.

Satisfactory storage can be achieved with proper and suitable packaging materials. Pellets of animal feeds are characterized by good storage stability, moderate density, and low cost.

Despite their good storage stability, they are affected by high humidity, biological factors like insects, pests, rodents, and microorganisms, and to some extent by oxygen. All these factors cause qualitative and quantitative.

3.2. Current trends in Packaging and Storage of Poultry feeds

In order to preserve the quality and wholesomeness of the product, many storage methods are being employed. Pellets are mostly stored in bags or in a variety of containers, or in sacks stacked in warehouses.

The method of choice of storage depends on factors like:

1. Type and value of produce.
2. Duration of storage.
3. Climate.
4. Transport system.

The advantages and disadvantages of bulk storage over sack storage are as follows:

Bulk	Sacks
1. Inflexible storage	1. Flexibility of storage
2. Mechanizable	2. Partly mechanizable
3. Rapid handling	3. Slow handling
4. Little spillage	4. Considerable spillage
5. High capital cost	5. Low capital cost
6. Low operating cost	6. High operating cost
7. Low rodent loss potential	7. High rodent loss Potential
8. Little protection against reinfestation	8. Reinfestation occurs

3.3. Type of packaging material used for Poultry feeds

- **Bulk Storage**

This is the traditional method of bulk stored in Bukhari type, Kothar type, or Morai type rural food structures constructed on elevated platforms which are supported on timber posts or brick/stone masonry pillars. They are constructed using bamboo/bamboo split, timber, reeds, red gram stems plastered with mud. Underground rural structures are also constructed and they are made waterproof using bitumen. Air-tight bulk storage silos keep the grain free from insects, rodents, and other pests. The shelf life of the product stored in silos depends largely on the moisture content of the grain and the storage atmosphere.

The raw material is also can be stored in these silos.

- **Bag Storage in Warehouses**

This is the most common method used worldwide for storage. Products are packed in jute/paper/rice straw/burlap / HDPE or PP woven bags and stored in a variety of types of buildings constructed with stone, local brick, corrugated iron, mud and wattle with or without plastered walls and cement or stone floor and corrugated iron or thatched roof. Such types of godown are planned for the storage of 100 to 500 tons of Products.

- **Jute /Hessian Sacks**

These are traditional bulk packages, for animal feed which offer good handling properties. But as such, they cannot protect the products from moisture ingress. So stacked jute bags are covered with tarpaulin sheets. Their protective functions can be improved by the inclusion of webs of paper, plastic, and foil. These prevent sifting of the contents and provide water vapor barrier property.

- **Plastic Woven Sacks**

Flat or circular woven plastic sacks of PP or HDPE with a suitable PE layer can be sued for Animal feed pellet packaging. They offer good protection at high humidity's economically. Up to 100 kg product can be packed in them.

- **Multiwall Paper Sacks**

For storage below 86% RH, paper bags made of 3 – 7 plies of kraft, union kraft, or extensible kraft are generally used to hold up to 50 kg capacity.

Laminating them further with PE/PP and/ or aluminum foil lining would further increase their utility. The advantage of bag storage over bulk storage of product is that bags may be piled under any convenient shelter and can be transported and handled without special equipment. The main disadvantage is that bag's storage space and bagging become expensive particularly where man-day charges are high. Under-water storage of grains in 60 kg unit packs packed in double plastic bags with nylon inner bag and nylon/ Al. foil/ PE outer bag was found to retain the original freshness of the product even after prolonged storage.

Relative merits & demerits of jute sacks & HDPE/PP woven sacks

S. No.	**Jute sacks**	**HDPE / PP woven sacks**
1.	Good stack stability:	Poor stacking and destacking (unstable stacks with perpetual chances of stack collapse). This has been solved by ant slip woven sacks.
2.	Good breathability, poor moisture protection sacks.	Good breathability in unlined woven sacks, good moisture protection in lined woven
3.	Higher incidence of bag	Better endurance and recyclable.

	damage indicating poor end-use performance	
4.	Amenable for use of hooks and better closure.	Poor recovery of holes caused by hooks increases
5.	Poor mechanical strength.	Good mechanical strength and lends for re-use
6.	Spillage may occur during transportation.	Least spillage during transportation.

3.4. Insect Infestation in Poultry feeds

Insect infestation is a major problem in Animal feed as they are the product of grains. They are the prime targets of many predators like insects, pests, rodents, mites, and undesirable microorganisms. Besides destroying a significant portion of food, they qualitatively affect the remaining part through the excretion of toxic chemicals and contamination with excreta and insect fragments. Standards specify maximum limits for these parameters. Though insect penetration can be controlled by using different packaging materials, initial insect contamination should be destroyed at the time of packing.

Insect resistance of some films and laminates

Films	**Time of penetration in months for different insects**			
	Oryzae	**Dominica**	**Panicium**	**Castaneum**
LDPE 50 □m	< 1	< 1	> 3	< 3
LDPE 100 □m	< 2	< 2	> 3	> 3
HDPE 25 □m	< ¼	< 2	> 3	> 3
HDPE 50 □m	2	2	> 3	> 3
HDPE 75 □m	> 3	> 3	> 3	> 3
Polypropylene 50 □m	> 3	> 3	> 3	> 3
Polypropylene 75 □m	> 3	> 3	> 3	> 3

75 □m MXXT Cellophane	< ¼	< 1	> 3	> 3
75 □m MXXDT Cello/LDPE 37 □m	< 1	< 2	> 3	> 3
PET 12 □m /LDPE 75 □m	> 3	> 3	> 3	> 3
MET.PET 12□m /LDPE 37 □m	> 3	> 3	> 3	> 3
75 □m Cello /Al.Foil 0.2 mm	> 3	> 3	> 3	> 3
Test Conditions: Temperature: 25—28°C, RH: 70-75%. *Source: Food Packaging Technology Department Central Food Technological Research InstituteMysore*				

3.5. Recent Trends

Retail packaging being the present trend, the stress is on the use of more decoration, transparency, simplification of package construction, and production of packages by automatic means. Since preservation in smaller packages is more difficult, the use of increased quantities of films and laminates for improved protection and increased shelf life will become popular. This will be expensive as more storage space and more packaging materials are required. Hence, a unit package must be carefully designed and automatically packed for cost reduction.

CHAPTAR -4

Standard for laboratory and Equipments Handling

4.1. Good laboratory practices

- All the apparatus used should be scrupulously washed and kept clean.
- If a grease film persists even after cleaning with a detergent, prepare chromic acid by adding 100 ml conc. H_2SO_4 to approximately 3.5 ml of saturated potassium dichromate solution. The mixture can be reused till it becomes greenish.
- The dichromate will strongly adhere to the glass surface. Wash it with ordinary water and finally with distilled water.
- Do not add water to acids as it leads to spurting.
- Use fume cupboards to protect against any types of fumes.
- If you happen to suck the acid into your mouth, wash repeatedly with copious amount of water.
- The last drop in the pipette should not be blown off, as it is not counted in the calibration of the pipette.
- As a general rule, calibrated glassware's viz. pipettes, burettes, measuring cylinders should not be heated or cooled rapidly as it will lead to change in volume.
- Animal nutrition laboratory should be well ventilated and provided with exhaust fans for effective removal of fumes.
- Use protective materials like apron, goggles, gloves etc. depending on the need. This will protect against artistic holes in your clothes.

Fig- Commonly used laboratory safety signs

4.2. Quality control of finished product

- All measures which are concerned with the quality control of finished product should be carefully reviewed to maintain high standards.
- The finished product should be examined for colour, texture, pellet size, strength, aroma, palatability and chemical composition before delivery.
- Periodical evaluation is also necessary to examine the health of the Poultry and effect of feed on their productivity through field survey.

- There may be seasonal variations in the standards or the basis of availability of basal diet and its quality and quantity during different seasons.
- The product manufactured should be analysed and compared with set standards. The finished product lot should be cleared for marketing only after the approval of the animal nutrition officer. Besides quality, the net weight, proper packaging and safe transport to the retail sale outlets may also be ensured.
- It is of utmost importance for the production unit to take adequate care in compounding of the feed as per formula prescribed by the animal nutrition officer.
- The wide variation in the chemical composition of the ingredients is obtained.
- This is the main constraint with which the nutritionists have to formulate the ration to maintain the quality of the feed at affordable costs.
- Choosing the best quality raw materials continuously throughout the year is nearly impossible.
- Further, nutritionists are not in a position to reject materials if there is variation in the specification since the availability is constant or lower and the demand is increasing.
- Therefore, fixing the cost of ingredients on the basis of nutrient content and using them in the formulation with certain additives is the most practical option possible.

4.3. Quality control during storage

Every care must be taken in the storage of raw materials and finished products , as one or more of the following problems may arise:

- Infestation
- Deterioration in quality
- Rats and birds problem
- Weight losses
- Fire hazards

- The storage godowns for raw materials and finished products should be separate.
- Raw materials are received from various sources and utilization of food grains unsuitable for human consumption is common.

- Stacking of different materials should be done in such a way that there are minimum chances of cross infestation.
- In such situations, infestations may occur and spread from one material to another. Cleaning, insecticide spraying and fumigations may help in checking infestation.
- Deterioration of raw materials as well as finished products may occur due to high moisture content, rancidity, mould and fungi growth etc. Immediate removal of damaged materials from the godowns may help in checking further deterioration of the remaining stock.
- Further the deterioration of raw materials may occur due to long storage of raw materials, especially rice polish fine, rapeseed meal, grains.
- Normally such materials should not be stored in godown / silos not more than a month. First In First out (FIFO) system should be adopted.
- The raw materials with moisture content more than 10 per cent may result in drayage loss during storage.
- The longer the duration of storage, more will be the moisture loss. To compensate moisture loss in filled finished product bags, extra feed should be filled in each bag depending upon season and duration of storage in the godowns.
- In case, the consignment has been transported by road, the vehicle driver should be shown wet or damaged consignment and his signature obtained on the goods receipt slip and register.
- If part of the consignment is either inferior or deteriorated or damaged, sorting of these materials should be done in supervision of the animal nutrition officer.
- Inferior materials should be rejected and supplier should be informed accordingly. If the supplier fails to lift the rejected material within a stipulated period, it should be disposed-off at the supplier's cost. Sorting charges should be realized from the supplier.
- The animal nutrition officer should regularly visit the stores. A careful and close examination for the presence of weevils, worms, moulds, fungal growth, rancid odour etc., is required. Evidence of damage to bags by rats and birds should be traced minutely.
- If there is any evidence of worms, weevils etc., immediate steps should be taken to undo the damage. The damaged material should be sorted and used or disposed immediately.

Indian Standards of Poultry Feeds (IS: 1374: 1992)

Types of feeds

1. Boilers starter feed
2. Finisher Feed
3. chick feed
4. Growing Chicken feed
5. Laying chicken feed
6. Breeder laying fee

- **Description:** The feed shall be free from rancidity, musty odor, toxic ingredients, adulterants, moulds and insects infestations
- **Packaging:** The feed shall be packed in clean, dry and sound, plain or polyethylene lines jute or laminated paper bags.
- **Aflatoxin:** The Aflatoxin content of poultry feed should not exceed 500ppb
- **Marking:** Each bag should suitably mark so as to give the all the information of the feed: name, type, net mass batch, manufacturing year and date etc.

Contact Us

Director

Indian Institute of Food Processing Technology

(Ministry of Food Processing Industries, Government of India)

Pudukkottai Road, Thanjavur - 613 005, Tamil Nadu

Phone No.: +91- 4362 - 228155, Fax No.:+91 - 4362 - 227971

Email: director@iifpt.edu.in; Web: www.iifpt.edu.in