Poultry Nutrition and Production in Andean Countries

Hugo Romero-Sanchez, PhD
Technical Manager Trouw Nutrition Hifeed B.V
Grupo Grica University of Antioquia, Medellín, Colombia

ABSTRACT

Poultry production has consistently increased in the Andean countries during the last decade. Poultry meat is the most important source of animal protein and the average broiler production has increased to a rate of 5% per year. Egg industry grows to lower extend while the turkey production is very low. Although local raw material is protected by governments, the region imports high percentage of corn and soy beans for poultry diets. Non traditional raw materials such as rice bran, tapioca, palm kernel, fish meal, etc are seasonal used.

Close to the Equator line (Venezuela, Colombia, Ecuador) the day length does not considerable change during the year and the temperature changes with the altitude above sea level. On the other hand, in regions far from the Equator line, like south of Peru and Chile, the day length and temperature varies according with the year's season. During the last 25 years, most of the poultry production has been relocated in low altitude regions. However, there is still an important percentage located in high altitude, mainly in Colombia and Ecuador, demanding different production and nutrition systems.

Economy Overview

The South America Andean region includes countries such as Chile, Peru, Bolivia, Ecuador, Colombian and Venezuela, having a total human population of 141 million. These countries have been known for political and economy instability. However, in the last decades democratic governments have been elected, and inflation rates have been controlled. Table 1, depicts main economic characteristic of Andean region countries. Chile is the most developed country in the region with the highest gross national income (GNI), one of the lowest inflation rates and the best position in the corruption perception index (23). Venezuela, on the other hand, is the country with highest inflation and corruption index (www.transparency.org).

Table 1. Population and Economic indicators in Andean Region Countries (2007-2008)

Variable	Chile	Colombia	Ecuador	Perú	Venezuela
Population (Mio)	16,5	46	13,3	28	35
GNI (USD)[§]	9810	3300	3080	3450	7320
Inflation (%)[§]	3,2	5,4	2,9	1	28
Corruption Index*	23	70	151	72	158

* Worldwide position in corruption between 180 countries.
[§]*Source: World bank 2007.*

Poultry and Feed Industry

As the GNI has increased during the last years, the average broiler production has increased to a rate of 5% per year. Egg industry grows to lower extend while the turkey production is very low, and Chile and Peru are the only countries with turkey breeders.

Bolivia is the only country which does not import considerable amount of raw materials, especially soybeans and sunflower. All the other countries depend upon on importation of cereals and oil seeds. The main suppliers of raw materials are Argentina, Paraguay, Bolivia and USA. From these raw materials, 95% of soybean and 55% of corn is imported. Soybean is imported from Argentina (75%), USA (20%) and Bolivia (5%); while corn is mainly imported from the USA (70%), and Argentina (25%).

Local raw materials need to be consumed by the feed industry before imported products are authorized by local governments. On the other hand, there is a seasonal and regional provision of non traditional by-products, like rice by-products, cassava. Corn production is focused on white corn for human consumption. Little yellow corn is produced domestically. There are intentions to increase white and yellow corn production via government financing programs, however the plan has not been successful and production figures have not shown significant changes.

Local associations and government institutions periodically publish data about poultry consumption (Table 2). In the Andean region countries, poultry meat is the most consumed meat, while pig meat shows the lowest consumption. Turkey meat consumption is lower than 0.5 kg per capita, except in Chile where it accounts for 10% of total poultry meat. In most countries consumption of laying hen meat is important, and basically all laying hens are process for human consumption. Most of the statistic data does not include this consumption.

Table 2. Meat consumption and feed production in the Andean Region.

Variable	Chile	Colombia	Ecuador	Peru	Venezuela
Poultry meat (kg)	32	20	25	29	27
Eggs (units)	180	180	105	144	114
Beef meat (kg)	13	31	11	6	13
Pork meat (kg)	13	3,4	2,6	4	5
Feed (Mio Tm)	3,9	4,9	2	2,9	4,4
Poultry feed (MioTm)	1,5	3,9	1,45	2,7	3,1

In Chile the poultry production is concentrated in the central valley where mild weather conditions and a healthy environment are ideal for poultry breeding. Likewise, it is concentrated at the industrial level, with only 8 companies operating across the country. Each one of these companies is present at every stage of the production chain, including hatching, breeding, processing and distribution, whereby a high level of product traceability is ensured. In 2006, Chile produced 613,757 tons of poultry meat, of which 84% accounted for broiler chicken, 15% for turkey and 1% for other birds. During the last decade, production has undergone extraordinary growth, with increases of

6.3% annually. Of the total meat consumed on a national level, 45% corresponds to chicken and turkey meat. Chicken meat constitutes the highest consumption per capita, with almost 30 kilos annually per capita while turkey products reach near to 3.9 kilos. Turkey consumption has experienced an increase of 88.5% over the last 10 years. The sector's improvement in production efficiency has resulted in process and product quality, allowing the Chile poultry industry to reach highly demanding markets such as Mexico, the European Union, China and Japan, among others. Currently, 83% of poultry production is destined for national consumption; however, the industry aims to increase its participation in exports in the short term. The industry aims to reach US$308 million in exports by 2010. Two major companies, Agrosuper and Ariztia accounts for 80% of poultry production, and they produce their own feed. Agrosuper produces around 1,7 million tonnes of compound feed, and almost half is broiler feed Therefore, the independent feed industry in Chile is small in poultry (Champion SCA, (app. 5000 tons per year for free market), Alimentos Cisternas and Lansa the 3 bigger ones).

Peru produces 800.000 Tonnes of chicken meat per year, with around 390 Million of chickens. Around 60% of the production is concentrated in 10 companies. Per capita consumption has reached 28 kg. San Fernando is the biggest integration with 108 Million of day-old-chicks (doc) per year of which 82% is growth out by them. Total feed production is 2.9 and more than 90% is for poultry industry. Main percentage of broiler production is sold alive, and pigmentation is important. Most of the poultry industry in Peru is located along the dry cost, where the low humidity and low precipitation is very suitable for production.

In Colombia the total yearly feed production is 4.9 Mio tonne of which 3.39 Mio tonne concerns to poultry sector. Broiler accounts for 59% of poultry feed, laying hens 35.4% and breeders 5.6%. Broiler integrators buy from feed mills. Also some feed mills own broiler companies or have strategic agreements with them. In Colombia, the broiler sector has a total feed demand of 1.8 Mio Tonne and consists of +/- 20 companies of which the top-10 accounts for 80%. Although some of the biggest companies own their own feed mill facilities, they buy the raw material, premix and nutritional consultancy with specialized feed mill companies. Further consolidation in the sector is expected in the middle term. Companies selling branded products do better as distribution channels and consumers have developed a stronger focus on food safety. In 2006, chicken meat production was 849.830 Tm and in 2007 grew 8% (924.896 Tm); this was produced with a total housing of 507.8 Million doc in 2006 and 560.2 Million doc in 2007. Future growth of 5% per year is expected based on the growing demand for poultry meat. The layer sector has a total feed demand of 1.18 Mio Ton. Composition of laying population is 73% in production, 23 in rearing and 4% in moulting. Around 80% of production is brown eggs. Rearing flocks are placed on floor, while production phase is mainly in cages. Forty percent (40%) of the population is in the Central region, while 30% is equally divided between Valle and Santander regions. Total egg production in 2006 was 8.757 Million eggs (525433 Tm) and diminished 5.3% in 2007 to 8.293 Million eggs (497,632 Ton).

Venezuela's poultry industry continues to develop productivity and output in spite of a price control policy, which does not allow producers to raise prices along their costs of production, and increased government imports of Brazilian poultry products. Poultry production in 2007 is estimated in 820,000 metric tons, and forecast production for 2008 is 860,000 metric tonnes, an increase of 5 percent as compared with the previous year. In Venezuela, about 80 percent of the animal feed goes to poultry, 12 percent to pork, and the rest to bovine. About 30 percent of the sorghum goes to poultry rations, where it is not a preferred ingredient, and a slightly higher concentration is used for swine. Demand for poultry products is expected to increase due to higher prices of beef, and a diminished cattle herd which has led to significant shortages of beef. Venezuela produces and consumes only small amounts of duck and turkey. Production and consumption was expected to grow throughout 2007 and 2008 because of improved disposable incomes and the relative cheap price of poultry as compared to other sources of animal protein (beef and pork.). About 80 to 90 percent of the poultry produced in Venezuela is purchased fresh by households. The rest goes to the processing sector (hams, sausages, frozen nuggets, etc.) Venezuela's annual per capita consumption of poultry is estimated at 35 kilograms.

In Ecuador, the total yearly feed production in 2006 was 1.8 Mio tonne of which 1,332 Mio tonne is poultry feed. Estimated total production for 2008 is 2.1 Mio Tonne. In 2007, Ecuador imported 17,000 Tm of feed, mainly from Peru (95%). Imported feed appears to be extruded feed for shrimp and fish. Broiler integrators produce their own feed. The compound feed sector has grown at a rate of 10% per year in the last 5 years. For 2008 Ecuador used 519.180 Tm of soy bean and 1.2 Mio Tonne of corn. From this raw material, 95% of soybean and 55% of corn was imported. Currently, soybean is imported from Argentina (75%), USA (20%) and Bolivia (5%); while corn is mainly imported from the USA (99%). Large egg producers produce their own feed as home-mixers in own feed mills. Few feed mills produce small portion of the layer feed to fill in production capacity.

Nutrition Practice

Local companies (integrations and feed mill) are major players and predominate in all these countries. Multinational companies have presence only in the trading of raw material and in the premix sector. For nutrient requirements, most nutritionists follow genetic companies' recommendations, with some adjustments from researches conducted in the USA and Brazil. Cobb and Ross share the genetic market with few Hybro (~350.000 Parent stock) and Hubbard (~50.000 Parent stock) flocks. For ingredient composition local companies conduct proximal analyses and adjust energy values with tables from Brazil, Spain and USA. Several local feed mills and few poultry integrations have acquired NIR equipments in the last 5 years.

Broiler diets

It is difficult to generalize about broiler diets since nutritionists follow genetic companies' requirements adjusting to local conditions according with empirical experience (table 3). In table 3, commercial diets from a feed mill in Colombia and broiler integration in Peru, are used as an example to illustrate the main nutrient levels. A feed mill, which is competing in the market with other local producers, tends to use high nutrient composition, while the broiler integration can set up lower nutrient requirements. Most integration companies use 4 diets, but some use a fifth diet, which basically retire antibiotics and reduce vitamins and minerals. On the other hand, the feed mills produce two or three diets for small farmers. To fulfil the average nutrient requirements of table 3, several raw materials are used at different inclusion rate (table 4).

Table 3. Example of nutrient levels for broilers in a feed mill in Colombia and a broiler integration in Peru.

	Colombia (days)				Peru (days)			
Nutrient	0-10	10-21	21-35	>35	0-10	10-21	21-35	>35
ME (kcal/kg)	3000	3100	3200	3300	2950	3000	3050	3100
CP (%)	23	22	21	19	22	20	19	17,5
Lys d (%)	1,35	1,25	1,15	1	1,3	1,2	1,05	0,9
Av.P (%)	0,5	0,46	0,44	0,4	0,5	0,47	O,40	0,36
Na (%)	0,23	0,18	0,18	0,18	0,26	0,18	0,16	0,16

As described in table 4, most corn and soy beans are from Argentina or USA. Some companies import full fat soy bean and process it locally. Bolivia is also an important producer of oil seeds such as soy beans and sunflower (SF) (Table 4), while Paraguay is a good supplier of soybeans (Table 5). Fish meal is produced along the Pacific Coast, mainly in Chile, Peru and Ecuador. However, prime fish meal price make it more suitable for fish and pet feed, while lower fish meal quality is delivered for poultry feed.

Table 4. Commercial broiler diets examples in Andean Countries.

Raw Material	Origin	Pre-starter	Starter	Grower	Finisher
Corn	Argentina/USA	38,4	59	44	63
SBM	Argentina/USA	18	23	15	8
Corn	Local	10			
Rice	Local	10		15	
Full fat SB	Arg/Brazil/Paraguay	8,7	12	10	22
SFM	Bolivia	3			1
Fish meal	Local	3	2,5	1	
Haemoglobin	Argentina/Local	1	2,0		2
Palm oil / Tallow	Local		0,5	3,7	1,38

Only main raw material is shown as an example of different origin and inclusion level

Broiler Breeder Diets

In broiler breeder diets it is possible to see higher variety of raw materials, especially during the rearing period. Although low density diets are preferred during the rearing period it is also common to see diets with higher energy values (Table 5). Most companies use pre-breeder diets where calcium increases to 2.2%. In rearing diets it is common to include local raw materials, such as rice bran (10 to 15 %), cotton meal (3 to 5%), palm kernel meal (2 to 3%), bakery by-products (5%) and molasses (2 %). Also in the male low density diets, several fibrous raw materials are used.

Males are grown separate from females and special grills are used to maintain separate feeding during the production period. Because low labour cost, most breeder companies are not fully mechanized. This allows the advantage to create several groups during the rearing period (grading), reaching high uniformity flocks. Grading is a common practice during the rearing and many companies start grading birds even at first week. Few breeders companies still use open houses without lighting programs, and most companies have implemented lighting programs. During the rearing period most companies use brown-out houses to control light intensity and during the production period 16 h of light are used. In farms located in south of Peru and Chile, there is an important effect of the season on day length, and therefore differences between in-season and out-season flocks are bigger.

Table 5. Nutrient levels for broiler breeder in Andean countries

Nutrient	Starter	Grower	Breeder I	Breeder II	Male Diet
ME, min	2860	2775	2860	2820	2700
ME, max	2900	2900	2870	2870	2750
Protein (%)	19.5	15.5	16.0	15.5	12
Lys (%)	1.00	0.70	0.78	0.76	0.6
TSAA (%)	0.82	0.58	0.64	0.54	0.48
Sodium (%)	0.20	0.20	0.16	0.18	0.2
Calcium (%)	0.97	0.95	2.90	3.20	1
Av. P (%)	0.45	0.43	0.45	0.40	0.4

Although most nutritionists are using digestible amino acids, for broiler breeders diets several companies use total amino acids (Table 5).

Local Raw Material

Although most raw materials are imported there is considerable and seasonal production of local raw material such as corn, rice, tapioca, etc. Corn and rice have high demand for the human food chain. Big poultry companies are getting involved in corn production projects. Rice is for human consumption and high rice by-products, the result of de-hulling and cleaning of brown rice, is used by the feed mill industry.

Rice

In Colombia rice is grown on 320.000 ha. The crop is normally grown twice a year and mono cropping is a normal practice. Use of uncertified rice seeds of low quality is common in areas of poor farmers. In Venezuela the rice area is approximately 140.000 ha, predominantly in the states of Portuguesa, Guárico, Cojedes and Barinas. Ecuador is the biggest rice producer in the region with 400000 ha, producing 1,6 Mio Tonne per year. Around 20% of Ecuadorian production is traditionally exported to Colombia.

The by-product of preparing white rice yields around 30% of rice polishing and 70% of rice bran (Leeson and Summers, 2005). However, most local mills produce a mixed of these two fractions that is generally called rice bran. Rice bran contains a small number of anti nutritional factors that are concentrated in the bran fraction. These anti nutrients include: phytic acid, trypsin inhibitor, and lectins. Although trypsin inhibitors and lectins can be inactivated by heating process, the local feed industry does not treat these rice byproducts. Most companies are using phytase and therefore phytic acid is not an issue. However, several field problems are associated with trypsin inhibitor and lectins. Lectins is a class of plant defense proteins with specific binding affinities for particular carbohydrate moieties present on glycoproteins present in cell walls and cell plasma membranes, and have been associated with a range of anti nutritive effects and some disease pathologies (Peumans and Van Damme, 1995).

The nutritional content of rice bran varies widely because of differences in hull content, degree of polishing during milling, and variety differences. Although the oil can be extracted during the milling process, most rice bran in Andean region contain its oil, which contributes significantly to the energy content but also leaves the bran susceptible to potential development of rancidity. Besides the rancidity problem, rice bran contains anti-trypsin factors (Benedito and Sarber, 1978) and high levels of phytate (Tangendjaja, et al. 2002). Even although rice bran should be stabilized with an antioxidant when storage at the mill for several weeks, most local rice bran does not contain any type of treatment. Therefore local feed mills must decide between rapid turnover rates or include antioxidant protection. Broken rice is another rice by-product, produced in low quantity, with nutrient content similar to white rice.

In spite of these problems rice bran is widely use after the harvesting season. The inclusion rate depends on age and corn prices, however can vary between 5 to 15 % for broiler starter and finisher, respectively (Table 6). Use of rice bran reduced feed cost per kilogram weight gain (Khalil et al., 1997), but raw rice bran was observed to induce pancreatic hypertrophy and reduce intestinal amylase activity (Martin 1998). Kratzer and Earl (1980) reported that some factor in untreated rice bran causes reduction of growth in chickens. Feed intake decreased with 80 and 100% substitution of maize with rice bran (Carrion and Lopez, 1989). Broken rice has also seasonal use, and it can be included from 10 to 40% for broiler pre-starter to finisher, respectively.

Table 6. Non-traditional broiler diets in Peru with high inclusion of rice and rice-byproducts.

	Pre-starter	Starter	Grower	Finisher
Local Corn	35,7	29	28	26,4
Broken rice	25	30	35	40
Full fat (Paraguay)	27	11		
SBM	6,1	16	18	15
Fish Meal	2	4		
Rice bran		5	10	15
Vegetal oil			1	1

With these ingredients cost of diet is considerable reduced, although variability of performance results is very high due to high variability of rice by-products. Follow up of suppliers is very important to improve variability and consistency of results; however such strategy has pitfalls in the implementation.

Cassava

To fulfil the low cereal productions some Latin America governments have tried to encourage the poultry companies to use cassava (Tapioca) crops as the new energy source for animal and poultry feeds. Many regional studies have been conducted to evaluate replacement of cereals with cassava meal in poultry feeds. The results of these studies have yielded wide variation in feeding value, nutritional problems, and productive performance. Although several researches were conducted in Asian countries the regional trials support the Asian data. The maximum level of cassava root meal in broiler diets has ranged from 10% (Armas and Chicco, 1973) to 30% (Gomez et al, 1987), and as high as 40 to 60% (De Brum et al, 1990). A similar range in level of incorporation is found in the diets of laying hens, with the cassava inclusion level ranging from 15% in starter diets (Thirumalai, et al., 1990) to 30 % in layer diets (Romero, et al, 2003). This variation has been due to differences in many factors that will affect its inclusion in poultry diets, such as anti-nutritional factors, cassava root processing methods, and nutritional and physical factors.

Cassava root meal is a source of energy, with high starch content (about *60*-70%). Cassava can replace cereals when supplemented with higher levels of protein, amino acids, fat, minerals, and vitamins. Cassava root products are deficient in carotene and other colouring carotenoids (García and Dale, 1999). Consequently these elements must be added to cassava based diets if the market requires a high degree of pigmentation of egg yolk or broiler skin. Unfortunately in countries like Ecuador and Peru pigmentation is very important, and cassava is less used. On the other hand, cassava pellets are high in potassium and the inclusion rate is limited to reduce the moisture content of excreta.

Cassava is processed by various methods to reduce toxicity and improve palatability and storage characteristics. Processing practices vary considerably from region to region, but all seek to reduce the toxic cyanoglucosides to a safe level. The processing techniques for *cas*sava tubers include peeling, boiling, steaming, roasting, fermenting, and drying (García and Dale, 1999; Romero et al., 2003). Drying is the most popular practice to reduce cyanide in many tropical countries. Several attempts to produce low cyanide varieties have been done for local research centres. In spite of these efforts cassava is only included at low rates.

Ascites

Although most of the broiler industry has moved towards the low altitude region, there still considerable number of broiler farms located in high altitude. In Colombia and Ecuador there are many farms located close to big cities above 4950 feet above the sea level, and several local studies have described the physiology of this syndrome (Hernandez, 1987) and how to control it (Betancourt et al., 2003). Fewer broilers are located in high altitude in Peru, and Chile. To control ascites, broiler companies apply feed restriction programs and nutrient modifications. Feed restriction is quantitative and qualitative, trough mash feeding and reduction of energy content. In Ecuador, where small and medium companies do not have pelleting process, mash feeding is used during the whole period. On the other hand in Colombia, where most companies have pelleting process, the mash feed is only used during 3 or 4 weeks, depending upon the altitude of the farm, and the ascites incidence. Nutritional modifications include use of arginine (Wideman et al., 1995), and KCl (Betancourt et al., 2004). Besides mash feeding, low density diets are also used to restrict body weight gain (Leeson et al., 1995).

Ascites can also be related with incubation at high altitude. Although most hatcheries have been re-located under 1650 feet, there are still several hatcheries at 3300 feet. Because many of these are open hatcheries, the temperature control at night is very complex. In cold nights the temperatures can drop below 18 C, and as a matter of fact the dampers are fully close decreasing air flow into the machine, increasing embryo hypoxia (Brake and Romero-Sanchez, 2005).

On the other hand, different responses to high altitude and compensatory growth between strains have been observed, and therefore some strains are preferred above others to be growth out above 5940 feet. However, these differences can be related to management and nutrition, and it is difficult to discuss about genetic difference for ascites tolerance.

Heat Stress

In low regions close to the Equator line the temperature and humidity is high during the whole year. Several strategies are used to ameliorate effects of heat stress. Although most companies are changing to close houses with tunnel ventilation, still there is big percentage of open houses. The use of synthetic amino acids and low crude protein is common practice. Although diets are design to maintain adequate dietary electrolyte balance it is a common practice at farmer level the use of vitamin and electrolyte packages. These products include vitamin C, sodium bicarbonate, betaine, etc. Under commercial conditions, adding salt to the drinking water of heat-stressed broilers has been reported to alleviate bird distress and to stimulate growth (Lesson et al., 1995). However, most nutritionists are adding high sodium levels (0.25 – 0.3 %) in the pre-starter and starter diets according with several published data from Brazil (Vieira., et al. 2003; Maiorka et al., 2004).

Feed Additives.

Currently most of growth promoter antibiotics are permitted in these countries, although Peru y Chile have experience without growth promoters since some companies have exported to countries like European Union and Japan, where traceability and high standards are demanded. Around 70-80% of companies use phytase but still few use other type of enzymes. Many companies have tried different kind of yeast cell wall products but consistency of results has been an issue. Nowadays new products like essential oils and organic minerals are being tested by local companies. There are some experiences with selenium and omega-3 enrichment of eggs, for a small niche of the population. As the economy grows it is expected to have more people willing to pay for organic products.

Pigmentation
Colour is strongly associated with food choices, and, depending on regional preferences, skin colour plays a large role in consumer acceptance of broilers (Bunell and Bauernfeind, 1962). Carotenoids are compounds responsible for skin color in broiler carcasses, and a particular class of carotenoids, xanthophylls, are the most prominent source of pigmentation in poultry feeds (Goodwin, 1954). In Ecuador and Perú, for instance, broiler is commercialized alive and pigmentation is an important factor.

This brighter yellow-orange is more intense than currently found in US markets, and causes Ecuador and Peru producers to use higher levels and different pigment source blends in broiler diets to achieve it. The high cost of the dietary pigments makes achieving this bright colour an expensive part of production costs. Skin pigment value is not a good skin colour parameter when the birds are alive because redness from blood vessels interferes with the reading. When birds received feed with pigments, the yellow pigments might have masked redness from the blood vessels and muscle, an effect that is observed as yellowness intensifies in processing too. The post mortem decrease in redness is probably due to bleeding that eliminates blood and fat solidification, which decreases the visual impact of the musculature colour in live birds (Castañeda et al., 2005).

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