COMMERCIAL POULTRY NUTRITION
THIRD EDITION

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1.1 World Animal Production

Production of most farm animal species has increased over the last 10 years, and predictions are for this trend to continue in the near future. Poultry has seen the greatest increase in production and again, this trend will likely continue. Both poultry meat and eggs are well positioned to meet demands for increased supply from our growing world population. Prediction of world populations is always subject to adjustment, but it seems as though we will have around 7 billion people to feed by 2008. However, an obvious trend occurring is that this population is quickly aging and also living in urban settings of ever increasing size. Today almost 2% of the world's population live in the 10 largest cities in the world, and by 2008, we will likely have 20 cities with populations in excess of 10 million people. These large urban populations obviously rely almost 100% on food supply from rural areas. Traditionally such rural food supply has been grown adjacent to the urban populations, but this situation is becoming increasingly more difficult as these urban populations reach 10-15 million. National and international movement of feed and food will become critical to feeding these large expanding populations. The population in the developed world is predicted to change little in the next 10 years, and so virtually all growth will be in developing countries, and especially in Africa and Asia. With its unpredictable weather patterns, Africa has always had difficulty feeding its growing population, and with increased urbanization, this situation will only deteriorate.

In all countries, there is an aging of the population, and it is predicted that the proportion of people ≥ 60 years of age, will double in the next 30 years. The purchasing power of many such individuals may not be adequate to sustain their usual diet supply. Up to now, and in the near future, we have been able to meet increased demands for food through a combination of increased supply coupled with improved production efficiency. Such improvements in efficiency of production will allow us to gradually upgrade the general nutritional status of the world population as a whole and it is evident that

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INGREDIENT EVALUATION AND DIET FORMULATION

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2.1 Description of Ingredients

1. Corn

Other Names: Maize

Nutritional Characteristics:

Corn has become the standard against which other cereals, cereal by-products and other energy-yielding ingredients are compared. In most poultry diets, corn will be the major contributor of metabolizable energy. World production is around 600 m tonnes of which 240 m tonnes are produced by the U.S.A. Although China is the world's second largest producer at around 100 m tonnes, Brazil at 40 m tonnes, is the second largest world exporter. The feed industry usually uses the equivalent of U.S.A. grade #2. As grade number increases, bulk density declines and there are greater permissible levels of damaged kernels and foreign matter allowed in the sample. Corn grade #2 should contain no more than 5% damaged kernels and 3% foreign material. While damaged kernels are unlikely to affect its energy value, foreign material is likely to reduce its energy value and hence monetary value. Broken kernels are also potential sites for mold infestation.

The energy value of corn is contributed by the starchy endosperm, which is composed mainly of amylopectin, and the germ, which contains most of the oil. Most corn samples contain 3 – 4% oil, although newer varieties are now available which contain up to 6 – 8% oil, and so contribute proportionally more energy. These high-oil corn varieties also contain 2 – 3% more protein, and proportionally more essential amino acids. The protein in corn is mainly as prolamin (zein) and as such, its amino acid profile is not ideal for poultry. This balance of amino acids, and their availability, must be seriously considered when low protein diets are formulated, because under these conditions the corn prolamin can contribute up to 50 – 60% of the diet protein. Corn is also quite high in the yellow/orange pigments, usually containing around 5 ppm xanthophylls and 0.5 ppm carotenes. These pigments ensure that corn-fed birds will have a high degree of pigments in their body fat and in egg yolks.

While #2 grade is the standard for animal feeds, lower grades are often available due to adverse growing, harvesting or storage conditions. Dependent upon the reason for lower grade, the feeding value of corn usually declines with increase in grade number. Table 2.1 shows the metabolizable energy value of corn necessarily harvested at various stages of maturity due to adverse late-season growing conditions.

Table 2.1 Corn maturity and energy value

Corn description	*Moisture at harvest (%)*	*100 kernel wt at 10% moisture (g)*	*AMEn (kcal/kg) at 85% dry matter*
Very immature	*53*	*17*	*3014*
Immature	*45*	*22*	*3102*
Immature	*39*	*24*	*3155*
Mature	*31*	*26*	*3313*

The energy value of corn declines by 10 – 15 kcal/kg for each 1 lb reduction in bushel weight below the standard of 56 lb/bushel. However, these lower bushel weight samples show no consistent pattern with protein or levels of most amino acids, although there is an indication of loss of methionine content with the immature samples.

Another potential problem with handling immature, high-moisture corn is that the drying conditions must necessarily be harsher, or more prolonged in order to reduce moisture level to an acceptable 15%. Excessive or prolonged heating causes caramelization of corn which then has a characteristic smell and appearance, and there is concern that lysine will be less available because of Maillard Reaction with available carbohydrates.

As detailed in subsequent ingredients there is processing of corn that yields products such as gluten meal and corn oil. However, in North America well over 95% of corn is used for animal feeds.

There is some debate regarding the ideal size of ground corn particles for various classes of poultry. Within reason, the finer the grind, the better the pellet quality, while in mash diets, too fine a grind can lead to partial feed refusal. Table 2.2 indicates guidelines for expected distribution of particle sizes of corn ground to be 'fine' vs. 'coarse'. There seems to be some benefits in terms of AMEn of using a finer grind for birds up to 3 weeks of age, while a coarse grind is better for birds >21 d of age.

Depending upon the growing season and storage conditions, molds and associated mycotoxins can be a problem. Aflatoxin contamination is common with insect damaged corn grown in hot humid areas, and there is little that can be done to rectify the horrendous consequences of high levels of this mycotoxin. There is an indication of aluminosilicates partially alleviating the effects of more moderate levels of aflatoxin. If aflatoxin is even suspected as being a problem, corn samples should be screened prior to

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3.1 Diet specifications

Table 3.1 shows diet specifications for Leghorn pullets, while Table 3.2 provides comparable data for brown egg birds. These nutrient specifications are intended for guidelines in diet formulation when general growth and development (as outlined by the primary breeders) is the goal of the rearing program. Pullets are grown under a range of environmental conditions and housing systems and these can influence nutrient needs. In most situations, variable management conditions influence energy needs, and so it is important to relate all other nutrients to energy level. In hot climates for example, the pullet will eat less and so nutrients, such as amino acids, will have to be increased accordingly. Pullets grown on the floor, rather than in cages, will eat more feed, and so amino acid levels can be reduced. The diet specifications are based on using conventional ingredients where nutrient digestibility is fairly predictable. When non-standard ingredients are used, it is essential to formulate to more stringent standards of digestibility, such as for digestible amino acids. Tables 3.3 – 3.6 show examples of diet formulations using corn, wheat or sorghum with and without meat meal.

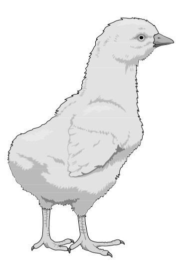
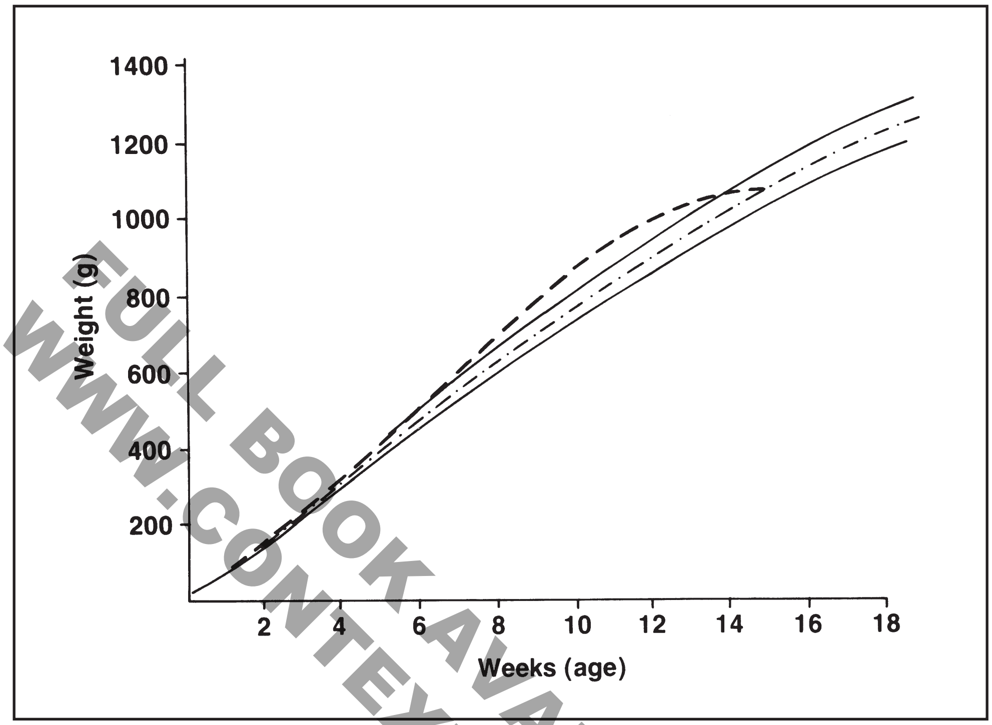


Table 3.1 Diet specifications for leghorn pullets

Age (weeks)	***Starter (0 to 6)***	***Grower (6 to 10)***	***Developer (10 to 16)***	***Pre-lay (16 to 18)***
Crude Protein (%)	*20.0*	*18.5*	*16.0*	*16.0*
Metabolizable Energy (kcal/kg)	*2900*	*2900*	*2850*	*2850*
Calcium (%)	*1.00*	*0.95*	*0.92*	*2.25*
Available Phosphorus (%)	*0.45*	*0.42*	*0.40*	*0.42*
Sodium (%)	*0.17*	*0.17*	*0.17*	*0.17*
Methionine (%)	*0.45*	*0.42*	*0.39*	*0.37*
Methionine+cystine (%)	*0.78*	*0.72*	*0.65*	*0.64*
Lysine (%)	*1.10*	*0.90*	*0.80*	*0.77*
Threonine (%)	*0.72*	*0.70*	*0.60*	*0.58*
Tryptophan (%)	*0.20*	*0.18*	*0.16*	*0.15*
Arginine (%)	*1.15*	*0.95*	*0.86*	*0.80*
Valine (%)	*0.75*	*0.70*	*0.65*	*0.60*
Leucine (%)	*1.30*	*1.10*	*0.92*	*0.88*
Isoleucine (%)	*0.70*	*0.60*	*0.51*	*0.48*
Histidine (%)	*0.35*	*0.32*	*0.29*	*0.26*
Phenylalanine (%)	*0.65*	*0.60*	*0.53*	*0.49*
Vitamins (per kg of diet):				
Vitamin A (I.U)	*8000*			
Vitamin D_3 (I.U)	*2500*			
Vitamin E (I.U)	*50*			
Vitamin K (I.U)	*3*			
Thiamin (mg)	*2*			
Riboflavin (mg)	*5*			
Pyridoxine (mg)	*4*			
Pantothenic acid (mg)	*12*			
Folic acid (mg)	*0.75*			
Biotin (µg)	*100*			
Niacin (mg)	*40*			
Choline (mg)	*500*			
Vitamin B_{12} (µg)	*12*			
Trace minerals (per kg of diet):				
Manganese (mg)	*60*			
Iron (mg)	*30*			
Copper (mg)	*6*			
Zinc (mg)	*60*			
Iodine (mg)	*0.5*			
Selenium (mg)	*0.3*			

Fig. 3.5 Potentially harmful adjustment to pullet weight.



Such adjustments are invariably brought about by use of very low nutrient dense diets and/or use of restricted feeding. Both of these practices have the desired 'effect' of slowing down mean growth, but at the great cost of loss of pullet uniformity.

e) Nutrient management

Although growing pullets do not produce large quantities of manure in relation to adult layers, nutrient loading of manure will likely be a management consideration. Under average conditions of feeding and management, pullets will retain about 25% of nitrogen and 20% of phosphorus consumed. Most of the remaining phosphorus will be retained in the manure while around 30% of the excreted nitrogen will be lost as ammonia, either in the pullet house or during storage prior to land disposal. Based on these values for nutrient balance, Table 3.30 provides information on nutrient flow for pullets through to 18 weeks. On a per pullet basis therefore, each bird produces about 0.1 kg N and 0.03 kg P in the manure to 18 weeks of age.

Manure nutrient loading is in direct proportion to corresponding diet nutrient levels. Using lower protein or lower phosphorus diets will invariably result in less of these elements appearing in the manure. Attempts at reducing crude protein levels in pullet diets, as a means of reducing feed cost and/or manure N loading, often results in poor growth rate (Table 3.31). Regardless of constant levels of the most important amino acids in these diets, pullets responded adversely to any reduction in crude protein. This data suggests that pullets have minimal needs for non-essential amino acids and/or that requirements for amino acids such as threonine and arginine are of more importance than normally

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FEEDING PROGRAMS FOR LAYING HENS

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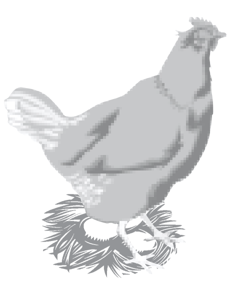

4.1 Diet specifications and formulations

Diet specifications for laying hens are shown in Table 4.1, and are categorized according to age and feed intake. There is no evidence to suggest that the energy level of diets needs to be changed as the birds progress through a laying cycle. The layer's peak energy needs are most likely met at around 35 weeks of age, when production and daily egg mass output are maximized. However, the layer quite precisely adjusts its intake according to needs for energy and so variable energy needs are accommodated by change in feed intake.

Most Leghorn strains will now commence egg production with feed intakes as low as 80 – 85 g/day, and it is difficult to formulate diets for such a small appetite. For brown egg strains, initial feed intake will be around 92 - 95 g/day and so formulation is more easily accommodated. For all diets, maintaining the balance of all nutrients to energy is the most important consideration during formulation.

In general terms, diet nutrient concentrations decrease over time, with the notable exception of the need for calcium. Thus, diet protein and amino acids expressed as a percent of the diet or as a ratio to energy, decline as the bird progresses through the laying cycle. In order to sustain shell quality, it is important to increase diet calcium level, and to concomitantly decrease diet phosphorus level, as the bird gets older. The need for less methionine is partially related to the need for tempering late-cycle increase in egg size, since this is usually uneconomical regarding egg pricing and larger eggs have thinner shells. There is little evidence for change in needs for vitamins and trace minerals as birds get older, and so a single premix specification is shown in Table 4.1. For most of the B-vitamins, it is possible to phase feed with up to 30% reduction by the end of the laying cycle.

Examples of layer diets using corn, wheat, or sorghum as the main energy source and with or without meat meal, are shown in Tables 4.2 – 4.5. The diets are categorized according to age of bird. It is difficult to achieve desired energy level in Phase I diets (Table 4.2) without resorting to inclusion of significant quantities of fat. If fat supply and quality is questionable, it may be advisable to reduce the energy level of the diet (and also all other nutrients in the same ratio), by up to 50 – 70 kcal ME/kg.

Table 4.1 Diet specifications for layers

Approximate age	***18-32 wks***		***32-45 wks***		***45-60 wks***		***60-70 wks***	
Feed intake (g/bird/day)	***90***	***95***	***95***	***100***	***100***	***105***	***100***	***110***
Crude Protein (%)	*20.0*	*19.0*	*19.0*	*18.0*	*17.5*	*16.5*	*16.0*	*15.0*
Metabolizable Energy (kcal/kg)	*2900*	*2900*	*2875*	*2875*	*2850*	*2850*	*2800*	*2800*
Calcium (%)	*4.2*	*4.0*	*4.4*	*4.2*	*4.5*	*4.3*	*4.6*	*4.4*
Available Phosphorus (%)	*0.50*	*0.48*	*0.43*	*0.4*	*0.38*	*0.36*	*0.33*	*0.31*
Sodium (%)	*0.18*	*0.17*	*0.17*	*0.16*	*0.16*	*0.15*	*0.16*	*0.15*
Linoleic acid (%)	*1.8*	*1.7*	*1.5*	*1.4*	*1.3*	*1.2*	*1.2*	*1.1*
Methionine (%)	*0.45*	*0.43*	*0.41*	*0.39*	*0.39*	*0.37*	*0.34*	*0.32*
Methionine + Cystine (%)	*0.75*	*0.71*	*0.70*	*0.67*	*0.67*	*0.64*	*0.6*	*0.57*
Lysine (%)	*0.86*	*0.82*	*0.80*	*0.76*	*0.78*	*0.74*	*0.73*	*0.69*
Threonine (%)	*0.69*	*0.66*	*0.64*	*0.61*	*0.60*	*0.57*	*0.55*	*0.52*
Tryptophan (%)	*0.18*	*0.17*	*0.17*	*0.16*	*0.16*	*0.15*	*0.15*	*0.14*
Arginine (%)	*0.88*	*0.84*	*0.82*	*0.78*	*0.77*	*0.73*	*0.74*	*0.70*
Valine (%)	*0.77*	*0.73*	*0.72*	*0.68*	*0.67*	*0.64*	*0.63*	*0.60*
Leucine (%)	*0.53*	*0.50*	*0.48*	*0.46*	*0.43*	*0.41*	*0.40*	*0.38*
Isoleucine (%)	*0.68*	*0.65*	*0.63*	*0.60*	*0.58*	*0.55*	*0.53*	*0.50*
Histidine (%)	*0.17*	*0.16*	*0.15*	*0.14*	*0.13*	*0.12*	*0.12*	*0.11*
Phenylalanine (%)	*0.52*	*0.49*	*0.48*	*0.46*	*0.44*	*0.42*	*0.41*	*0.39*

Vitamins (per kg of diet):	
Vitamin A (I.U)	*8000*
Vitamin D_3 (I.U)	*3500*
Vitamin E (I.U)	*50*
Vitamin K (I.U)	*3*
Thiamin (mg)	*2*
Riboflavin (mg)	*5*
Pyridoxine (mg)	*3*
Pantothenic acid (mg)	*10*
Folic acid (mg)	*1*
Biotin (µg)	*100*
Niacin (mg)	*40*
Choline (mg)	*400*
Vitamin B_{12} (µg)	*10*
Trace minerals (per kg of diet):	
Manganese (mg)	*60*
Iron (mg)	*30*
Copper (mg)	*5*
Zinc (mg)	*50*
Iodine (mg)	*1*
Selenium (mg)	*0.3*

FEEDING PROGRAMS FOR BROILER CHICKENS

CHAPTER 5

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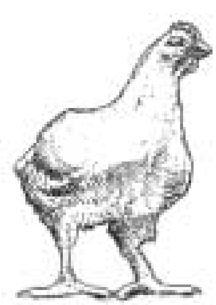

5.1 Diet specifications and feed formulation

Genetic selection for growth rate continues to result in some 30-50 g yearly increase in 42-49 d body weight. There has also been an obvious improvement in feed efficiency and reduction in the incidence of metabolic disorders over the last 5 years, and so these changes have dictated some changes in feed formulation and feed scheduling. The modern broiler chicken is however, able to respond adequately to diets formulated over a vast range of nutrient densities. If there is no concern regarding classical measures of feed efficiency, then the highest nutrient dense diets are not always the most economical.

To a large extent, the ability of the broiler to grow well with a range of diet densities relates to its voracious appetite, and the fact that feed intake seems to be governed by both physical satiety as well as by cues related to specific nutrients. For example, varying the energy level of a broiler diet today has much less of an effect on feed intake, as expected on the basis of appetite being governed by energy requirement. This apparently subtle change in bird appetite has led to increased variability in diet type and diet allocation used by commercial broiler growers. However, as will be discussed later, attempting to 'cheapen' broiler diets through the use of lower protein/amino acid levels, while not having major effects on gross performance, leads to subtle changes in carcass composition. Feed programs may, therefore, vary depending upon the goals of the producer versus the processor.

Another major change in broiler nutrition that has occurred over the last 5 years is the realization that maximizing nutrient intake is not always the most economical situation, at least for certain times in the grow-out period. A time of so-called 'undernutrition', which slows down early growth rate appears to result in reduction in the incidence of metabolic disorders such as Sudden Death Syndrome and the various skeletal abnormalities. A period of slower initial growth, followed by 'compensatory' growth is almost always associated with improved feed efficiency, because less feed is directed towards maintenance. As increasing numbers of broilers are grown in hot climates, an understanding of the bird's response to temperature, humidity and photoperiod is becoming more important.

Diet specifications are shown in Tables 5.1, 5.2 and 5.3. Table 5.1 shows relatively high nutrient dense diets, while Table 5.2 indicates an alternate program for low nutrient dense diets. The choice of such feeding programs is often dictated by strain of broiler, environmental temperature and the relative cost of major nutrients such as energy and protein. Within these feeding programs a common vitamin-mineral premix is used, albeit at different levels, according to bird age. Because birds will eat more of the low vs. high nutrient dense diets, there is potential to reduce the premix nutrient levels by up to 10% for Table 5.2 vs. Table 5.1. When broilers are grown to very heavy weights (63 d+) then there is an advantage to using lower nutrient dense diets (Table 5.3). Tables 5.4 – 5.7 show examples of high nutrient dense diets appropriate for the specifications shown in Table 5.1. There are six variations of diets for the starter, grower, finisher and withdrawal periods. The diets differ in the major cereal used namely corn, sorghum or wheat, and with or without meat meal as another option.

Table 5.1 High nutrient density diet specifications for broilers

Approximate age	***0-18d Starter***	***19-30d Grower***	***31-41d Finisher***	***42d+ Withdrawal***
Crude Protein (%)	22	20	18	16
Metabolizable Energy (kcal/kg)	3050	3100	3150	3200
Calcium (%)	0.95	0.92	0.89	0.85
Available Phosphorus (%)	0.45	0.41	0.38	0.36
Sodium (%)	0.22	0.21	0.2	0.2
Methionine (%)	0.5	0.44	0.38	0.36
Methionine + Cystine (%)	0.95	0.88	0.75	0.72
Lysine (%)	1.3	1.15	1.0	0.95
Threonine (%)	0.72	0.62	0.55	0.5
Tryptophan (%)	0.22	0.2	0.18	0.16
Arginine (%)	1.4	1.25	1.1	1.0
Valine (%)	0.85	0.66	0.56	0.5
Leucine (%)	1.4	1.1	0.9	0.8
Isoleucine (%)	0.75	0.65	0.55	0.45
Histidine (%)	0.4	0.32	0.28	0.24
Phenylalanine (%)	0.75	0.68	0.6	0.5
Vitamins (per kg of diet)	100%	80%	70%	50%
Vitamin A (I.U)	8000			
Vitamin D_3 (I.U)	3500			
Vitamin E (I.U)	50			
Vitamin K (I.U)	3			
Thiamin (mg)	4			
Riboflavin (mg)	5			
Pyridoxine (mg)	4			
Pantothenic acid (mg)	14			
Folic acid (mg)	1			
Biotin (μg)	100			
Niacin (mg)	40			
Choline (mg)	400			
Vitamin B_{12} (μg)	12			
Trace minerals (per kg of diet)	100%	80%	70%	50%
Manganese (mg)	70			
Iron (mg)	20			
Copper (mg)	8			
Zinc (mg)	70			
Iodine (mg)	0.5			
Selenium (mg)	0.3			

CHAPTER 6

FEEDING PROGRAMS FOR BROILER BREEDERS

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6.1 Diet specifications and feed formulations

The continuing increase in genetic potential of the broiler chicken poses ever-greater challenges for feeding and managing breeders. Growth and reproductive characteristics are negatively correlated, and because of the relative economic significance of broiler performance within integrated operations, broiler performance is necessarily of primary importance. As appetite and weight for age increase in commercial broilers, so nutrient restriction of young breeders must start at earlier ages and/or be of increasing severity at older ages. The modern breeder hen at 22 weeks of age must be comparable in weight to her offspring at 6 weeks of age. It is, therefore, not too surprising that appetite control of parent flocks is becoming more challenging. Like most other classes of poultry, the absolute requirements of broiler breeders are influenced by both feeding level and diet nutrient specifications. However, this dual effect means that nutrient intake can be controlled much more closely, and so represents great potential for matching intake to requirement. High-yield breeders are often slightly later maturing (7 – 10 d) than are conventional broiler breeders and have a longer feed clean-up time. In general, managers should not react too quickly in changing the feed allocation or diet as they normally would to circumstances arising with conventional breeders. High-yield roosters also pose some interesting new feed management problems, related to their aggressive behaviour. Tables 6.1 and 6.2 show diet specifications for growing and adult breeders, while Table 6.3 provides examples of corn based diets. Tables 6.4, 6.5 and 6.6 indicate nutrient specifications for adult birds as detailed by the primary breeding companies.

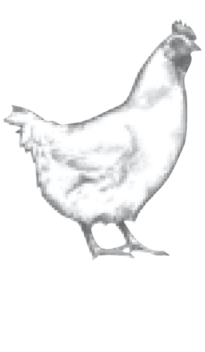


Table 6.8 Skip-a-day feed restriction program for pullets and roosters (diet at 2900 kcal/kg)

Age (wks)	*Pullets (g)*	*Roosters (g)*
1	Ad-lib	Ad-lib
2	Controlled 25/d	Controlled 30/d
3	Controlled 30/d	Controlled 40/d
4	70	80
5	80	90
6	90	100
7	100	110
8	105	115
9	110	120
10	115	125
11	120	130
12	125	135
13	130	140
14	135	145
15	140	150
16	145	155
17	155	160
18	165	170
19	175	180
20	185	190

The skip-a-day feed intake will obviously depend upon nutrient density and environmental conditions, yet these values can be used as guidelines. The concept of feeding to body weight and the regulation of body weight will be discussed more fully in a subsequent section. Table 6.8 indicates a restricted feeding program for both pullets and cockerels to be initiated at 4 weeks of age. Prior to this, 'controlled' feeding should be practiced so as to acclimatize birds to a limited feed intake. Controlled feeding should be adjusted to ensure that birds are cleaning up their feed on a daily basis within 4 – 6 hours. Because different strains of birds have different growth characteristics, then initiation of controlled and restricted feeding must be flexible in order to control body weight. For strains with inherently fast early growth rate, restricted feeding on a daily basis may be necessary as early as 7 – 10 d of age. For other strains, *ad-lib* feeding to 3 – 4 weeks is possible since they have a slow initial growth rate.

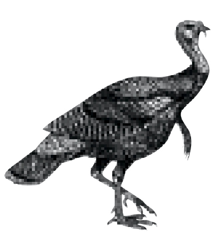
With skip-a-day, birds are given these quantities of feed only every other day. The concept behind this program is that with every other day feeding, birds are offered a considerable quantity of feed and this is easier to distribute so that even the smallest most timid bird can get a chance to eat. The usual alternative to skip-a-day feeding is feeding restricted quantities every day. For example, at 11 weeks of age, pullets could be fed 60 g each day. The problem with every day feeding is that feed is eaten very quickly and so all birds within a flock may not get ade-

FEEDING PROGRAMS FOR TURKEYS

CHAPTER 7

7.1 Commercial turkeys

Genetic potential for growth rate of turkeys continues to increase, and standards for male turkeys are now close to 1 kg per week of age at marketing weights of 18 – 20 kg. Unlike most other meat birds, there are distinct differences in the market weights of males and females and so it is accepted that the sexes must be grown separately. Male turkeys are now commonly grown to 18 – 24 weeks of age, and females to 15 – 16 weeks of age. A proportion of females will be sold as whole carcasses, while males are usually further processed in some way. A growing concern with these large turkeys is integrity and quality of the breast meat, since PSE (pale soft exudative) meat, as sometimes occurs in pigs, is now raised as an issue during processing. There has been no major change in carcass fat:protein over the last few years, and so meat quality is the main concern regarding carcass quality. Other carcass defects, such as breast buttons and other skin abnormalities are often a factor of management rather than genetics or nutrition *per se*.



There still needs to be some flexibility in developing feeding programs for turkeys. The diet specifications shown in Table 7.1 are general guidelines that can be used for both male and female turkeys. Depending on the marketing age of hens, the diets will perhaps be scheduled a little more quickly and/or the last diet used is a compromise between the Developer #2 and Finisher as shown in Table 7.1. The turkey will grow quite well on a range of diet nutrient densities, although grow-out time will increase and classical feed utilization will decrease, with lower nutrient dense diets. Poorer performance than expected with some high energy diets is often a consequence of not adjusting amino acid levels to account for reduced feed intake. Examples of diets based on corn and soybean meal are shown in Table 7.2 and growth standards are shown in Table 7.3.

Breast muscle deposition is now maximized at around 18 weeks of age in large toms, with deposition of about 65 g/d. Deposition of leg and thigh muscle on the other hand plateaus early, at around 14 weeks of age when there is a maximum daily deposition of about 45 g. Nutrient specifications from the commercial breeding companies are detailed in Tables 7.4 and 7.5.

Variable results to such formulations may be related to saturation characteristics of the fat being used. The young poult seems somewhat better than the chick in digesting saturated fatty acids, yet when these predominate, overall digestibility is quite low (Table 7.8).

The saturates C16:0 and C18:0 are fairly well digested when in the presence of a large quantity of unsaturates as occurs in soybean oil. This synergism likely relates to ease of micelle formation, which is a necessary prerequisite of transport from the lumen to the brush border of the epithelium, digestion and subsequent absorption. When there are minimal unsaturates available for micelle formation, then digestion of saturates is exceptionally low, not getting much over 50% by 21 d of age. Since medium chain unsaturates such as C8:0 and C12:0 in ingredients like coconut oil, do not necessarily need prerequisite micelle formation or action of bile salts then they are better absorbed by young birds (Table 7.9).

The digestion of medium chain fatty acids is exceptionally high, even for very young poults, and so these provide a viable alternative to other, possibly more expensive, vegetable oils containing unsaturates. There is also some research suggesting that three week old turkeys metabolize corn with about 10% less efficiency compared to 17 week old birds.

So-called Field Rickets continues to be an ongoing problem at certain farms. Since some farms seem to have greater occurrence than do others, there has always been suspicion of an infectious agent. However, when homogenates from the digesta of affected poults are fed to normal birds, there is no effect on poult liveability or skeletal development. Obviously, dietary levels of calcium, phosphorus and vitamin D_3 come under close scrutiny, but rickets does not seem to be a simple deficiency of any one of these nutrients. There are reports of prevention from using 25(OH)D_3 rather than vitamin D_3, while other

Table 7.8 Digestibility of C16:0 and C18:0 fatty acids within soybean oil and tallow (%)

		C16:0		*C18:0*	
		Soybean oil	*Tallow*	*Soybean oil*	*Tallow*
Poult	*7d*	*96*	*65*	*51*	*50*
	21d	*99*	*59*	*51*	*36*
Chick	*7d*	*81*	*35*	*73*	*6*
	21d	*94*	*54*	*88*	*31*

Adapted from Mossab et al. (2000)

Table 7.9 Fat digestion by young poults

	Lipid digestibility (%)		
Diet	***3-5d***	***6-8d***	***9-11d***
1. Corn-soy	*74[b]*	*76[b]*	*78[b]*
2. 1 + 10% AV-fat	*69[c]*	*72[b]*	*71[c]*
3. 1 + 10% MCT[1]	*90[a]*	*92[a]*	*90[a]*

[1]Predominantly C8:0
Adapted from Turner et al. (1999)

CHAPTER 8

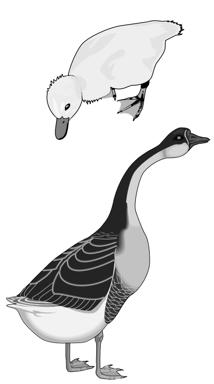
FEEDING PROGRAMS FOR DUCKS & GEESE

Page

8.1 Ducks

The waterfowl industry has been relatively static in terms of overall production and marketing opportunities. There are now very few internationally recognized commercial breeders and so this leads to more standardization of performance. Asia, and particularly China, continue to be major producers of both meat and eggs, while eastern Europe is a major center of goose meat production. Interestingly the growth potential of Pekin type duck strains continues to still outperform that of modern broiler chickens.

Growth rate of meat ducks continues to improve on an annual basis, with males being around 3.2 kg at 42 d. Nutritional programs are aimed at finding a balance between expression of this growth rate vs. control of carcass fatness. Diet specifications for both commercial and breeder ducks are shown in Table 8.1, while examples of corn-soybean diets are shown in Table 8.2.



In formulating diets for meat ducks, care must be taken in adjusting the balance of protein:energy to try and minimize carcass fat deposition. The duck seems to respond in a similar way to protein:energy as previously described for the broiler chicken and turkey, such that higher protein diets in relation to energy generally result in less carcass fat. The duck seems to be able to digest fiber slightly better than does the chicken, and as such, metabilizable energy values for ducks may be 5 – 6% greater than corresponding values for chickens – such differences should be considered in setting energy specifications of diets.

Methionine and lysine are likely to be the most limiting amino acids in diets for ducks, and the normal base level of 2 and 5% of crude protein respectively seem applicable to the duck. Growth characteristics of Pekin ducks are shown in Table 8.3.

In developing feeding programs for ducks, carcass composition must be taken into account, especially for late-grower and finisher diets. Table 8.4 outlines the yield and commercial portions of Pekin ducks, while Table 8.5 details the fat and protein deposition in the carcass at 49 d of age. At 49 d of age, abdominal fat represents only some 2% of body weight, which is comparable to that found in chickens – this data confirms that the major problem with fat in the body of the duck is subcutaneous fat depots.

Commercial Poultry 3.indb 377 11/5/2012 10:05:04 AM

There seems to be an advantage to feed restriction in growing breeder candidates. Most breeding stock is selected from within commercial flocks at normal market age, and so there is a great challenge to 'hold' birds up to time of sexual maturity. Low nutrient dense holding diets (Table 8.1) fed on a restricted basis according to desired body weight seem to be the only practical method of both delaying sexual maturity and controlling mature body size. Without such control, egg production is often very poor, and fertility of males may be virtually non-existent. Under such conditions, breeder candidates should be fed according to body weight as was previously described for broiler breeder stock (Table 8.9).

Restricted feeding of juvenile breeders from 3 – 20 weeks results in greater numbers of settable eggs and some 10% improvement in fertility. As occurs with turkeys, ducklings from young breeders do not grow as well as do those from older birds, and this situation cannot be resolved by supplements to breeder diets (Table 8.1). Heavy breeder strains can also successfully be molted as discussed previously for chickens and turkeys. Table 4.45 gives a general outline of a molting program. As with other species the initial requirement is for loss of 25 – 30% of body weight, and this is achieved by feed withdrawal and reduction in day length. The body reserves of the breeder, and her ovary and oviduct are then re-established through gradual return to *ad-lib* intake of a breeder diet over a 5 – 6 week period.

Table 8.9 Effect of restricted feeding of juvenile breeders on the performance of breeders from 20 – 60 weeks of age

		Feeding system to 20 weeks of age		
		Ad-lib	*75% ad-lib*	*50% ad-lib*
Feed intake (kg)	*3 – 8 wk*	7.4	5.6	3.7
	8 – 20 wk	17.3	13.0	8.7
Body wt (kg)	*8 wk*	3.1	2.8	2.1
	20 wk	4.0	3.4	2.5
	60 wk	4.3	4.1	3.8
Eggs	*20 – 60 wk*	163	180	187
Fertility (%)	*20 – 60 wk*	83	92	92

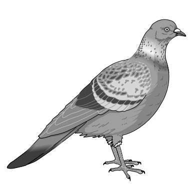
Adapted from Olver (1995)

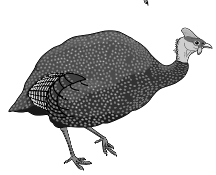
FEEDING PROGRAMS FOR GAME BIRDS, RATITES AND PET BIRDS

CHAPTER 9

9.1 Game birds

While there is some recent information on nutrient requirements of quail and pheasants, there is still a tendency to rely on trends occurring in turkey nutrition. A challenge in designing diets for game birds is varying market needs and especially commercial meat production vs. growing birds for hunting preserves or release. Birds grown for release generally do not need to grow at maximum rate and in many instances this is, in fact, a detriment to flying ability. Nutrient requirements and examples of diets shown in Tables 9.1 and 9.2 relate only to commercial meat production. For release programs, then some type of low nutrient dense holding diet is usually fed for example after 7 – 9 weeks of age with pheasants.





Pheasants – Table 9.1 outlines starter, grower, holding and breeder diet specifications for pheasants. The pheasant starter diet should be fed to 4 weeks of age, followed by the first grower diet to market age or until they are selected for breeding. Diets shown in Table 9.2 are complete diets and need not be supplemented with grain. However, the feeding of 5 to 10% cracked grain can be utilized after 12 weeks of age for birds that are to be released for hunting. The grain portion should be switched to whole grain at 16 weeks of age at which time one half of the feed allotment can be grain. Such a feeding program results in a stronger, hardier bird and one that is more able to forage for itself when released.

The pheasant breeder diet should be fed to the birds starting at least 2 weeks before eggs are expected. Again, this is a complete diet and no supplements should be added to it. Table 9.3 indicates weight gain and feed intake data for male and female pheasants to 18 weeks of age.

Quail – Quail diet specifications are shown in Table 9.4. The quail starter diet should be fed as a complete feed up to 6 weeks of age. At this time, the birds should be placed on the grower diet either until they are marketed as meat or until one week before table or hatching eggs are expected from the females. As mentioned above, a small percentage of scratch grain may be employed. Table 9.5 shows body weight and feed intake data for both male and female quail to 10 weeks of age.

During the breeding season, the females markedly reduce their feed intake somewhat like a turkey breeder. Thus, it is important that they be in good condition carrying sufficient nutrient reserves, so that quality eggs are produced, leading to potentially healthy offspring. Table 9.11 shows gross composition of eggs from ostriches and emus.

Table 9.11 Ratite egg components

	Weight (g)	Albumen (%)	Yolk (%)	Shell (%)
Ostrich	1200	54	32	14
Emu	600	53	34	13

9.3 Pet birds and pigeons

Most pet birds are fed diets based on whole seeds rather than complete feeds as pellets. Feeding birds along the guidelines outlined in Table 9.12 would seem more logical from a nutritional viewpoint, although nutrition *per se* does not always seem to be the major factor involved in diet selection by owners.

Use of complete pelleted feeds has been met with resistance by owners, and not all species of bird readily accept conventional pellets. However, by using extruded pellets and incorporation of color/taste/smell additives both the owner and bird can be coaxed into using such complete feeds. There is increased demand for hand-reared birds due to better behavioral disposition and the potential for a ban in trade in exotic species. Consequently there is increased demand for information on diets for hand feeding of newly hatched birds. While many such hatchlings are fed on baby food/peanut butter mixes, a gruel formulated to the specifications shown in Table 9.12, and composed of more conventional ingredients, should prove more economical for large-scale operations. However, due to the monetary value of many of these pet birds, economics of nutrition is not always a major factor, especially when one considers the actual feed intake of these very small birds.

Table 9.12 Diet specifications for pet birds

	Budgie		Parrots		Hand feeding
	Young	Adult	Young	Adult	
Crude Protein (%)	23.0	15.0	21.0	14.0	26.0
Metabolizable Energy (kcal/kg)	3000	2900	2900	2800	3200
Crude fat (%)	5.0	5.0	5.0	4.0	10.0
Crude fiber (%)	3.0	3.0	4.0	3.0	3.0
Calcium (%)	1.2	1.0	1.0	0.9	1.4
Av Phosphorus (%)	0.45	0.45	0.45	0.4	0.7
Sodium (%)	0.17	0.17	0.16	0.14	0.18
Methionine (%)	0.50	0.30	0.43	0.25	0.60
Methionine + Cystine (%)	0.92	0.61	1.00	0.52	1.20
Lysine (%)	1.30	0.75	1.20	0.68	1.40

Mineral-vitamin premix as per turkey with 200 mg/kg Vit. C

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