

Broilers

Better Nutrition and Management for a Better Bottom Line



Broilers

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CRF Broiler Research Past and Present

Whether you have a small operation or are a large commercial producer, your birds' nutrition is important to you. Overall health is determined in large part by meeting any animal's nutritional needs.

To be successful in the broiler business, you have to remain updated on changes in nutrition and management. To help in these areas, your feed supplier has joined with other feed manufacturers in establishing Cooperative Research Farms (CRF) so that you may benefit from its worldwide feed research.

In fact, CRF's initial research efforts were done with broilers. In the 50 plus years since, CRF has conducted more than 500 experiments with broilers and broiler breeders. Nutritional areas have included; protein/amino acids, vitamins/minerals, energy, feeding programs, enzymes, ingredient evaluations, and the influence of breeder nutrition on progeny performance. Strain cross information has generally been included in most of the experiments. Medications, equipment evaluations, problem solving, physical characteristics of feed and birds, and management techniques are some of the other areas researched. There are two basic sides to nutrition. One is the nutrient needs of the birds by age, sex, health status, and management. The other side is the nutrient content of the diet (ingredients), which are digested and utilized by the bird.

The history of CRF broiler research has been to evaluate nutrition in terms of strain cross, health status, and feeding programs. CRF has used internal facilities such as Bridgeville, Hershey and Talmo as well as university facilities and private research facilities throughout its history. Battery cages, grow-out batteries, floor pens and modern broiler production houses have been used to conduct experiments. Today, CRF's broiler research is conducted in a scientifically advanced research operation in Quebec, owned by CRF member La Coop Fédérée.

Our ingredient and feed evaluations have progressed simultaneously with management and feeding programs. The result is a wealth of information that has been incorporated into this manual, designed to provide practical answers on nutrition, housing and modern broiler management.

Members of CRF have invested in the scientific research behind the feeds they sell. Behind every feed tag, you'll find solid science — technological and operational breakthroughs you'll get nowhere else.



Vital Nutrients

The Care and Feeding of a Successful Broiler Operation

General Scope

Ensuring proper nutrition in all poultry is a time-intensive process that takes a combination of updating currently used ingredients and evaluating new ingredients (or new forms of old ingredients.) It's the only way to ensure your feeds match your flock's needs.

Thanks in large part to CRF research advances, we know more of the life cycle needs for growth, reproduction, tissue regeneration and the abilities of the diet to maintain a healthy bird in the presence of stress and health challenges.

Feed is often the largest of a producer's operating expense, yet it easily pays for itself: In addition to raising healthy, viable flocks, producers view this expenditure as key to having a healthy, viable business.

Water

The most important nutrient you supply your birds is water, and it is consumed in greater quantity than any other nutrient. Birds will die more quickly from lack of water than with a lack of any of the other nutrients.

Birds should have free and convenient access to water. The amount of water required varies with age, health, ambient temperature and the reproductive status of your birds. Watch for diarrhea or high urinary output, which may be due to high protein or salt intake. A reliable estimate of water needed is 1.7 to 2 times the amount of diet consumed. Therefore, a bird consuming a quarter-pound of feed per day would need up to a half-pound of water.

Water requirements also vary with water quality. Poor quality drinking water is often responsible for less-than-optimum performance. Have your water analyzed at least once a year. Spring is an excellent time for this annual appraisal, as runoff from rains may alter water quality. A change in the level of your water table or well can result in a change in water quality.

A water suitability analysis is an economical management tool. Shown below are elements analyzed in a water analysis. While not comprehensive, the minerals listed are the more common ones that are most typically of concern.

Elemental Analyses (ppm)

Rating	NO3 Nitrate	Mg Magnesium	Ca Calcium	SO4 Sulfate	Na Sodium	Cl Chloride
No problem	0-45	30	50	75	30	0-70
Chance of problem	45-100	0-60	50-80	75-150	30-50	70-150
Likely problem	100-200	60-90	80-100	150-300	50-150	150-300
Avoid	>200	>90	>200	>300	>150	>300



CRF's broiler research facilities in St. Jean Baptiste, Quebec

When minerals are dissolved in water, it becomes able to conduct electricity. By measuring this conductivity, you can calculate the total amount of dissolved solids. This measurement can be expressed in parts per million (ppm) of dissolved solids as a means of measuring water quality.

Effects of Total Dissolved Solids

Content of Water (ppm)	Comment
>500	Not recommended for human consumption
<1000	Should present no serious problem
1000-3000	May cause diarrhea
3000-5000	Will cause diarrhea and temporary refusal
>5000	Unfit for birds

Acidity and alkalinity are measured as pH. Values below 7.0 are acid; those above are alkaline. Most water supplies have a value between 6.5 and 8.0. Some producers add acidifiers to reduce the water pH to between 5.5 – 6.0 to improve gut health.

Purity of water refers to the presence (positive) or absence (negative) of bacteria presumed to be coliform. Water positive for coliforms should not be used as a water source without chemical treatment. Drinking water contaminated with coliform bacteria may cause diarrhea and can lead to serious health problems.

Several kinds of water treatments are available to solve various problems. For very high levels of hard water, softening of the water or acidification may be necessary to reduce problems with clogging of watering nipples. There are water-softening devices where sodium replaces calcium and magnesium. Chlorinating will

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destroy bacteria levels. Filtration will remove some organic and mineral particles. De-ionizing resins remove most all minerals from the water but are expensive. Water lines can be a source of lime, slime, rust and algae. They may also be loaded with bacteria, fungi and viruses. Effective cleaning and sanitizing agents are chlorine, iodine and ammonia.

Sampling water requires some preparation. You'll need a clean bottle (sterilized if the water is being checked for purity). Keep the sample cool and transport it to the lab as quickly as possible. Be sure you obtain a representative sample by allowing the water to run before filling your container. For coliform bacteria samples, sterilize the tap with a flame before drawing the water sample. Most labs have special water sample bottles, which simplify the process.

Energy

A constant supply of energy is necessary for all birds to sustain life. Energy for all the birds systems comes from the feed they eat or their body stores.

Fats and oils are the most concentrated sources of energy. On a per-unit-of-weight basis, they have more than twice the energy (calories) than can be derived from a similar amount of carbohydrates or protein. Whether you're seeking to optimize growth or reproductive capability, fat provides readily available energy. Fats and oils provide an essential fatty acid, linoleic acid. Because fats can be applied in a liquid form, there less loss due to fines and dust. There is a general palatability improvement with fat addition.

Key quality control points your fats-and-oils supplier should be providing:

- Know sources of fat blends and suppliers.
- Know fatty acid structure.
- Determine the total fatty acids and free fatty acids of all fat purchased.
- Monitor moisture, impurities and unsaponifiables.
- Determine peroxide values and AOM frequently.

Carbohydrates are organic compounds composed of Carbon, Hydrogen, and Oxygen (CHO). As they comprise $\frac{3}{4}$ of the dry weight of grains, they are a large part of the bird ration. They serve as a source of energy for the different metabolic processes. They can be transformed into adipose tissue and stored in the body. The insoluble and indigestible CHO from the structural portion of carbohydrates is called fiber. The soluble and digestible CHO portion is labeled nitrogen-free extract (NFE). Corn and wheat are the key cereals where growing conditions permit suc-



cessful cultivation. They are primarily an energy source, although they do supply a significant amount of protein.

Key quality control points your carbohydrates (grains) supplier should be providing:

- Monitor moisture levels and store properly.
- Check for toxins.
- Adjust energy content by moisture level.
- Adjust crude protein and amino acid levels.

Protein

Protein is digested by a series of hydrolytic enzymes so that its component amino acids can be absorbed from the intestinal tract and used to form body proteins. A large number of the amino acids can be converted to CHO, thereby supplying energy for the body. A few amino acids are ketogenic and form ketones, which also can be used for energy.

Amino acid requirements have been defined for each poultry type or strain, as well as age and function within each species. Protein nutrition has precise amino acids levels, but the ingredients available don't always fit the precise needs of any bird. It is the level of the limiting amino acid which determines how much

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the bird will have at its disposal for growth, tissue replacement, feathers and other amino acid-based needs of the body. Another factor in formulating a ration is that the digestibility of amino acids from any ingredient is not 100 percent. Bear in mind, too, that genetic changes cause a change in amino acid requirements. Today, the amount of waste and manure production has become regulated by governmental agencies, and thus excess protein is also a formulation concern.

Soybeans are a key source of high levels of plant protein. They can be processed in different ways. When a significant amount of oil is left in the soybean meal, it can be a potent source of energy for the bird.

Key quality control points your plant-protein supplier should be providing:

- Set specifications for all plant protein meals.
- Use actual protein and amino acid values in formulation.
- Check for over-processing. Potassium hydroxide is a good measure of protein solubility and there are accurate quick cards, which will provide a urease value.
- Check for flow agents.

Animal proteins help ensure feeds meet your flock's amino acid requirements. Key quality control points your animal-protein supplier should be providing:

- Identify processing type and animal source by supplier.
- Use an antioxidant.
- Monitor crude protein and amino acid contents by supplier.
- Monitor phosphorus, calcium, and sodium levels.
- Run occasional peroxide values and AOM tests to check storage.
- Test pepsin digestibility occasionally, and always with new suppliers.

Minerals

Macro-minerals are defined as those inorganic elements required by the bird as a percentage of the diet. Calcium and phosphorus are required for the skeleton. Sodium, potassium and chloride help maintain the osmotic and pH relationships in the body.

Trace minerals are listed in terms of parts per million (ppm) and function within the body processes. CRF poultry research has worked out digestibility and interaction data between the inorganic elements. Here again, environmental factors indicate that excretion of excess or indigestible minerals, such as phosphorus, copper, and zinc can have a negative effect on the environment.

Vitamins

Vitamins are organic compounds which are essential for health, growth and maintenance of the body. While they are needed only in minute amounts, they are a vital part of a bird's diet and must be supplied in the diet to avoid a deficiency, disease or metabolic syndrome. There are a number of substances and conditions — including mycotoxins, cocci, and organisms, which cause enteritis, which can interfere with vitamin absorption, resulting in failure of vitamin absorption and therefore a “vitamin deficiency”.

Ingredient Quality Control

By having quality control standards, your CRF member can provide greater control over your return on investment. However, it will take a commitment of finances and time to monitor results and make required adjustments. Some of these adjustments may include eliminating or controlling specific ingredients.

Virtually all ingredients possess some factor which must be eliminated or controlled in order to maximize the nutritional value of the ingredient. In many ways, these factors have been catalysts in the feed milling industry and have led to many advances. You may rely on your CRF member's ability to know, measure and maintain its quality of feeds over the long term.



Nutritional Requirements

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Growing

The availability of more ingredients has allowed more accurate formulations to better meet a bird's needs. While CRF has conducted many broiler experiments, genetics of birds (and those of plants that supply feed ingredients, for that matter) are constantly changing. These studies have been on an applied basis, keeping our research on an immediate usage time line. Economics have been a major factor in determining which areas to investigate. Vitamins and trace minerals are relatively inexpensive. The levels shown in Table 1 are generally minimum levels that satisfy general production activities and/or prevent deficiency syndromes. (National Research Council — Nutrient Requirements of Poultry: Ninth Revised Edition, 1994).

Typical broiler production feeds combine a decrease in amino acids concentrations with an increase in energy density as the bird ages. Higher energy levels do improve feed efficiencies; however, CRF research has consistently shown that improved feed efficiencies are not always cost effective. CRF diets are cost efficient and effective for growers. Expected body weights and average daily gains by age are shown in Table 3 using Cobb/Ross averages.

See Tables 1, 2 and 3 on pages 8 and 9.

Breeders

CRF has conducted broiler breeder research at its own research facilities for many years. In addition to examining nutritional levels, which maximize breeder performance, progeny trials were conducted to ascertain any nutritional imbalances. These studies showed that both breeder nutrition and health program had an affect on progeny performance. Tables 4 and 5 provide suggested nutrient recommendations from the National Research Council's Nutrient Requirements of Poultry: Ninth Revised Edition for growing and producing broiler breeders. Because breeders are fed to achieve specific body weights, it is important that the diets provide needed nutrients for the bird based on the programmed feed intake. For your particular strain, consult the breeder guide for the recommend body weights in the growing and production stages.

See Tables 4 and 5 on page 9.

Chick Management

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Brooding

Heat is provided by gas, oil, electricity, coal or other fuels; and can be supplied by a central heat source that will heat the complete house or as a restricted heat source heating a partial section of the house. Gas or electric brooders are typically used with broilers. A six-foot diameter Hover-type gas will accommodate about 500 chicks. Start the brooder 48 to 24 hours before the chicks' arrival and adjust the floor temperature to 92° F (33°C). Measuring the temperature on the floor with an infrared thermometer is the most accurate method. Reduce temperature linearly by 5° F each week until supplemental heat is no longer required. A temperature of 70° F (21°C) at six weeks is generally sufficient and the absolute minimum that should be maintained. Checking the temperature of the legs of the young chicks is a good way to know if chicks are comfortable; legs must not be cold.

If using infrared lamps, use porcelain sockets hung with a chain or wire (not the electric cord) at least 15 inches above the litter to minimize fire hazard. More than one heat lamp is recommended in case a bulb burns out. Since the infrared heat lamps heat the birds and not the air, air temperature measurements are not useful. The following guidelines are recommended:

- At 50° F (10°C) house temperature, use one 250-watt bulb per 40 chicks.
- For each degree over 50° F, one extra chick can be brooded per lamp.
- For each degree under 50° F, subtract one chick per lamp.

To reduce temperature to the birds, use smaller lamps, turn off some of the lamps or raise the lamps to 24 inches above the litter.

You may place an 18-inch high cardboard brooder guard ring around the brooding area for the first week to ten days, depending upon temperature. This will confine the birds to the heat, water and feed during the critical period and allow them to seek a comfortable temperature. Rings should have a diameter two to three feet larger than the brooder or heat lamp areas. For bigger operations, you may turn on only those lights on one side of the barn to confine the chicks on that side. Use feed boxes or feed on paper until five to six days old. It is a better practice to make available fresh feed each day to stimulate the chicks to eat. Using supplemental bottle waterers still results in a better chick start according

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to the weight measurement at seven days. Aim at having a weight at seven days of age at least four times the weight at arrival. For example, a chick weighing 40 grams at arrival should weigh 160 grams at seven days.

Another way to check for an optimal chick start is the percentage of crop filled. Take as many chicks as possible six, 12 and 24 hours after their arrival. Verify the number of chicks that have their crop filled with feed by feeling it with your fingers. The goal is to be as close as 100% as possible, but 96% is likely to be the best average that a poultry producer will be able to achieve.

Bird comfort can best be judged by watching the birds. Listen to the birds — sharp chirping indicates discomfort for some reason. If the birds tend to huddle or congregate in certain spots, check the temperature and brooding equipment and inspect for drafts at floor level. It may be necessary to readjust the brooder rings, moving them closer or further away, depending on whether the birds are too cold or hot. Pay careful attention to nightly temperatures.

Space

Follow the general brooding, feeder and waterer management to minimize early mortality. Having the proper temperature, water and feed available are very critical the first seven to 10 days. Chicks sometimes have trouble finding feed and water and “starve-outs” can be high if birds are stressed at this early age.

As birds get older, equipment and space requirements increase. The following are recommendations: See table below.

Recommended Equipment and Space Requirements

	1-6 Weeks	6-12 Weeks	12-30 Weeks
Floor Space (Sq. ft. per bird)	1.0	2.0	2.5-3.5
Water Space (per 100 birds)			
Fountains, gallons	8	15	20
Trough - Automatic, inches	100	100	100
Bell Type - Automatic	1	2	2
Nipples - Automatic	10	12	14
Feeder Space (per 100 birds)			
Trough, inches	200	300	300
Tube type 15 inches diameter	3	4	6

NOTE: A four-foot trough open on both sides provides 96 linear inches or 244 centimeters.
For reference, 1 sq. foot = 0.09 sq. meters

Chickens can be allowed outside or placed in range pens after four weeks of age, depending on the weather, bird development and feathering. Range pens should provide 30 square feet (2.8 sq. meters) per bird and be well drained. Use a four-to-five foot (1.2 – 1.5 meter) fence to confine birds and keep out predators. Grass grazing with movable pens is a nice method to provide maximum amount of xanthophylls and so produce darker meat or egg yolks.

Ventilation

Ventilation is required to remove moisture, ammonia, dust and fumes. It also decreases airborne disease organisms and provides oxygen. There needs to be a constant exchange of air without over-ventilating and causing drafts. Inside fans can improve air circulation and save heat. Insufficient ventilation results in wet litter, and excessive ventilation results in dusty litter. Ammonia can increase the susceptibility of birds to respiratory diseases as well as retarded growth. If the ammonia present causes your eyes to burn, it is at a level that is detrimental to the chickens. Standard ventilation with air inlets on one side of the barn and exhaust vents on the other is correct for starting birds. But with high temperatures (as in summer), tunnel ventilation is more efficient in creating a high airflow. High or low-pressure water mists are also available for the more cautious producers. The temperature is lowered by the evaporative cooling effect of water. The investment cost versus the possible improvement in viability during hot weather will drive the decision to utilize equipment like this.

Lighting

During the first day provide bright light for 24 hours. Have a line of 100-watt bulbs, which will attract chicks to the water and feed. After a few days, a second line with 15 or 25-watt bulbs can be used. Light intensity should be 0.5-1.0 foot candles. Provide 18 hours or more of light per day. At night, a dim light will prevent chicks from piling. For the commercial grower with solid sidewall barns, an example of a lighting program with light intensity is provided in the following table. This should be taken as a basic program and adapted for particular situations including zero to 10 days mortality, bird average daily gain and historical performance in the barn. Days in the table below are given as indicators; body weight should drive the light changes.

Lighting Recommendations ^{a,c}

Age (Days)	BW (g)	Light (Hour)	Darkness (Hour) ^b	Light Intensity (Lux)
0	40	24	0	20
1 to 3	48 – 75	23	1 ^b	20
4 to 7	95 – 160	18	6	10
8 up to ...	195 - ...	14	10	5
Days prior to slaughter ^c				
17		16	8	5
14		18	6	5
11		21	3	5
8		23	1 ^d	5
Until slaughter		23	1	5-10 ^f

a For Cobb genetic birds, follow the program as shown. For Ross birds, decrease light following the program to 18 hours of light – six hours of darkness and come back on the program 11 days prior to slaughter.

b Once the shut-off time of the lights is established this time must remain the same for the entire grow out, and only the time of opening will modify length of light and darkness.

c If birds are below the provided weight charts at 21 days of age, you can increase light more rapidly. If birds are heavier than the chart at 21 days of age, wait to increase the light. Consult with a specialist/technical representative before modifying programs.

d It is important to keep a darkness period in the day until slaughter for bird health.

e For a first partial removal of birds, follow this program until the first removal, then come back with 18 hours of light – 6 hours of darkness until 11 days prior to slaughter to follow program again until final slaughter removal.

f Raise the light intensity to 10 lux 24 hours before removal of the birds.

Management Nutritional Interactions

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Preventive Medicine

Preventive medications, as well as competitive exclusion products, can control salmonella, necrotic enteritis and other enteric pathogens. Coccidial infections need to be controlled. The main control is a coccidiostat in the feed, however vaccination programs have been developed and are being used as an alternative to coccidiostats. Metabolic diseases generally have genetic, nutrition, management and disease influences. Management, low temperatures, high energy diets and excessive salt may increase the level of ascites. High growth rate also has been indicated as a factor with ascites and SDS (Sudden Death Syndrome). The use of mash diets and alternative lighting programs has been shown to be beneficial.

Vaccination Programs need to be designed on an area or operational basis. These programs need to be combined with good biosecurity. Know the immune status of parent flocks to determine the programs of the broiler progeny. Vaccinations in the hatchery are effective. Some antibiotics provide production advantages by helping to control enteritis and other conditions. Again biosecurity and good management practices are very important.

Diseases

Disease conditions result in a variety of problems, which can lead to nutritional deficiencies. Nutritional deficiencies which can lower resistance to disease include: vitamins A, E, riboflavin, and pantothenic acid, in addition to amino acids and metabolizable energy intake.

Stress

Stress is a relatively new aspect to running an efficient broiler operation. A primary goal of management and husbandry practices is to eliminate or reduce stress factors. The supplementation of vitamins have been shown to be justified. There are also some non-nutritive feed additives, which can exert positive nutritional results. Antioxidants provide protection against nutrient loss in feeds. Mold inhibitors can reduce fungi growth and the production of mycotoxins. Pelleting agents may improve pellet durability and efficiency of feed utilization.

Causes/Solutions of Typical Problems

The table located to the right is included as a guideline for locating causes of problems.

Problem Solving

Problem	Possible Cause	Solution
Early Mortality	Poor chick quality	Check hatchery and eggs Check chick transport
	Brooding	Adjust brooders
High Mortality	Disease	Consult veterinarian
	Metabolic Disease	Check ventilation Check lighting program Check feed formulation Avoid excess early growth rate Check hatchery ventilation Ascites
	Infectious diseases	Establish cause Consult veterinarian
	Leg problems	Check Calcium, Phosphorus, Vitamin D, Riboflavin Adjust lighting programs
Poor Early Growth	Nutrition	Check starter availability and quality Check water supply Check crumble size and quality
	Chick quality	Check hatchery
	Environment	Check temperature, humidity Check lighting and air quality
	Appetite	Check for indications
Poor Late Growth	Low nutrient intake	Feed quality, formulation Feed intake, accessibility Lighting program too restrictive Check water access
	Infectious disease	See high mortality
	Environmental conditions	Check ventilation, density, temperatures and litter conditions
Poor Litter Quality	Nutrition	Poor-quality fat, excess salt or protein
	Environment	Insufficient or inappropriate litter Drinker design/ adjustment, high humidity Stocking density, insufficient ventilation
	Infectious disease	Enteritis conditions
Poor Feed Conversion	Poor growth	See growth above
	High mortality	See high mortality above
	Feed wastage	Check settings, feeder adjustments Allow birds to clean feeders twice daily
	Environment	Check house temperatures
	Infectious disease	See high mortality above
Poor Feather Cover	Environment	House temperatures too high
	Nutrition	Check diets for sulfur, amino acids Check dietary sodium level
	Genetics	Check with genetic source
Processing Plant	Ascites	See high mortality
	Blisters and burns	Check stocking density and litter quality Increase bird activity with feed or light
	Bruises and breaks	Check handling and catching
	Scratches	Excess light and stocking density Handling procedures at weigh and catch Check access to feed and water

Sources and Tables

The Care and Feeding of a Successful Broiler Operation

Table 1: Added Vitamin and Trace Mineral Recommendations as Percentage or Units per Kilogram of Diet (90% Dry Matter)

Nutrient	Unit	0 – 3 Weeks ^a	3 – 6 Weeks ^a	6 – 8 Weeks ^a
Macrominerals				
Calcium ^b	%	1.00	0.90	0.80
Chlorine	%	0.20	0.15	0.12
Magnesium	%	0.06	0.06	0.06
Nonphytate				
Phosphorus	%	0.45	0.35	0.30
Potassium	%	0.30	0.30	0.30
Sodium	%	0.20	0.15	0.12
Trace Minerals				
Copper	mg	8	8	8
Iodine	mg	0.35	0.35	0.35
Iron	mg	80	80	80
Manganese	mg	60	60	60
Selenium	mg	0.15	0.15	0.15
Zinc	mg	40	40	40
Fat Soluble Vitamins				
A	IU	1,500	1,500	1,500
D ₃	ICU	200	200	200
E	IU	10	10	10
K	mg	0.50	0.50	0.50
Water Soluble Vitamins				
B ₁₂	mg	0.01	0.01	0.007
Biotin	mg	0.15	0.15	0.12
Choline	mg	1,300	1,000	750
Folacin	mg	0.55	0.55	0.50
Niacin	mg	35	30	25
Pantothenic acid	mg	10	10	10
Pyridoxine	mg	3.5	3.5	3.0
Riboflavin	mg	3.6	3.6	3
Thiamin	mg	1.80	1.80	1.80

NOTE: Where experimental data are lacking, values typeset in bold italics represent an estimate based on values obtained for other ages or related species.

a The 0-3-, 3-6- and 6-8-week intervals for nutrient requirements are based on chronology for which research data were available; however, these nutrient requirements are often implemented at younger age intervals or on a weight-of-feed consumed basis.

b The calcium requirement may be increased when diets contain high levels of phytate phosphorus (Nelson, 1984).

Table 2. Example Nutrient Recommendations for Broilers (90% Dry Matter).

Nutrients	Unit	Starter	Grower	Developer	Withdrawal
ME*	kcal/kg	3030	3120	3200	3220
Crude Protein	%	22.0	20.0	18.0	17.0
Calcium	%	0.90	0.85	0.80	0.75
Phosphorus	%	0.70	0.65	0.60	0.55
Available					
Phosphorus	%	0.44	0.39	0.34	0.30
Sodium	%	0.18	0.18	0.18	0.16
Chloride	%	0.16	0.16	0.16	0.16
Potassium	%	0.60	0.50	0.45	0.45
Lysine	%	1.30	1.12	1.00	0.95
Methionine	%	0.50	0.43	0.38	0.35
TSAA**	%	0.92	0.84	0.79	0.75
Tryptophan	%	0.22	0.19	0.17	0.16
Arginine	%	1.40	1.20	1.10	1.00
Threonine	%	0.88	0.78	0.70	0.65
Choline	mg/kg	1600	1350	1150	1000

* Metabolizable Energy (ME) levels may vary depending upon available grains and ingredients.

** Total Sulfur Amino Acids

Typical feed consumption levels:

- Starter 0.7-0.9 Kg/bird

- Grower-Developer 1.0-2.3 Kg/bird

- Withdrawal 1.0-1.5 Kg/bird depending on age at market

Data Sources and Information

Breeder Guidelines for Specific Breeds

Aviagen – www.aviagen.com

Cobb-Vantress – www.cobb-vantress.com

Hubbard – www.hubbardbreeders.com

Hybro – www.hybrobreeders.com

CRF Poultry Research Trials

Key References

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G. Diaz and J.D. Summers. <http://posc.tamu.edu/library/dother.html>

Table 3: Body Weights and Average Daily Gains*

Days of age	BW ¹ (g)	Daily Gain (g)	Daily Intake ² (g)	Cum. Intake (g)
0	42			
1	51	9		
2	63	11		
3	76	13		
4	91	15		
5	109	18		
6	129	20		
7	152	23		147
8	177	25	29	176
9	206	28	34	210
10	237	31	38	248
11	271	34	43	290
12	309	37	48	338
13	349	41	53	391
14	393	44	58	449
15	440	47	64	513
16	490	50	69	582
17	543	53	75	658
18	599	56	81	739
19	658	59	87	826
20	720	62	93	919
21	785	64	100	1019
22	852	67	105	1124
23	921	69	111	1235
24	992	71	117	1352
25	1066	73	123	1475
26	1141	75	127	1602
27	1217	77	133	1736
28	1295	78	138	1873
29	1374	79	144	2018
30	1454	80	148	2166
31	1535	81	152	2318
32	1616	81	156	2474
33	1698	82	159	2633
34	1780	82	163	2796
35	1861	82	166	2962
36	1943	82	168	3129
37	2024	81	170	3300
38	2105	81	173	3472
39	2185	80	174	3646
40	2264	79	174	3820
41	2343	78	177	3997
42	2420	77	179	4176
43	2496	76	178	4354
44	2571	75	177	4531
45	2645	74	179	4710
46	2717	72	178	4888
47	2788	71	179	5067
48	2858	69	179	5247
49	2926	68	176	5423
50	2992	66	177	5600
51	3057	65	178	5777
52	3120	63	174	5951
53	3181	61	175	6126
54	3241	60	172	6298
55	3299	58	173	6471
56	3356	57	170	6640
57	3411	55	169	6809
58	3464	53	167	6976
59	3516	52	164	7139
60	3566	50	164	7303
61	3614	48	162	7465
62	3661	47	161	7626
63	3706	45	157	7783
64	3750	44	159	7943
65	3792	42	154	8097
66	3833	41	152	8249
67	3872	39	151	8400
68	3910	38	147	8547
69	3946	37	147	8694
70	3982	35	145	8839

Table 4: Nutrient Requirements of Meat-Type Hens for Breeding Purposes as Units per Hen per Day (90% Dry Matter)

Nutrient	Unit	Requirements
Protein and Amino Acids		
Protein ^a	g	19.5
Arginine	mg	1,110
Histidine	mg	205
Isoleucine	mg	850
Leucine	mg	1,250
Lysine	mg	765
Methionine	mg	450
Methionine + Cystine	mg	700
Phenylalanine	mg	610
Phenylalanine + Tyrosine	mg	1,112
Threonine	mg	720
Tryptophan	mg	190
Valine	mg	750
Minerals		
Calcium	g	4.0
Chloride	mg	185
Nonphytate Phosphorus	mg	350
Sodium	mg	150
Vitamin		
Biotin	µg	16

NOTE: These are requirements for hens at peak production. Broiler breeder hens are usually fed on a controlled basis to maintain body weight within breeder guidelines. Daily energy consumption varies with age, stage of production and environmental temperature, but usually ranges between 400 and 450 ME kcal per hen at peak production. Where experimental data are lacking, values typeset in bold italics represent an estimate based on values obtained for other ages or related species.

a Broilers do not have a requirement for crude protein per se. However, there should be sufficient crude protein to ensure an adequate nitrogen supply for synthesis of nonessential amino acids. Suggested requirements for crude protein are typical of those derived with corn-soybean meal diets, and levels can be reduced somewhat when synthetic amino acids are used.

Table 5: Nutrient Requirements of Meat-Type Males for Breeding Purposes as Percentages or Units per Rooster per Day (90% Dry Matter)

Nutrient	Unit	Age (in weeks)		
		0 - 4	4 - 20	20 - 60
Metabolizable Energy ^a	kcal	--	---	350 - 400
Protein and Amino Acids				
Protein ^b	%	15.00	12.00	---
Lysine ^c	%	0.79	0.64	---
Methionine ^c	%	0.36	0.31	---
Methionine + Cystine ^c	%	0.61	0.49	---
Minerals				
Calcium	%	0.90	0.90	---
Nonphytate Phosphorus	%	0.45	0.45	---
Protein and Amino Acids				
Protein ^b	g	---	---	12
Arginine ^c	mg	---	---	680
Lysine ^c	mg	---	---	475
Methionine ^c	mg	---	---	340
Methionine + Cystine ^c	mg	---	---	490
Minerals				
Calcium	mg	---	---	200
Nonphytate Phosphorus	mg	---	---	110

NOTE: Where experimental data are lacking, values typeset in bold italics represent an estimate based on values obtained for other ages or related species.

a Energy needs are influenced by the environment and the housing system. These factors must be adjusted as required to maintain the body weight recommended by the breeder.

b Broilers do not have a requirement for crude protein per se. However, there should be sufficient crude protein to ensure an adequate nitrogen supply for synthesis of nonessential amino acids. Suggested requirements for crude protein are typical of those derived with corn-soybean meal diets, and levels can be reduced somewhat when synthetic amino acids are used.

c Amino acid requirements estimated using the model of Smith (1978).

* - Page 4 - Ross x Ross 308 North American Broiler Performance Objectives

1 - On-farm body weight (i.e., feed present in intestinal tract)

2 - Feed consumption per living bird

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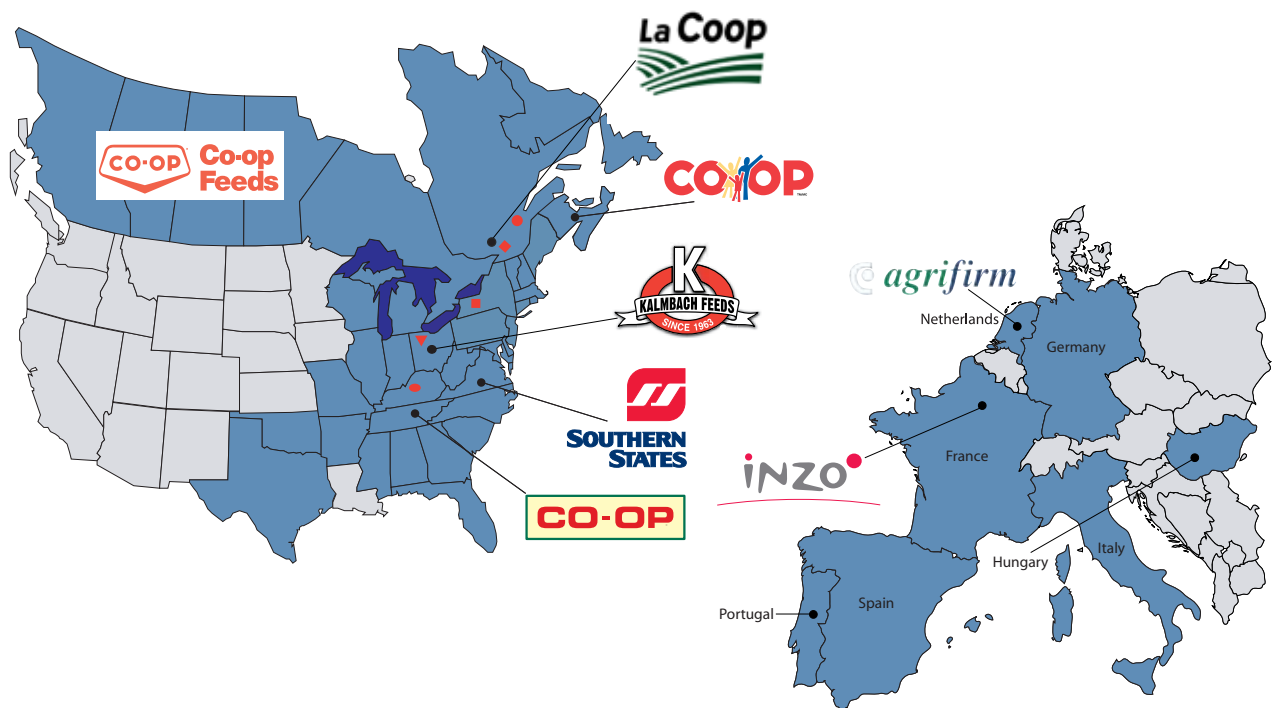
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