The future of poultry nutrition

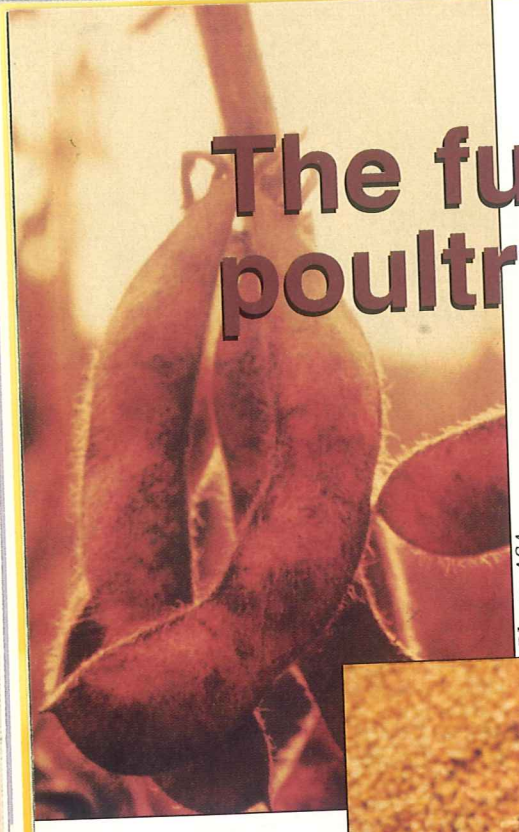
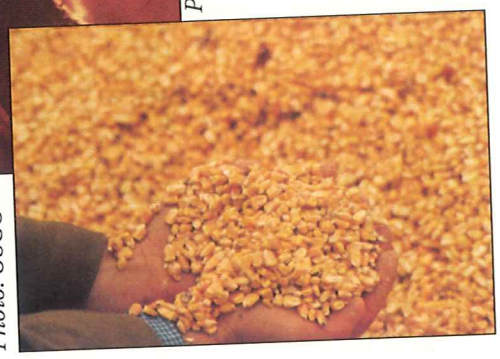


Photo: ASA



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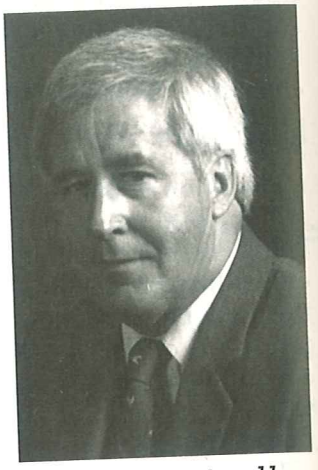
*Nutrition and feeding have taken almost inconceivable leaps forward during the four decades since POULTRY INTERNATIONAL was first published. Our guest author reminds us of just some of the major milestones and what we have to look forward to. What is the future for "ideal protein" formulations, low-pollution diets, antibiotic-free feeds and genetically engineered corn and soy?—**Dr Park Waldroup***



The many accomplishments that have taken place in the field of poultry nutrition over the last 50 years have been almost unbelievable. This period coincides with the development of the integrated system for poultry production, making this industry among the most efficient producers of high quality protein. I have been fortunate to watch this growth through my student days and as faculty researcher working in the area of poultry nutrition.

Much of the basic work on the known nutrients was fairly well accomplished by 1948 with the discovery of vitamin B12, the last known vitamin. Since then, much of the progress has been made in defining the requirements for the known nutrients, largely triggered by the application of the mathematical system, linear programming, and the development of computers. I recall as a college junior in 1958 when Prof. C. C. Chamberlain, under whom I had taken a number of nutrition classes, stopped me in the hall and showed me an article in 'Feedstuffs' magazine about the use of the computer in feed formulation. This further stimulated my interest in nutrition.

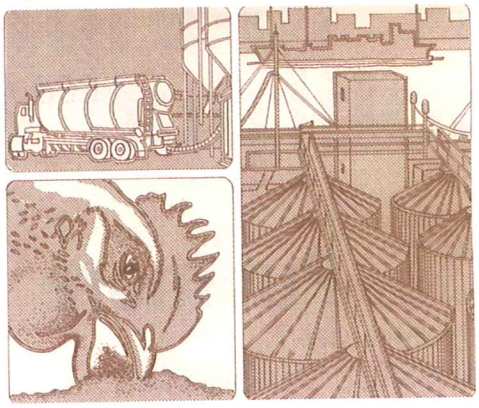
As the industry began to accept diets formulated by linear programming, it became apparent that more information was needed on nutrient composition, particularly energy and amino acids and much research work was directed towards the determination of metabolisable energy and amino acid values. These data allowed nutritionists to focus upon the requirements of the broiler for these nutrients, which comprise around 95% of the cost of broiler diets. Broilers became the best-fed animals in the world, including Man!

We have come to a new era in poultry nutrition – the global economy is growing, consumers are ever more concerned about health and food safety and the broiler industry has matured. Poultry nutritionists will be faced with different challenges in the next decade. I will attempt to predict some of the changes that will take place.

Emphasis on early nutrition

There will continue to be an emphasis on early nutrition, as this may influence the development of the intestinal tract and later utilisation of nutrients. Further reducing the time needed to grow a bird to market increases the percentage of the total feed consumed in the first week post-hatch. More importantly, several research groups have demonstrated that the type of diet fed shortly after hatch, or even injected into the egg or embryo before hatch, can impact upon the development and

maturation of the intestinal villi and possibly improve the overall performance of the bird. This may have more impact in turkeys than in broilers but I believe we will see the development of feeding systems designed to improve overall nutrient usage and intestinal development during the first week post hatch.



Inevitable shift in nutritional emphasis

With the maturation of consumer demand for poultry that we are now seeing in the United States and in many European countries, coupled with the growing concerns and demands regarding the perceived health, safety and nutritional value of chicken products, we are going to see a major shift in emphasis in the area of poultry nutrition. For lack of a better term, I am going to call this "The Age of Minimisation". We have already begun to see the effects of environmental concerns in the area of phosphorus (P) nutrition. The demand to reduce the faecal output of P has led to some major changes in ingredient composition as well as some changes in nutritional philosophy. Similar changes are in store for nitrogen excretion as well.

Reduction in phosphorus levels

For many years, nutritionists have placed a great emphasis on ensuring adequate and even excessive levels of P in the diet of broilers, even though it is an expensive nutrient. There are several reasons for this, the first being that a strong skeletal structure is one of the most desirable traits in a growing bird. Leg disorders such as rickets, tibial dyschondroplasia, twisted leg, and other similar conditions have been nagging problems in broiler production. Even though these are not only related to the mineral content of the diet, nutritionists have been reluctant to provide P levels that might be considered as marginal, despite research over the decades suggesting that P levels for older broilers could be markedly reduced. Secondly, broilers are subjected to a great deal of "environmental insult", especially in relation to catching, cooping, hauling and processing. Again, the frequency of broken bones during the journey from broiler house to processing plant has little to do with skeletal strength and dietary nutrients, but woe be unto the nutritionist when the frequency of broken bones exceeds the norm! When faced with the need to reduce overall dietary P levels to meet perceived environmental concerns, nutritionists have been placed in a different milieu.

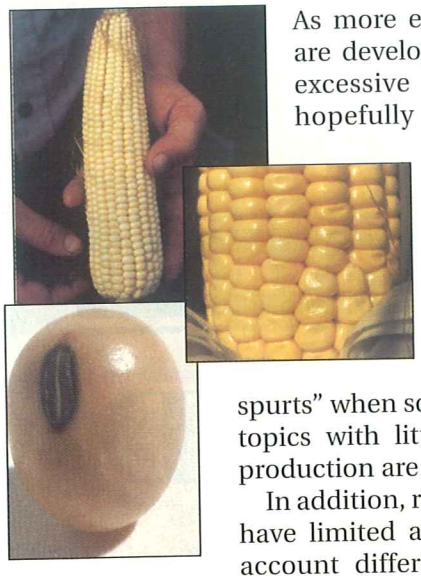
Faced with the pressure to reduce P levels, the application of phytase enzymes has come into the forefront. Fortunately, several companies have entered this or are approaching this market, which should lead to a more competitive situation from an economical standpoint. One problem with current products is their poor stability during heat processing. Pelleting is considered desirable for optimum broiler performance so it is unlikely that the industry will forego the process to preserve phytase activity. Indeed, pelleting may become more necessary in future as we shift usage of various ingredients and utilise ingredients that are more fibrous or bulky than currently in widespread use. Development of phytase enzymes that are more heat stable is imperative.

Reduction in animal protein meals

Victims of the reduction in dietary P levels in the USA have been rendered animal by-products such as meat and bone meal. Although these have been banned from animal diets in the UK and limited in many other areas, they have long been a staple in US feeds, providing both calcium (Ca) and P, as well as being a good source of essential amino acids. The economic value for such products in poultry diets has been attributed equally between the mineral and protein contents. For years, the average usage level of animal protein feedstuffs in the US has been 5-7% although the level today approaches 3% in broiler diets. Some attribute this reduction to the decision by some poultry companies to go to diets void of animal protein due to possible consumer concerns about the unlikely possibility that consumption of chickens fed animal by-products may lead to BSE. However, I believe the reason to be that rendered meat products are variable in P content. A nutritionist faced with the request to reduce dietary P but retain sufficient phosphate will prefer to use mineral supplements that are more consistent in P content.

There are no governmental restrictions regarding the use of rendered animal by-products in poultry diets in the US but I foresee this taking place in the near future, triggered by consumer concerns rather than scientific research. If it does happen, we must carefully examine all areas where the rendered meat products contribute to the nutritional value of a feed - not only the obvious areas such as amino acids and P but also to trace mineral needs, especially zinc (Zn). We should remember that much of the research on Zn needs by the chick occurred simultaneously with the advent of computer diet formulation, a practice that reduced the number of feed ingredients,

particularly those of animal origin. Plant proteins such as soybean meal are poor sources of Zn, much in a form chelated with the phytate molecule. Because Zn is an environmental concern, there may be resistance to the use of higher levels to overcome the loss of that supplied by the animal proteins. Animal proteins are also rich sources of vitamins but reduced usage will have less impact in this respect as most diets are fortified with complete vitamin premixes far in excess of their needs.



Reducing crude protein levels

The introduction of methionine supplements in the late 1950s was the result of the development of linear programming that changed the way diets were formulated. The use of this amino acid is almost universal in poultry nutrition and it has aided the reduction in overall dietary protein content. Lysine supplements were adopted more slowly as soybean meal is a source of this amino acid and the economy of substitution was not as great as for methionine. More recently, threonine and tryptophan have also become available commercially, although their usage has been limited. Other amino acids are on the horizon.

As a consequence of amino acid supplementation, protein levels have been reduced markedly. Reducing nitrogen in excreta has not been as prominent a concern as that of phosphate but there is still pressure to reduce it. It is possible to manufacture diets that contain almost no excess amino acids - in relation to our current thoughts on requirements. However, animal performance deteriorates once the total protein is reduced below a certain point, partially attributable to poor digestibility or amino acid imbalance. Protein levels will not be reduced below those currently used until we have a more complete understanding of the decline.

Amino acid balance

Since the discovery of amino acids as the building blocks of protein, it has been the dream of nutritionists to develop the "ideal" or perfectly balanced protein mixture and various groups have researched this area. However, little research to date has demonstrated that diets formulated to meet some ideal pattern supports performance greater than that obtained on a typical well-balanced diet. Granted, nutrient efficiency may be greater on such diets but our industry works on the basis of economy. As more economical amino acid supplements are developed, we will continue to reduce the excessive levels of some amino acids and hopefully create diets that are used more efficiently.

Modelling to estimate requirements

Classically, nutrient requirements were developed on an empirical basis, motivated by economic incentives. We experience "research spurts" when something new becomes limiting while topics with little immediate impact upon cost of production are overlooked.

In addition, requirements developed by this system have limited application, as they do not take into account differences that might be influenced by other factors, e.g. environment, gender, population density. Developing models that take these factors into account will offer a more dynamic estimate of nutritional needs under circumstances that may be unique to a particular situation. These models might estimate of nutritional needs more precisely, reducing the excretion of excess nutrients.

Unfortunately, research into developing such models is dwindling. Poultry research laboratories are being consolidated with larger animal departments, where they can lose their identity. Many laboratories have been disbanded. Institutions that remain involved in poultry research are replacing scientists whose research had immediate practical application with those whose research is more focused on technological problems that are unlikely to find application in the poultry industry for some time to come. I do not disparage this type of research but the industry's current problems should not be forgotten. Modelling to estimate the nutrient needs of poultry today lies in the private sector and it is unlikely that university groups will become involved in this endeavour because of costs.

Antibiotic usage

Since the early 1950s, the use of antibiotics in feeds has been considered desirable by the poultry industry. At first, much of the boost from antibiotic usage came from disease control, as infectious diseases such as air sacculitis were still common. Antibiotics such as the tetracyclines that functioned primarily in disease control gradually gave way to compounds developed primarily to enhance growth and feed utilisation. Better ways were found to limit common diseases. These antibiotics, such as bambermycins and bacitracin, function in large measure by controlling the intestinal environment. Contrary to widespread belief by consumers, they are

not absorbed into the body and leave no residues that might be passed on to humans eating the meat. Nevertheless, the use of these products has come under considerable scrutiny in recent years, not only in Europe where most are banned totally but also in the USA. Again, some poultry companies have made a choice to produce broilers without the use of antibiotics. Over the last two years, approximately 30% of the broiler complexes that participate in a major agricultural survey that includes more than 98% of all the broilers produced in the US reported that they no longer use antibiotics in their diets. Until recently, none used this in their advertising campaigns perhaps because they have felt that this might limit any decision to use antibiotics in the future. However, times are changing and more companies may reduce their antibiotic needs if only in self-defence.

European producers may remark that they have already met this challenge but problems with necrotic enteritis continue to be reported. The problem will be less challenging in broilers fed typical US diets based on corn and soybean meal as these give rise to less fermentable material in the lower intestinal tract than typical European diets. However, I do not believe we will be totally free of such problems. It is frequently remarked that the industry will shift to other products such as probiotics or to competitive exclusion systems to overcome the loss of antibiotics. We have evaluated several such products but have failed to find any that provide a consistent response in typical American diets - either with or without antibiotics.

The future of antibiotic usage in the US remains to be seen. Legislation has been recently introduced to limit the use of growth promoting antibiotics, and people generally believe that the use of antibiotics by the livestock industry is a big factor in the development of antibiotic resistance. Whether this is true or not, the perceptions of consumer buying the chicken has a stronger impact than a scientific report.

New feed enzymes

The development of enzymes that improve the use of non-starch polysaccharides in wheat and barley has made a major contribution over the last decade in areas where these grains are the primary source of carbohydrates. Noticeably absent are enzymes that consistently aid the utilisation of the oligosaccharides common in legumes, especially soybean meal. The oligosaccharides not only detract from the potential nutritive value but they are also detrimental to digestion and utilisation of other nutrients. They cause sticky excreta and may contribute to the development of leg disorders in soy-based diets. As we will likely reduce our usage of animal by-products in the near future, more soybean meal will be used in the diet, making it even more desirable to develop effective enzymes for this purpose.

Soybean processing

More than 50% of all the soybean meal used in the US goes into poultry feeds although the birds do not utilise the oligosaccharide fraction well. The system of processing that we use to extract the oil and toast the meal was developed when the oil was the most valuable product and most of the meal was fed to ruminants. Today, the meal is the more valuable product and monogastrics are the primary user of that meal - a situation unlikely to change in coming years. Yet, we have been processing soybeans in the same way for more than 60 years. Other methods can be used to remove most of the oligosaccharides, making a more valuable protein source for monogastrics. Solvent extraction systems are under scrutiny by both environmental and occupational health and safety groups, and I predict that changes will be mandated in the way we process soybeans. I hope that the emphasis will be upon producing a material with poultry in mind.

More alternative ingredients?

Everyone who attempts to predict the future of poultry mentions that new or improved feed ingredients will be developed. Corn and soy have provided the basis for poultry diets in the US for decades and no doubt will continue to do so. These crops are well adapted to the climatic and soil conditions of the American Midwest and South, and are unsurpassed in yield of energy and protein under such conditions. I foresee greater use of canola and other protein crops in US diets but

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the sheer volume of soybean meal and corn produced here makes any major shift in ingredient usage unlikely in the next 25 years.

Genetically modified crops

What remains to be seen is the future of plant breeding to improve the nutritive value of these two very important crops. Plant breeders have made tremendous progress in improving yields, disease and pest resistance, and other agronomic factors that are of economic importance but little emphasis has been placed upon modifying their nutritional value. High-oil strains of corn have taken a foothold and plant breeders are evaluating the improvement in the amino acid quality of corn, for example. Corn presently makes up about one third of the protein in a poultry feed. Even a marginal improvement in the amino acid quality could greatly reduce the overall protein needs of poultry and nitrogen excretion into the environment. Insertion of the naturally occurring gene that modifies the phytate P content of both corn and soybeans is within the realm of reality, offering additional means to reduce the P in excreta.

Again, advances in these areas are directed by government regulation, international trade barriers and consumer concerns. It is reasonable to argue that insertion of foreign genetic material such as resistance to corn borers into corn or brazil nut genes into soybeans is undesirable, but unfortunately this has tarred all genetic research with the same brush. Are we not ourselves all "genetically modified organisms"? Over the centuries, Man has used genetic selection to produce a wide variety of domestic animals, improve crops, and generally benefit our way of life. A few years ago, we feared global starvation but improvements in both crops and livestock have helped to diminish this fear. Who would have believed that India would become an exporter of wheat and soybeans or that rice would be used as a livestock feed in Southeast Asia?

It is my sincere hope that the fears about using biological techniques to develop new or improved genetic varieties of plants and animals do not limit the progress that will be needed in years to come to support the population of our planet.

More niche products

As consumption of poultry matures, we will see more attempts to produce chickens for various niche markets. American consumers now spend under 10% of their disposable income on food. For them, food is a bargain. Many are willing and able to pay a premium price for what they perceive as healthier or more nutritious - organically grown birds, free-range chickens and meat with a modified fat content. The animal nutritionist has a role to play in the development of diets that will enable economical production of such products. — *Dr Park Waldroup, Professor of Poultry Nutrition, University of Arkansas,* USA