Feed ingredients for ration for livestock and poultry

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Feeding of Broiler

Feed Formulation

In the previous chapters we have discussed about the feed stuff suitable for poultry, nutrient requirements of poultry and methods of estimation of nutrient requirements. The second step of feeding management is how to fulfil these nutrient requirements through the available feed ingredients and computes the ration of optimum nutrient density so that it can satisfy bird's daily nutrient needs.

Feed formulation is a process by which different feed ingredients are combined in a proportion necessary to provide proper amount of nutrients needed at a particular stage of production. For feed formulation the knowledge of nutrient composition of feed stuffs is very essential along with the knowledge of nutrient requirement. The formulated feed should be palatable and should not cause any serious digestive disturbance or toxic effects to the birds.

There are some factor that should be considered in feed formulation for optimum efficiency and better output from birds.

- **Acceptability:** The feed formulated should be made of fresh, good quality ingredients.
- **Digestibility:** The nutrients in the feed should be digestible and released into the gastrointestinal tract to be absorbed by the birds. Feed with high fibre content can not be utilized efficiently by poultry.
- **Cost:** The requirement of the birds can be met through several combinations of feed ingredients. However, when the costs of these ingredients are considered, there can only be least-cost formulation. The least-cost feed should ensure that the requirements of the birds are met and the desired objectives are achieved.
- **Avoiding anti-nutritional factors and toxins:** The presence of anti-nutritional factors and mycotoxins in the feed ingredients affects the digestion and utilization of some nutrients and not only makes them unavailable to the birds but also produces several conditions and diseases. The inclusion of these feed ingredients should, therefore, be limited in the formulation.
- **Other factors:** other factors that should be considered are texture, moisture and the processing of feeds need to be considered.

Method of Feed Formulation

During feed formulation the information of nutritive value of feed ingredients is not enough; the maximum inclusion levels of ingredients depending on several factors discussed above also play very important role in formulating a balanced chicken feed. The approximate inclusion levels of various feed ingredients, which are changeable depending on different factors, in poultry ration may be considered as follow:

1. For energy: Maize upto 65 % of the ration, jowar (sorghum) upto 45 %, wheat upto 25 % with enzyme, wheat bran upto 15%, rice upto 15%, rice by-products

(bran, polishing) upto 15%,

2. For protein: Soybean meal upto 30%, sesame oil cake upto 10%, corn gluten upto 15%, linseed meal-15 % (20% in layers), ground nut oil cake upto 20 %, safflower meal or sunflower meal upto 10%, meat meal or fish meal upto 10%, blood meal or feather meal upto 2%
3. For energy and essential fatty acids: Fats and oils like tallow, lard, soybean oil, coconut oil or palm oil up to 5% after 3 weeks. Poultry fat, fish oil and vegetable oils are good sources of linoleic acid which is dietary essential in birds. Besides supplying energy, the addition of fat improves the absorption of fat-soluble vitamins but increases the inclusion of antioxidants. Birds fed diets having higher levels of poly unsaturated fatty acids tend to produce soft fat.
4. For minerals, vitamins, essential amino acids and additives: Calcium can be added in the form of limestone powder (LSP), dicalcium phosphate (DCP) and oyster or other marine shells. Phosphorus can be added from manufactured products such as dicalcium or monocalcium phosphate. Phytate phosphorus only becomes available when phytase enzyme is added to the ration. Sodium and chlorine are usually added as salt (NaCl) at about 0.25% of the ration. If animal by-products are being fed the minerals present in these feed ingredients should be used in the calculation of the amount to be added. Trace minerals and vitamins are required in small quantities. Synthetic trace minerals and vitamins are commercially available for poultry and added to their diets as per needs. These are added to the ration as per the instruction of the manufacturers. Organic or inorganic synthetic amino acids like methionine, lysine, etc. are also added to the feed. Commercial preparations of additives like probiotics, prebiotics, enzymes, acidifiers, emulsifiers, antioxidants, anticoccidials, toxin binders, etc. are mixed with the feeds at the rate following manufacturers' recommendations.

Method of Feed Formulation

Steps in feed formulation

Suppose we want to prepare 100 kg ration for broiler starter (nutrient requirement as per BIS 2007: (CP = 22 % and ME = 3100 kcal/kg diet). In practical diet formulation by calculation the essential steps are as follows.

Step I:

Minor ingredients are fixed at slack space (4.125 kg) may be left to include them later (Table 1). Trace minerals, vitamins, feed additives can be fixed because the contribution of major feed ingredients for these nutrients is little. Slack space may be left for addition of salt, calcium and phosphorus sources, supplemental amino acid to balance the diet.

Ingredients in slack space

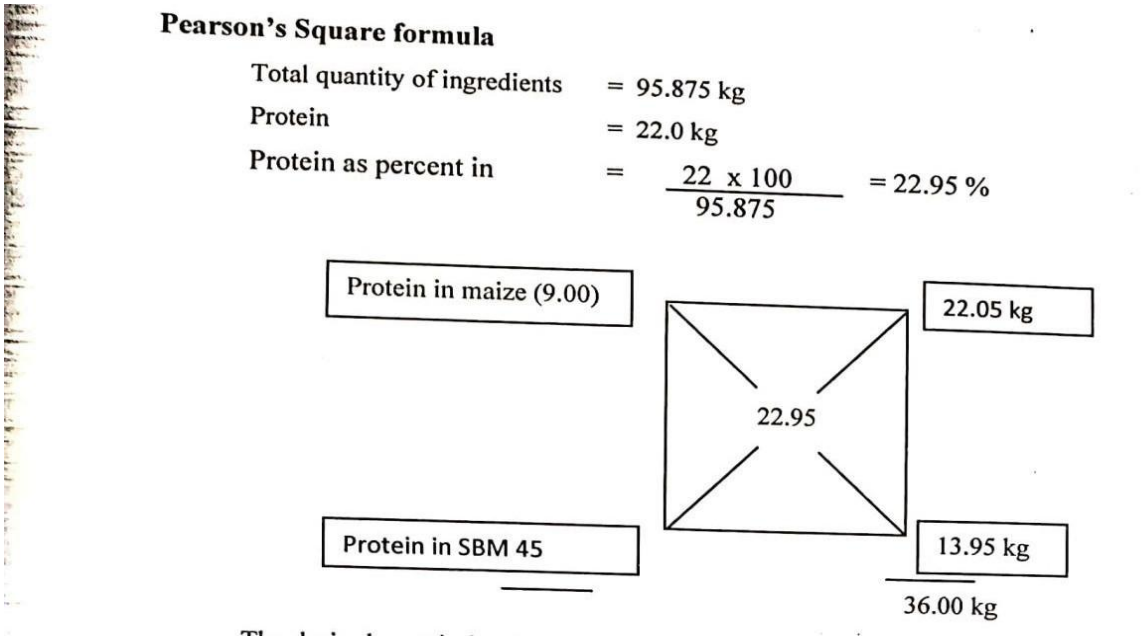
S.No.	Ingredients	Parts (%)
1.	Common salt	0.325
2.	Dicalcium phosphate (DCP)	1.758
3.	Limestone powder (LSP)	1.375
4.	DL-methionine	0.227
5.	L-lysine	0.105
6.	Toxin binder	0.050
7.	Coccidiostat (Maduramicin)	0.050
8.	Choline chloride	0.050
9.	Sodium bicarbonate	0.10
10.	Trace mineral premix	0.050
11.	Vitamin Premix	0.025
12	Antioxidants	0.010
Total		4.125

Step II:

Vegetable protein sources and energy sources are added to provide the required amount

of protein and energy. Till now 4. 125 kg of ingredients were added. Remaining 95. 875 kg of ingredients are to be added to get 22.0% protein because slack space will not provide any protein.

Soybean meal as vegetable protein sources and maize as energy sources are considered. The required protein level can be calculated by Pearson's square formula.



The desired protein level as percent is entered in the centre of square. The protein percent of SBM and maize is entered at the corners. The difference between the protein percent is the ratio of different ingredients to be mixed.

For 95.875 Kg maize = 22.05/36.0 x 95.875 = 58.72 kg

For SBM = 13.95/36x95.875 = 37.15

Ingredients	Parts	CP (%)	ME (kcal/kg)
Maize (9,3300)	58.72	5.28	1937.76
SBM (45,2400)	37.15	16.72	891.6
Total	95.875	22.00	2829.36
Shortfall		0.00	(270.64)

Step V: The ME energy content of the diet has to be balanced. The shortfall of 270.64 Kcal can be met by addition of vegetable oil (5.1 parts) through trial and error method.

Step VI: The phosphorus content of the diet is calculated in forms of available phosphorus. Phosphorus from animal and inorganic sources is considered completely available whereas that from plant sources is considered to be 30 % available.

Step VII: The requirement of calcium can be met by supplementation of limestone and bone meal.

Step VIII: The limiting amino acids in synthetic form can be supplemented to meet the requirement. The requirement for these limiting amino acids can also be met by inclusion of animal protein sources.

Step IX: A check is made for the total of the ingredients and also for all the nutrients if desired. If the total of the ingredients is not 100, cereal or cereal byproducts can be added to make it 100.

Table – Final ration for broiler starter

Ingredients	Parts/kg	CP (%)	ME (kcal/kg)
Maize	52.4	5.28	1729.20
Soybean meal	38.4	16.72	921.60
Vegetable Oil	5.1		448.80
Common Salt	0.325		
DCP	1.758		
LSP	1.325		
DL-meithionine	0.227	0.22	
L-lysine	0.105	0.10	
Toxin binder	0.050		
Coccidiostat	0.050		
Sodium bi carbonate	0.050		
Trace mineral	0.050		
Vitamin premix	0.025		
Antioxidant	0.010		
Total	**100**	**21.996**	**3099.6**

Physical Form of Diet

The methods give the information about quantity of ingredients used in feed formulation. The nutrients for poultry are properly utilized when the formulated feed is given in suitable physical form respective to categories of birds. The poultry feeds are generally prepared in the following physical forms.

Mash

Ground and completely homogenously mixed feed is called mash. This feed is suitable for all categories of birds. The preparation cost is less and loss of nutrient during processing is also less but the major disadvantage of feeding mash feed is that there is wastage of feed during handling and consumption by birds.

Pellet

Ground feed compacted by steaming and forcing the material through die openings is called pellet. This feed is suitable for all categories of birds more than age of 2 -3 weeks. The preparation cost is more as compared to mash feed. However, the wastage of feed is less and selective feeding is prevented causing optimum utilization.

Crumble

Pelleted feed reduced to granular form is called crumble. This feed is more suitable for birds of 0 -3 weeks of age because of smaller particle size of feed. The preparation cost is more as compared to mash feed. The wastage of feed is less and selective feeding is also prevented similar to pelleted feed.

Feeding Management of chicken

Poultry can be managed under different feeding systems, depending on the husbandry practice and feeds available.

1. Complete dry feed offered as a mash *ad libitum*
2. Complete dry feed offered as pellets or crumbles *ad libitum*
3. Complete feed with added whole grain
4. Complete wet feed given once or twice a day
5. A complete feed offered on a restricted basis
6. Choice feeding- Choice feeding can be applied on both a small or large commercial scale. Under choice feeding or 'free-choice feeding' birds are usually offered a choice among three types of feedstuffs:

- An energy source (*e.g.* maize, rice bran, sorghum or wheat)
- A protein source (*e.g.* soybean meal, meat meal, fish meal or coconut meal) plus vitamins and minerals
- In the case of laying hens, calcium in granular form (*i.e.* oyster-shell grit)

Feeding Management of Broiler

Broiler feeding programme is more emphasized on live weight gain and feed conversion ratio of broilers and profitability of farmers. The growth of broilers depends upon the level of balanced protein in their diet along with other nutrients. In absence of optimum level of protein and amino acids the growth is restricted and birds need longer time to reach the marketable weight. The feeding of high protein (23% CP) in initial phase results in higher weight gain and due to lower feed intake it does not significantly affect the cost of

production. In finishing stage the energy level is enhanced to convert energy into body fat, thereby producing the desired body weight for the market.

During feeding the feeds should be appropriate in particle size for maximum acceptability. Crumble feeds are more suitable for age of 0-3 weeks and latter mash or palleted feed is given. The feed should be free from all type of contamination and fungal infestation. The feeding is done with right kinds of feeding equipments for chicks. Small feeder should be used and their number should be more. As the size of birds increase feeder height and size is increased. The feeding is generally done twice in a day morning and evening when feed intake is likely to be the highest due to lower environmental temperature. There always must be provision of fresh and clean drinking water optimum performances of the birds.

The feed intake during initial age is very small and it is increased after the age of 2 weeks resulting in higher weight gain and after the age of 6-8 week the feed consumption is high but gain is less so at this age the birds are suitable for table use.

The main factors that influence the feed intake are breed characteristics, feeds and feeding management and environmental temperature.

During the hot weather birds require less energy to maintain body temperature. As environmental temperature increases birds consume less feed at the rate of 1.5% with increase of 1^0C rise in environmental temperature. This means birds tend to get less protein and other nutrients which cause reduction in growth and production. To avoid this effect the nutrient density of ration should be increased in correct proportion during summer months.

The broiler birds have higher feed intake, higher digestibility of feed and higher rate of conversion of feed into body mass. Feed conversion ratio (FCR) is defined as the ratio between amount of consumed feed and body weight gain for a specified period. Presently the FCR of broiler birds ranges around 1.6-1.7. The FCR has inverse relationship with feed efficiency or feed utilization efficiency.

Factors affecting FCR

Factors affecting FCR are

1. **Type of feed:** When feed is balanced in nutrients the FCR is low.
2. **Forms of feed:** When crumble and pellet feeds are given to chicks the FCR is low as compared to mash feeding.
3. **Strain of bird:** Strain of birds affects the FCR, e.g. Vencobb-200 has FCR around 1.7 and Vencobb-400 having FCR around 1.65.
4. **Environmental temperature:** FCR is directly proportional to environmental temperature.
5. **Age and weight of the bird:** Initially FCR is low. As the age advances the FCR also becomes higher.
6. Poor health of birds and farm management increase FCR.

Average growth rate and feed requirements for broiler chicken (2014):

Balanced feed	Age in weeks	daily feed intake/bird (g)	Weekly total feed intake (g)	Cumulative feed intake (g)	Body weight gain (g)	Total body weight (g)	FCR (Cum)
	0 day	**little**			**40 g**		
pre-starter	1st week	25	175	175	188	228	1.07
pre-starter	2nd week	45	315	490	440	480	1.11
starter	3rd week	70	490	980	790	830	1.24
starter	4th week	120	840	1820	1280	1320	1.42
finisher	5th week	145	1015	2835	1795	1835	1.58
finisher	6th week	150	1050	3885	2290	2330	1.69
			3885				

NUTRITION UNDER STRESS CONDITION

NUTRITIONAL MANAGEMENT OF POULTRY BIRDS DURING SUMMER:

Today poultry birds are more susceptible to heat stress than ever before due to their higher production performance and feed conversion efficiency. Poultry production in the tropical countries suffers badly due to high ambient temperature and humidity. Because, in hotter months there are some undesirable effects on the performances of poultry birds and ultimately leads to economical losses to the poultry farmers. There is decreased feed intake but increased water intake. There is reduction in production of eggs, reduced size of egg, poor shell quality and increased cracked eggs. There is decreased weight gain of the birds and poor feed conversion efficiency, lower disease resistance. Decreased number of fertile eggs and reduced hatchability percentage. Prostration due to heat stroke and possible mortality ultimately causes economic loss in poultry industry.

Effects of summer heat on feed intake of poultry birds:

Poultry birds take feed primarily to fulfill its energy requirements or to keep its body warm. There are two sources of energy for the poultry birds. One is from the feed itself and another source is the environmental temperature. When feed energy is increased in a constant environmental temperature then feed intake of the bird decreases. Feed intake of the bird is also decreases when the environmental temperature is increased though the feed energy remains constant. The ideal ambient temperature range for poultry birds lies between 13-20^0C. Consumption of feed decreases by 1.5- 2% for every 1^0C increase in ambient temperature in the range of 20^0C-30^0C while the feed intake may decline by 4-5% for each 1^0C rise in temperature in the range of 30-40^0C. So, in high environmental temperature only energy requirement of the feed is reduced but other dietary nutrient requirements like protein, minerals and vitamins remain the same, in fact the summer diets need to contain higher level of these nutrients.

Feeding protocols to be followed during the period of high temperature:

The increasing proportion of poultry production in tropical and subtropical regions makes it necessary to reconsider the nutritional strategies which aimed to alleviate the negative effects of heat stress by maintaining feed intake, electrolytic and water balance and by supplementing micronutrients such as Vitamins and minerals to satisfy the special needs during heat stress. To enhance the birds' thermotolerance by early heat conditioning or feed restriction seems to be one of the most promising management methods in enhancing the heat resistance of poultry birds.

The fall in feed consumption may cause general or specific nutrient deficiency. Strategies such as temporary feed restriction or feeding at specific times of the day, increasing density of nutrients in diet (because feed intake decreases during heat stress), providing birds with extra electrolytes and vitamin (especially through drinking water), and changing the lighting programme may all be helpful in managing heat stress-induced problems in poultry.

There are two simple ways to increase nutrient consumption are to increase nutrient density and take advantage of natural increases in feed consumption at certain times of the day. A very direct way to ensure optimum nutrient intake despite decreases in feed consumption is to increase the nutrient density of the ration. During the hottest period of the day when ambient temperature exceeds 36^0C, then offering of feed to the birds should be restricted. But a wet mash prepared by mixing water can be offered in feeders during the hotter parts of the day. It will result in higher intake but no mash should remain in the feeders overnight otherwise mould will grow in the wet feed. Use anti-stress drugs, vitamins like vitamin A, E, C and probiotics in the feed or water.

If birds are fed during the cooler part of the day, feed consumption will be higher. So, birds should be encouraged to consume feed at night and early in the morning that is at cooler part of the day. Birds should not be fed during the afternoon in periods of hot weather since this will increase the amount of body heat that they must dissipate and thus increase the potential for heat prostration. During the late afternoon there is a significant rise in body temperature, which, if severe, may kill the bird. The late afternoon may not be the hottest time in the day, but it is the peak of digestion in birds when eating in the early-mid morning period. A good management strategy for layers to aid in reducing heat stress is to withdraw feed prior to the anticipated time of peak temperature so that it may take an unneeded heat load off the bird. For broilers, a period of darkness in the late afternoon can be used to avoid excessive activity. If using a feed withdrawal program, it can be beneficial to give supplemental lights during the period of natural darkness. For night feeding light schedule should be adjusted with intermittent lighting program. A second alternative is to feed the birds at the time of day when feed consumption is highest. The light-to-dark cycle results in a U-shaped feed consumption curve. Shortly after light come on, feed consumption is high. It gradually declines during midday and then increases about 1 hour before lights are turned off.

When the laying house temperature is above 32^0C, birds are uncomfortable and the feed consumption is greatly reduced with low egg production. Over 37^0C, the mortality rate is rather high. Coupled with these, the farmer often faces low egg prices also. For each 2.5^0C increase in house temperature above 30^0C, the energy requirement changes about 22Kcal/kg of feed. The heat stress can be reduced by feeding diets with result in relatively lower heat increment production in the body. Among the nutrients utilized by the body for energy, the fat energy has lower feed increment capacity than proteins and carbohydrates. Protein causes the maximum heat increment. As the total amount of energy in the feed is decreased, the proportion of total energy provided by the added fat may be as high as 4.5% of the ration. This practice not only increases the energy intake, but also reduces the specific dynamic effect of the diet thus helping birds to cope better with heat stress. As compared to proteins and carbohydrates the digestion of fat results in less production of body heat per calorie of feed energy. The heat load of the bird can be replaced by reducing other dietary energy with dietary fat. Reduced growth rate due to heat stress can partially be overcome by increasing fat calories of diet. The non-energy nutrients like proteins, amino acids, minerals and vitamins are increased in the feed formulae in proportion to feed intake. The protein content of the feed may be reduced by about 0.5% below the calculated value if better quality proteins containing more of lysine and methionine are used in place of incomplete proteins. In some cases the intake of required amino acids can be optimized by providing synthetic amino acids such as lysine and methionine in increased quantity. Otherwise provision of higher rate of animal protein should be made. Vitamin supplement must be increased by 20-40% depending up on the heat stress. Increase mineral supplementation by 20-30% as feed consumption is lowered in summer. So, nutritional manipulations such as addition of fat, reduction of protein, addition of essential amino acids, minerals and vitamins is one of the option to be followed to ameliorate the effect of heat stress in the poultry birds.

At higher temperature there is a reduction in the body synthesis of Vitamin C. There is impairment of the thyroid gland function of the birds in high ambient temperature. Addition of vitamin C can partially restore this impairment and protect the birds from the effect of heat stress by drastically reducing the mortality due to heat stress. **Vitamin C @330 mg/kg feed or water** should be provided to the birds in the hotter days. With the Vitamin C supplementation of summer diets there is an improvement in egg production and shell quality of eggs.

Pellet feeding is beneficial when low energy diets are used in summer months. In order to enhance increase in feed intake, the feed should also be offered in pelletted form. Provision of 10% more feeders inside the shed may encourage the birds to consume more food

Drinking Water management during summer:

The normal intake of feed: water is 1:2 but this ratio rises to nearly 1:4 or even more

when temperature exceeds 35^0C. Birds need more water at higher temperatures. It is always recommended to provide birds with cool water. So, plenty of clean and cool water must be ensured during the summer months. Lowering the water temperature helps to keep the birds cool. Ensure that the water is clean and of optimum quality. Waterers must be protected from sunlight to prevent heating of water. Waterers must be provided in adequate number on deep litter system along with fresh supply of clean water at regular intervals which may be minimum four times a day. Cool water must be provided to the newly arrived chicks. This helps to avoid dehydration and stress. Addition of dextrose and electrolytes may help to maintain the ionic balance of the body in extreme summer heat. Because the electrolyte balance in birds is altered during heat stress due to panting. Panting increases carbon dioxide loss in the bird, which reduces the bird's ideal water intake. By adding electrolytes to the feed or water, birds increase their water intake, which aids in keeping a constant body temperature and maintains an effective system of evaporative cooling. Potassium chloride and ammonium chloride @ 2-3kg/ ton of feed is beneficial in reducing mortality in birds. These replace electrolytes which can correct the acid base imbalance during hotter days and encourage consumption of water. Molasses or jaggery may be added to water in hot days. The concentration of medicines in drinking water should be reduced in summer months as the water consumption of the birds is very high. There was beneficial effect to use water having sodium bicarbonate (1000 mg/liter) for boiler rearing during summer season. It increases water intake and improves survivability and performance of broilers. The high environmental temperature causes excessive loss of CO2 due to hyper ventilation and respiratory alkalosis develops. So, concentration of HCO3 in the blood decreased and blood pH is increased. Thin shelled or shell less egg is the result of this condition. Supplementation with sodium- bi- carbonate in feed @ 4 kg/ton or in drinking water will be helpful in this condition.

NUTRITION AND INFECTIOUS DISEASES

- During early stages of Ranikhet disease, requirement of **vitamin K** is increased.
- **Vitamin A** in excess than the minimum levels needed for growth is important in the prevention of severe lesions and losses from the CRD.
- Excess protein above the normal requirements markedly increases the vitamin A requirements of chicks.
- Vitamin A is involved in maintaining the integrity of the cells of the mucous membrane and secretion of mucus.
- Vitamin A helps in increasing the antibody synthesis against pathogens. e.g. Salmonella.
- **Folic acid** deficiency causes a marked reduction in the number of white blood cells. Its deficiency also causes anemia.

Feeding of antibiotic: It is used in reducing early chick mortality and also in times of stress. Thus, this is indicated in stress conditions like overheating, chilling, vaccination, deworming

and debeaking. It is fed 2 days prior to stress and 2-5 days following stress.

NUTRITION AND COCCIDIOSIS

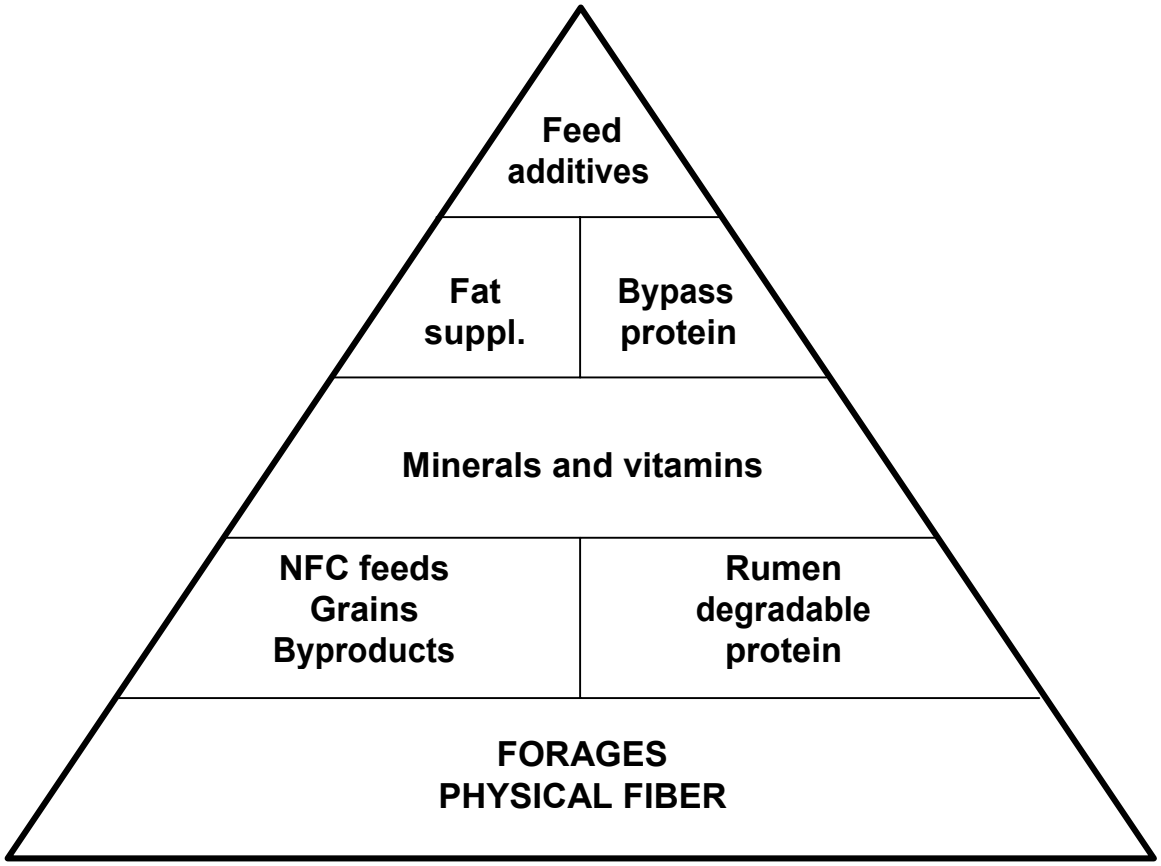
- Chickens receiving ten times more vitamin A than the minimum requirement gain their appetite faster and also grow faster, when infected with oocyst of coccidian. Vitamin A store of the infected bird is lowered down as compared with the healthy chicken. Dose: *In severe out-break 60 I.U. dose of vitamin A per bird per day almost completely prevented mortality*, while mortality was almost complete in the chickens fed vitamin A deficient

  diet. Vitamin A is important for keeping the epithelial lining of the intestine healthy and intact.
- Requirement of vitamin K increases (from normal 1.2 mg/kg to 8 mg/kg feed) in the coccidiosis affected birds which gives maximum growth rate and feed efficiency in the affected birds.
- Higher levels of dietary protein and Ca favors establishment of oocysts of coccidia but a low protein and low Ca diet discourage them. For activation of trypsin enzyme, protein and Ca is required. Whenever trypsin activity is low, due to low Ca and protein, cysts of oocysts of coccidia are not dissolved; hence, ova are not released in the intestine.

Dairy ration and feed formulations

The Feed Pyramid

Use the Feed Pyramid to think about how rations should be formulated and cows fed. A basic ration with high quality forages (bottom three sections of pyramid) should support up to 75 lb of milk per day. Fats, bypass proteins and feed additives are needed by higher producing cows and should top off the base ration.



DRY MATTER INTAKE (DMI)

Milk Cows

DMI (lb/day) = .0185 × BW* + .305 × 4% FAT MILK (lb/day)
4% FAT MILK (lb/day) = .4 × MILK (lb/day) + 15 × FAT (lb/day)

Estimated daily DMI for milk cows

3.75% fat milk	Body weight, lb			
	900	1100	1300	1500
	- - - - - - - - - - - - - DMI, lb/day* - - - - - - - - - - - -			
30	26	29	33	37
50	31	35	39	42
60	34	38	42	45
70	37	41	45	48
80	40	44	48	51
90	43	47	50	54
100		50	53	57
100+		52	56	60

*Decrease DMI .2%/day for cows <90 days in milk

Dry Cows

Far-off (2 to 8 weeks before freshening) DMI (lb/day) = 1.8 to 2.0% BW

Close-up (0-2 weeks before freshening) DMI (lb/day) = 1.5% BW

DMI guidelines for dry cows

BW	DMI range	
	Far-off	Close-up
- - lb - -	- - lb/day - -	- - lb/day - -
900	16 - 18	14 - 16
1100	20 - 22	16 - 18
1300	23 - 26	18 - 22
1500	27 - 30	20 - 24

*BW = Body weight

Check the following when observed DMI is different than expected:

(DMI is amount the cows consume, not amount fed)

DMI 5% above guidelines

1. Feed weight accuracy - mixer scales calibrated, good feed mixing.
2. Weigh back amounts accounted for.
3. Moisture or DM content of feeds correct.
4. Cow body weights.
5. Compare milk production to amount of DMI. Cows should average 1.8 to 2.2 lb of milk per lb of DMI.

DMI less than predicted

1. Ration DM below 50%.
2. Empty bunks, cows not on full feed.
3. Inadequate bunk space, crowded facilities.
4. High fiber ration, check NDF and ADF.
5. Low salt intake.
6. Water intake restricted or quality problem.
7. Moldy feed.
8. Poor bunk management, old feed not cleaned out.
9. Unpalatable feeds and/or low quality forages being fed.
10. Heat stress and/or poor barn ventilation.
11. Excess RUP (bypass protein) being fed.

ENERGY - REQUIREMENTS AND SOURCES

Carbohydrates and fat are the major source of energy in dairy rations. Carbohydrates should be considered as the primary source with fat an additional source when ration energy recommendations cannot be met.

Ration recommendations and concentrations

	Lactation stage				
Item	Early	Mid	Late	Dry	Close-up
Net energy-lactation (NE_L), Mcal/lb	.78 - .81	.74 - .78	.70 - .74	.60 - .65	.70
Non-fiber carbohydrates (NFC), %	37 - 42	35 - 40	30 - 40	20 - 30	35
Fat, add %, maximum	3	3	2	0	1

Non-fiber carbohydrate (NFC) is a measure of starches, sugars and pectins. NFC values for feeds are calculated as follows:

NFC (%) = 100 - [NDF% + CP% + ASH% + FAT%]

All values are on a DM basis

Excess ration NFC symptoms

1. Low or fluctuating DMI.
2. Low milk fat %, high milk protein %.
3. Acidosis problems.
4. Rapid hoof growth, sore feet.
5. Excessive corn in the manure.

Inadequate ration NFC symptoms

1. No peak milk, generally low production.
2. Considerable body weight loss, especially in early lactation.
3. Ketosis problems.
4. High milk fat %, low milk protein %.

Fat feeding guidelines

1. Maximum fat added to a lactating ration should be 4% ofDM.
2. General feeding guidelines, maximum amount of fat from source:

   Animal fat - 1.0 lb/cow/day Plant/vegetable - 1.2 lb/cow/day Inert fats - 1.0 lb/cow/day

3. Symptoms of excess fat feeding:

   Low DMI
   Over-conditioned (fat) cows Loose greasy manure
   High milk fat test (>3.6%) with low fiber (<19% ADF) ration

Grain processing/rumen degradability

Rumen degradability or digestion of starch from fastest to lowest in grains as follows: Oats, Wheat, Barley, Corn, Sorghum

Processing also affects degradability with steam flaking, fine grinding and ensiling increasing degradability compared to coarse or whole dry grains.

Energy feeds

Feed	NE_L Mcal/lb	Fat %	NFC %	Feeding limit lb/cow/day
	- - - - - - - - - DM basis - - - - - - - - -			- - As fed - -
Grains				
Corn, shelled	0.92	4	75	25
Ear corn	0.90	3	62	30
Barley	0.87	2	61	15
Oats	0.75	2	46	15
Byproducts				
Beet pulp	0.81	3	30	10
Brewers grains - wet	0.81	6	21	25
Corn gluten feed	0.82	3	19	15
Distillers grains	0.99	10	16	5
Soybean hulls	0.85	2	14	10
Wheat midds	0.87	5	34	10
Fats				
Tallow	2.65	99	0	1.0
Vegetable fats				

Free oil	2.65	99	0	0.5
Cottonseed, fuzzy	1.01	20	13	7
Soybeans, cracked	0.92	19	16	5
Sunflowers, whole	1.10	40	10	3
Rumen inert fats	2.5+	80+	0	1

PROTEIN RECOMMENDATIONS AND SOURCES

Four forms of protein are often considered in evaluating or formulating rations. Crude protein (**CP**), or total protein, is first and foremost. Rumen degradable protein (**RDP**) and rumen undegradable protein (**RUP**) are used to fine-tune protein feeding. Soluble protein (**SP**) is considered in some cases for rumen fermentation, and should be about 50% of RDP in rations.

Ration protein recommendations

	Lactation stage				
Protein	Early	Mid	Late	Far-off dry	Close-up dry
CP, % of DM	18 - 19	16 - 17	13 - 15	12 - 13	15 - 16
RDP, % of CP	60 - 65	64 - 68	64 - 68	65 - 68	60 - 64
RUP, % of CP	35 - 40	32 - 36	32 - 36	32 - 35	36 - 40
SP, % of CP	30 - 35	30 - 40	30 - 40	30 - 35	30 - 35

Protein Checks and Considerations

1. All rations should be balanced for CP requirements first and then for RDP, RUP and SP.
2. Guideline is: 1 lb of CP is required to produce 10 lb of milk (example: 7 lb CP intake = 70 lb milk).
3. Forages should be checked for loss of CP from heat damage. Heat damage indicators:

   ADF-CP/CP ratio >13%
   Forage color is dark brown to black Manure dark color and dry
   DMI high with low milk production

4. Excess RUP in ration results in:

   Lowered milk production
   Manure may be

stiff, dry
DMI low because of inadequate rumen RDP decreasing digestibility of feeds

5. Excess RDP in ration indicators:

Low milk production; high, early peaks with low persistency High milk urea nitrogen (MUN) levels: (>18 mg/dl)
Loose manure

6. General RUP and RDP feeding guidelines based on forages in the

ration: High corn silage, >50% of forage DMI

- Limit use of corn based protein supplements like corn gluten meal, brewers grains and corn distillers grains because of low lysine contents
- Feed soybean meal based protein supplements
- Consider feeding some urea

High alfalfa based rations, >50% of forage DMI

- More need for higher RUP supplements
- Corn based or animal RUP sources complement alfalfaprotein

Protein sources	Feed	CP	RUP	RDP
	% of DM	- - - - - - - - - % of CP - - - - - - - - -		
Grains				
Corn, dry	10	50	50	12
Corn, high-moisture	10	60	40	30
Barley	13	75	25	22
Oats	13	80	20	30
Forages				
Alfalfa hay	20	70	30	35
Alfalfa haylage - <40% DM	20	80	20	60
- 40-50% DM	20	75	25	50
- >55% DM	20	70	30	40
Grass hay	12	63	37	35
Grass haylage	12	70	30	50
Corn silage	8	70	30	45
Corn silage - NPN Protein	12	65	35	55
sources Blood meal	88	20	80	10
Brewers grains, dry	28	47	53	10
Canola meal	40	77	28	25
Corn gluten meal	68	45	55	5
Cottonseed, fuzzy	24	65	35	27
Distillers dry grains	32	45	55	15
Fish meal	67	30	70	10

Linseed meal	38	65	35	40
Meat and bone meal	54	45	55	15
Soybean meal - 44%	49	65	35	18
Soybeans, raw	41	80	20	30
Soybeans, heated	41	50	50	18
Sunflower, meal	32	76	24	30
Urea	287	100	0	100

FIBER AND FORAGE RECOMMENDATIONS

Three measures of fiber should be evaluated in dairy rations: Acid Detergent Fiber (**ADF**), Neutral Detergent Fiber (**NDF**), and NDF from Forage (**NDF-Forage**). The NDF- Forage considers the NDF from hays, haylages, corn silage and 50% of the NDF in whole cottonseed. Any NDF from non-forage sources, like grains or byproducts other than cottonseed, are not considered in calculating NDF-Forage. Ration guidelines are below:

	Lactation stage			
Measure	Early	Mid	Late	Dry
ADF, minimum	18*	20	21	28
NDF, minimum	28	28	32	35
NDF-Forage, minimum	20	21	21	25
NDF-Forage, maximum	24	26	28	--

*Increase to 20% minimum when fat added to rations

Effective, Physical or Cud Chewing Fiber

Cows need a minimum of 15 and preferably 20% of the forage particles over 1.5 inches long to stimulate rumination. Cows should chew 11 to 12 hours/day or about 15 minutes/lb of DMI.

Particle size guidelines - Forages and TMR

	Separator box level		
Feed	Top	Middle	Bottom
	- - - - - - - - - - - - - - - - - % by weight - - - - - - - - - - - - - - - - -		
Chopped hay	15 - 25	40 - 60	<30
Haylage	15 - 25	30 - 50	<40
Corn silage	<5	50 - 65	<40
TMR	>7	30 - 50	<50

Assessing fiber adequacies in rations:

Excess fiber

1. Low milk production, cows not peaking.
2. DMI lower than expected.
3. High milk fat %.
4. Energy content of feed or ration is generally inverse of fiber content. High fiber levels mean low energy. Early lactation cows fed high forage rations may become ketotic and have rapid and excessive body weight loss.

Fiber deficiencies

1. Acidosis, off-feed problems, fluctuating DMI.
2. Low milk fat %.
3. Cows not chewing their cud.

Byproduct fiber values:

Feeds like whole (fuzzy) cottonseed can substitute for some forage in rations. Their "effectiveness" to substitute for forage fiber depends on particle size. Grinding and processing tends to reduce particle size and, thus, reduce the effectiveness of even high fiber byproducts substituting for large quantities of forages in rations. All rations should contain a minimum of 20% NDF-Forage (DM basis). Effective fiber from forages and high fiber byproduct feeds should be a minimum of 75% of total NDF in the ration.

Effective NDF (% of NDF) of some feeds

Feed	NDF, %	Effective NDF, % NDF	NDF-Forage, %
Legumes and grasses			
Hay	45	100	100
Haylage - coarse	45	80	100
Haylage - fine	45	60	100
Corn silage			
1/4" chop	24	70	100
Processed	32	80	100
Concentrates			
Barley	19	40	7.6
Beet pulp	41	40	16.4
Brewers grains	47	35	16.5
Corn, ear	26	35	9.1
Corn, shelled	10	0	0
Corn gluten feed	35	35	12.2
Cottonseed, whole	44	50	22.0

Malt sprouts	44	45	19.8
Soybean hulls	64	20	12.8
Wheat midds	36	33	12.0

MINERAL AND VITAMIN GUIDELINES

Ration guidelines

	Lactation stage			
Mineral/vitamin	Early	Mid	Late	Dry: far-off
	- - - - - - - - - - - - - - - - - - % of DM - - - - - - - - - - - - - - - - - -			
Calcium	>0.80	0.70	0.60	0.50
Phosphorus	0.50	0.45	0.40	0.30
Magnesium	>0.30	0.25	0.20	0.20
Potassium	1.50	1.20	1.20	0.65
Salt	0.50	0.50	0.50	0.50
Sulfur	0.25	0.20	0.20	0.20
	- PPM -			
Iodine	0.60	0.60	0.60	0.60
Iron	50	50	50	50
Cobalt	0.10	0.10	0.10	0.10
Copper	10	10	10	10
Manganese	40	40	40	40
Selenium	0.30	0.30	0.30	0.30
Zinc	40	40	40	40
	- - - - - - - - - - - - - - - - - - 1000 IU/day - - - - - - - - - - - - - - - - - -			
Vitamin A	150	100	100	80
Vitamin D	30	30	30	25
Vitamin E	0.5	0.5	0.5	1.0

Some key mineral and vitamin evaluation points:

Lactating cows

Calcium:	>150 grams/day or .75% of ration DM
Phosphorus:	about 100 grams but maximum of .50% of ration DM
Calcium at:	.9 to 1% and magnesium at .3% when fat is included in ration
Salt:	3 to 4 ounces/cow/day (1 oz for maintenance plus 1 oz/25 lb of milk) DCAD of: +20 milliequivalents or greater/100 grams of DM
Selenium:	6 to 7 milligrams/cow/day
Vitamin E:	400 to 600 IU/day

Dry cows

Calcium:	<100 grams/day
Phosphorus:	30 to 40 grams/day
Vitamin E:	800 to 1000 IU/day

Close-up dry cows - without anionic salts

Calcium:	<100 grams/day without anionic salts Potassium: <1% of DM
Other minerals:	same as for far-off dry cows

Close-up dry cows - with anionic salts

Calcium: 150 grams/day

Phosphorus: 40 grams/day

Magnesium: 4% of DMI

Sodium (Na): .05% of DMI

Potassium (K): 65% of DMI

Chloride (Cl): up to .8% of DMI

Sulfur (S): up to .4% of DMI

Example ration: Na - .1%, K - 1.2%, Cl - 1% and S - .45% (DM basis) [(.1% × 43.5) + (1.2% × 25.6)] - [(1% × 28.2) + (.45% × 62.6)] = -21.3 meq/100 grams DM

DCAD calculation: [(Na% × 43.5) + (K% × 25.6)] - [(Cl% × 28.2) + (S% × 62.6)]

****Goal:*** -10 to -30 meq/100 g of DMI

BODY CONDITION SCORES

Recommended scoring time	Body condition score 1 = thin; 5 = fat
Freshening	3.2 - 3.5
Breeding, 60-90 days	2.5 - 3.0
Late lactation	3.0 - 3.5
Dry off	3.2 - 3.5

Body condition should not drop more than .5 score from freshening to pregnancy.

Weight gain during lactation requires about 2.5 lb of corn (2.3 Mcal NE_L) /lb of gain in addition to grain for milk.

NUTRITION MANAGEMENT

Feed Bunk

- 1 to 3% weigh back or feed remaining after 24-hour feeding period.
- Cows need 24 to 30 inches of linear bunk space, but may get by at 12 inches if TMR fed and available at all times.
- Cows eat best in grazing position off smooth surfaces.

Ration Formulation

- When balancing rations, the reference cow should be at the 75th percentile of the herd. To calculate reference cow, take the average peak milk of older cows and add the daily average of all cows and divide by 2.

Example: Bulk tank average - 60 lb, peak milk older cows

- 86 lb (60 + 86) □ 2 = 73 lb of milk to balance for

Two groups: Balance rations at 20% above average milk production of each group.

Three or more groups: Balance rations at 10 to 15% above average milk production of each group.

Water Intake

- Cows should consume 3 to 5 lb of water per pound of DM consumed.

Example: 50 lb DM intake at 4 lb of water/lb of milk DM intake
= 200 lb of water/day or 200 □ 8 lb/gallon = 25 gallons

Ration Check

All rations should contain at least 1 feed from each category:

Forage

Grains
Protein
supplements Ca P mineral
Salt

FEED COST GUIDELINES

Target - Milking Cows

<$5.00/cwt milk produced

Daily cow cost: $3.00 to $4.00

Ingredient costs Feed	% of total daily cost
Forages	35 - 50
Grains/byproducts	30 - 40
Purchased protein, minerals, vitamins, additives	10 - 20