EQUIPMENT FOR POULTRY PRODUCTION

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Summary

This article provides a brief introduction to the science of poultry production. An astounding growth in poultry production has occurred during the last half of the 20th century, with large-scale integrated systems that incorporate all aspects of production emerging to take advantage of economies of scale. Consequently, poultry meat and eggs are now relatively inexpensive sources of protein in developed countries, and often the first meat-based protein source in developing agricultural economies. These benefits are achieved from improvements in engineering, genetics and nutrition. This article reviews the basics of the modern industry and how equipment is used to automate activities and reduce physical hardships for growers. Also, numerous pictures of modern facilities and equipment are provided for the reader to envision the tremendous size of modern poultry facilities, and to show specific pieces of equipment.

1. Introduction

Poultry are raised both for meat, and for eggs. Poultry production spans the globe, ranging from simple backyard coops to highly advanced, technologically sophisticated rearing operations. Poultry production in developing countries can provide a reliable protein source for growing populations, and its development can signal a countrys transition to a modern agricultural base.

Modern poultry production relies on a sophisticated network of enterprises including feed milling, storage and delivery, bird production facilities, hatcheries, breeding programs and their facilities, slaughtering plants, egg handling and storage facilities, and downstream marketing of final product. The reader may be surprised to learn of the magnitude of typical poultry facilities. For example, it is not uncommon for a single grower to be responsible for 50 000 to 100 000 or more chickens raised for meat, and as many as a million laying hens. Such intensive production requires large material flows of feed, water, ventilation air, electricity, heat energy, lighting. In a sense, modern poultry facilities are biological reactor vessels, with these factors as inputs, and the output being either meat or eggs.

This article provides details regarding modern commercial poultry production equipment. While some of this equipment will be seen to be similar to that used in other livestock operations, the integrated nature of modern poultry facilities has given rise to some specialized equipment. The nature of this equipment is uniquely intertwined with the industrys highly developed and vertically integrated format.

2. Types of Poultry

While poultry are primarily reared for meat or eggs, other uses include leather and feathers, and in some regions, birds may be used in sporting events. The main types of poultry include chickens, turkeys, ducks and ratites (emus, ostrich, etc). For meat production, differences between poultry types are mostly related to the length of the growth phase. Ratites are raised for meat and for other products including feathers and leather, but will not be discussed here.

For the purposes of this article, the terms “broilers” and “layers” shall be used to denote meat-type and egg-producing birds, respectively. The majority of poultry used worldwide are chickens, although turkeys and to a lesser extent ducks account for significant meat production. Thus, equipment for a “broiler chicken” will generally be similar to that for a turkey reared for meat, unless specifically noted.

3. Types of Chicken Housing Systems

Broilers and Turkeys

Modern meat-type chickens, commonly called broilers, are typically raised in large buildings (“houses”). Birds are placed in these houses when newly hatched and may remain in the same house until removed for slaughter. Feed, water, light, and environment control are constantly provided. A typical broiler house may house 16 000 to 28 000 birds. Turkeys are grown in similar houses, but they may be moved between two or three houses during their growth because they are grown to much larger weights than are broiler chickens.

Layers

Modern egg-producing poultry, or layers, are typically raised in large buildings in cages arranged in tiers. These tiered cages are configured to provide feed and water, and allow for the ready removal and transport of eggs. Cage sizes, and number of birds per cages, vary by country according to customs and regulations. A typical layer house may contain 100 000-200 000 birds. It is common for multiple houses to be connected together at one end for automating egg collection, and feed and water delivery tasks. Layer houses may be either single storey or "high-rise" structures with room below the growing area for manure storage.

Breeding Flocks

Modern poultry production includes flocks of parent birds (“breeders”) to produce fertile eggs for broiler or layer operations. Housing is typically similar to broiler and turkey housing, but feeding, light control and density of birds are much different.

4. Economic Impact of Poultry Production

Table 1 lists gross output of the worlds larger poultry producers, for both meat and eggs. These data are published annually in a number of sources, including the United States Department of Agricultures Agricultural Statistics Service, and others. The largest producers of poultry meat include United States, China, European Union and Brazil. The largest producers of eggs include China, U.S.A., Japan and India. These differences in production arise from a number of different factors, including feed cost and availability, market restrictions and regulations on production and environment effects, and the development of export markets.

	Broilers (tonnes)	**Eggs (tonnes)**
North America	**17,615**	**109,656**

U.S.	15,021	77,256
South America	**6370**	**24,380**
Brazil	4441	16,890
European Union	**8319**	**82,724**
France	2307	16,350
Italy	1170	12,050
United Kingdom	1477	10,700
Germany*	717	13,900
Asia	**16,618**	**425,483**
China	12,500	328,000
Japan	1235	43,200
India	595	29,500
Africa	**1272**	**no data**
South Africa	887	no data
*includes former East Germany		

Table 1. World poultry meat and egg production (USDA, 1998)

Economics of World Poultry Production

The value of poultry production is significant. The direct value of meat and eggs is alone substantial. For example, the combined value of U.S. production from broilers, eggs, turkeys and the value of sales from chickens in 1999 was $22.4 billion. Of this total, broilers, eggs, and turkeys constituted $15.1 billion, $4.32 billion and $2.84 billion, respectively.

The value of the poultry industry to economies is also substantial. Developed supply and distribution markets for poultry products, and for inputs to the poultry industry, provide a large multiplier effect. In developing countries, a transition from poultry importer, to self-sufficiency, and to net poultry exporter marks a significant trend in developing agribusiness infrastructure.

4.1. Factors Affecting Production

It is generally accepted that there are three factors affecting poultry production, which are attributed to the success of modern systems. These are 1) improved genetic strains specialized for use (meat *vs.* eggs) and regional conditions, 2) improved knowledge of nutritional requirements and ability to match these for variable conditions, and 3) stable interior environment including air temperature and lighting. Each factor is discussed below.

Genetics

A demonstration of improvements in bird genetic lines can be found in the improved performance characteristics of broilers. According to a report from 1944, after 90 days of growth, broilers weighed 1.3 kg with a feed conversion efficiency of about 3.9 kg feed per kg live weight. Typical current values are 40 days of age to reach 2 kg with feed conversion efficiency of 1.8 kg kg^{-1}. These remarkable improvements in poultry genetics have been created by specialty genetic improvement companies. Their goal is continuous improvement of positive characteristics and elimination of negative characteristics. The ability of these companies to provide genetic strains appropriate to general climatic conditions, disease challenges and nutritional variations has greatly assisted the adoption of modern production methods.

Nutrition and Disease Management

The significant reduction in feed required to produce poultry meat (or eggs) is not solely attributable to genetics. Both nutrition and environment also play important roles, for without proper nutrition and a healthy stress-free environment, birds cannot achieve their genetic potential.

Scientific research into nutritional requirements for poultry is an ongoing effort. A majority of scientific articles on poultry research focus on improving the understanding of bird nutrition, both for fundamental knowledge of nutrition and for direct application to the industry. One key aspect of nutritional research is to optimize the requirements of birds for local conditions. In the Americas, broiler production relies on corn and soybean meal for the main protein constituents, whereas in other parts of the world, other sources of protein are used.

Likewise, our knowledge of disease management has drastically reduced production losses associated with poor health. Methods of biosecurity, such as limiting public access to facilities and reduced exposure to possible disease vectors, are now routinely applied in the industry.

Environment

Poultry are warm-blooded and must have a satisfactory environment in order to maintain their body temperature. If the environment is too hot or too cold, birds must expend energy to maintain this core temperature (e.g., by shivering in cold or panting in heat). They also adjust their feed intake, eating more food in colder conditions and eating less in warmer conditions. As bird genetics have improved in terms of production efficiency, the limits on optimal environments have shrunk. Thus, poultry must be provided with uniform, stable room temperatures.

Environment is also important for bird health. Environment factors, especially respirable dust and high concentrations of noxious room gases, can be correlated with increased mortality and reduced performance. By contrast, in 1944, the mean mortality of broilers was approximately 17 percent whereas at the end of the 20th century, it was reduced to below 4 percent. A major factor in this amazing improvement has been better control of the environment in which birds live.

In addition to providing an ideal thermal and light environment for poultry, modern systems have been developed to automate the delivery of feed and water. Thus, birds eat when they are hungry and drink when they are thirsty (subject to management methods) and are not required to await a visit by personnel to provide feed and water, or to fight their neighbors for a share.

The automation of the poultry environment is closely related to the equipment used to raise poultry. This topic is covered below.

4.2. Economic Structure of Industry

In the early days of the growth of the poultry industry, growers purchased baby chicks, medicine, feed and equipment from feed dealers. This marketing strategy arose naturally as a few growers and feed mill operators sought to achieve an economy of scale.

This system caught on over the next few decades, expanding its integration of services to include trucking, slaughtering, marketing and providing value-added processing. Modern growers in this "vertically integrated" system of production provide the service of growing birds for a fee paid by an "integrator". The integrator company typically provides all services and materials needed by growers.

Layer production has also undergone consolidation. It is common to find a layer complex producing over 1 million eggs per day in one location. Although not always vertically integrated like broiler companies, egg producers have integrated many services into their organizations to achieve production efficiencies.

In the last 50 years, the broiler industry has managed to lower the cost of live production by 88 percent, from roughly $4.95 to $0.55 per kg based on 1995 US dollars. This has helped to make poultry meat an attractive and inexpensive source of protein; thus per capita consumption of poultry meat has surpassed all other meat sources. This in turn has driven the industry to provide a variety of further processed and value added products.

These dramatic improvements in bird production came about as production stages were "integrated" by specialty companies. They combine these production stages under one enterprise in order to capitalize on economies of scale (Figure 1). A vertically integrated system can reduce costs in two ways.

First, they coordinate production capacity at each stage of production. Secondly, independent profit centers are eliminated. By matching hatchery capacity, feed mill capacity, grow out capacity, and slaughtering capacity and removing independent operators from each of these tasks, integrators were able to achieve current production efficiencies. A general conceptual model for a vertically integrated system is shown in Figure 1.

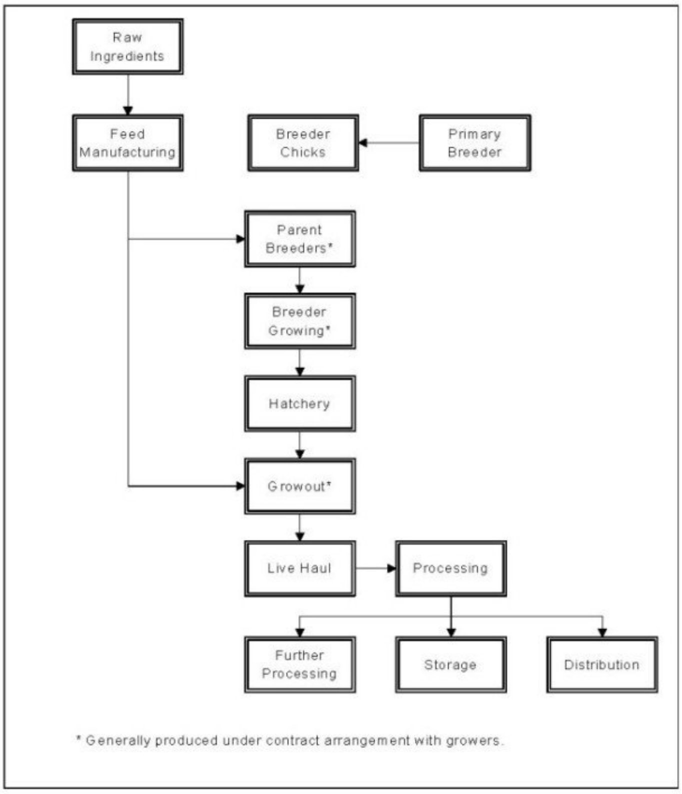

Figure 1. Example flow chart of integrated broiler production system

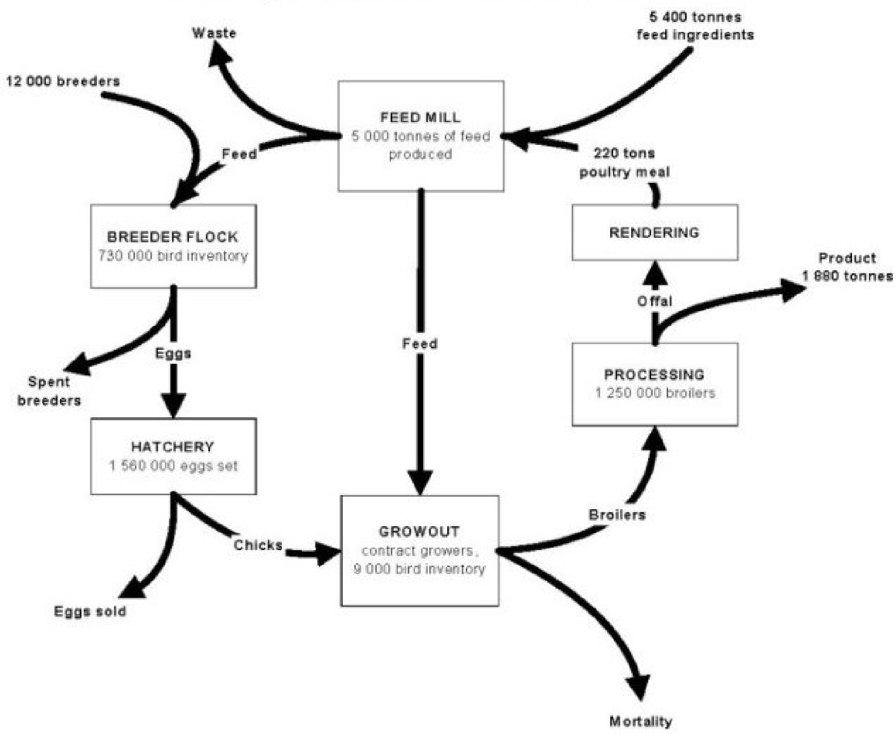

Figure 2. Weekly flow of materials through an integrated poultry broiler enterprise

A schematic of weekly flow of materials for a broiler production enterprise is provided in Figure 2, demonstrating the operations that integration has consolidated and the magnitude of the systems.

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Biographical Sketch

Professor Richard S. Gates teaches, conducts research and provides outreach services at the University of Kentucky College of Agriculture. He has degrees in Agricultural Engineering from the University of

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