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Poultry Production Technology

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Foreword

The digital age has its preferences. The reading time has been encroached upon by a watching time. The access to information is easy and a plenty where Wikipedia has emerged as the most powerful encyclopedia ever. Yet, a book is a book! We wish to promote the habit of reading books. Finding books is not difficult or expensive (www.pdfdrive.com) but a local context and indigenous experiences could be missing.

The University of Agriculture, Faisalabad (UAF) has achieved global rankings of its flagship programs and acceptance as a leader in the field of agriculture and allied sciences. A competent faculty, the stimulating ecosystem and its learning environment have attracted increasing attention. Publication of books is an important KPI for any institution of higher learning. Hence, UAF has embarked upon an ambitious 'books project' to provide reference texts and to occupy our space as a knowledge powerhouse. It is intended that the UAF books shall be made available in both paper and electronic versions for a wider reach and affordability.

UAF offers more than 160 degree programs where agriculture remains our priority. There are about 20 institutions other than UAF who are also offering similar degree programs. Yet, there is no strong history of indigenously produced text/reference books that students and scholars could access. The last major effort dates back to the early 1990's when a USAID funded TIPAN project produced a few multiauthor text books. Those books are now obsoleted but still in demand because of lack of alternatives. The knowledge explosion simply demands that we undertake and expand the process anew.

Considering the significance of this project, I have personally overseen the entire process of short listing of the topics, assemblage of authors, review of contents and editorial work of 29 books being written in the first phase of this project. Each book has editor(s) who worked with a group of authors writing chapters of their choice and expertise. The draft texts were peer reviewed and language corrected as much as possible. There was a considerable consultation and revision undertaken before the final drafts were accepted for formatting and printing process.

This series of books cover a very broad range of subjects from theoretical physics and electronic image processing to hard core agricultural subjects and public policy. It is my considered opinion that the books produced here will find a wide acceptance across the country and overseas. That will serve a very important purpose of improving quality of teaching and learning. The reference texts will also be equally valued by the researchers and enthusiastic practitioners. Hopefully, this is a beginning of unleashing the knowledge potential of UAF which shall be continued. It is my dream to open a bookshop at UAF like the ones that we find in highly ranked universities across the globe.

The poultry sector has shown remarkable improvement due to scientific innovations in genetics, nutrition, management and disease control. There is a highly mechanized

segment of commercial poultry continuously rising as an industry and an equally important backyard/traditional (rural) poultry production. This book has addressed the subjects of efficient management, quality production and provision of safe products to the consumer. Alongwith food safety, the book also covers the welfare of birds and environmental issues of the poultry industry.

Before concluding, I wish to record my appreciation for my coworker Dr. Muhammad Farooq who worked skillfully and tirelessly towards achieving a daunting task. Equally important was the contribution of the authors and editors of this book. I also acknowledge the financial support for this project provided by the USDA endowment fund available to UAF.

Prof. Iqrar A. Khan (*Sitara-e-Imtiaz*)
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Preface

Poultry sector is continuously progressing throughout world. Poultry industry is one of the most vibrant segments of agriculture sector in Pakistan. It generates direct or indirect employment for 1.5 million people. Poultry population is estimated to be 932 million which includes 83.32 million rural poultry, 794.63 million broilers, 42.65 million layers and 10.70 million breeding stock.

Poultry Production Technology covers various segments of poultry industry, starting from overview of poultry industry to IT applications. Each author selected for this book has experience and depth of knowledge for writing his chapter. Tables, figures and pictures are given to enhance understanding of readers. Mega layer and broiler units along with processing plants are installed in Pakistan to fulfill countrymen needs and have tremendous potential for export of poultry. Poultry farmers may earn more by practicing various management tools as mentioned in this book. However, there is huge potential in Pakistan Poultry Industry to increase production and export of poultry products. This book will be helpful to poultry industry at present and times to come in achieving goals and successfully competing in international poultry market with quality products.

This book comprises of 09 chapters and glossary as given below

(1) Poultry Industry
    Chapter 1 describes poultry industry status and components.
(2) Poultry Breeding and Selection
    Chapter 2 states selection and breeding of poultry.
(3) Incubation Principles and Hatchery Management
    Chapter 3 collates hatching eggs, hatchery management and incubation.
(4) Poultry Housing and Equipment
    Chapter 4 covers poultry housing systems and modern poultry equipments.
(5) Poultry Farm Management
    Chapter 5 describes brooding, rearing and production practices, induced molting, computerized record keeping and feasibility reports.
(6) Poultry Feeding
    Chapter 6 covers feed ingredients, feed forms, scientific poultry feeding.
(7) Poultry Hygiene and Disease Prevention
    Chapter 7 discusses measures against diseases vaccination and medication.
(8) Poultry Processing
    Chapter 8 describes standards, grades, processing of eggs and meat.
(9) IT Application in Poultry Production
    Chapter 9 covers IT application in poultry production.
Glossary covers glossary related to different aspects relating to poultry.

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Chapter 1

Poultry Industry

Shahid-ur-Rehman and Shafaq Shakeel[†]

Abstract

Poultry industry is flourishing globally to meet protein needs of people. Both eggs and meat industries are being run on scientific lines using most advance technologies and sophisticated equipments. This chapter focuses poultry species, history in different phases and development of poultry industry in Pakistan. Rural poultry contribution and development of Lyallpur Silver Black are discussed along with automation and processing. Various components of poultry industry are discussed along with their role and business operations. Planning steps for poultry farming business with various objectives are discussed. Production cost of broilers, layers, poultry and poultry products along with trends and potentials of poultry meat and egg industry are discussed in this chapter.

Keywords: Poultry industry, History and development, Business components, planning, Cost estimates, Uses of poultry and its products, Trends and potentials

1.1 Introduction

The term poultry includes species of those birds which render useful services with economic benefits and can reproduce freely under human care which includes; chicken, duck, quail, turkeys, pigeon, peafowl, geese, pheasants, guinea fowl, swans and ostriches. Poultry science deals with use of principles and practices for efficient production and marketing of poultry and poultry products. These practices

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include breeding, incubation, brooding, housing, feeding, disease control, marketing and poultry farm management.

1.1.1 History and Development of Poultry Industry in Pakistan

Poultry meat and eggs supply was on small scale from Desi birds up to 1963. These birds are hardy, living under scavenging conditions, produces 60-70 eggs/annum. Mortality rate during brooding and growing is high in Desi birds. 16 million "Desi" chicken were raised annually in Pakistan during 1957-1965 and their contribution towards supply was less than 2%.

Commercial poultry farming started in 1963 in Pakistan to fulfill protein needs of countrymen because meat and egg production from Desi birds was not able to meet the increasing demand of meat and eggs. PIA with Shaver Breeding Farms of Canada started a poultry breeding operation in Karachi to produce good quality chicks. Lever's Brothers Pakistan (Ltd.) established feed mill at Rahim Yar Khan to produce balanced ration for raising broilers and layers.

Before 1963, rural poultry which indigenous birds were kept as about ten to twelve birds as back yard birds/family were the only source to fulfill the demand for eggs and poultry meat. During this period, main efforts were focused to improve rural birds mainly in terms of improvement in egg and meat production and increasing productive life span of Desi birds. Various exotic breeds were introduced in rural populations to improve productive potentials of Desi birds. These were White Leghorn, Rhode Island Red, New Hampshire and White Cornish. Department of Poultry Husbandry, University of Agriculture, Faisalabad made an endeavor to improve Desi birds and in 1965-66 an improved breed Lyallpur Silver Black (LSB) was evolved. LSB birds improved egg production form 60-70 egg in Desi to 150 egg/year with about 10 g improved egg weight. As far as meat production is concerned LSB birds were able to attain 1.4 kg weight in 3 months of age under favourable management conditions (Siddique 1964).

Foundation stone of commercial poultry industry was laid in 1963, when modern broiler and layer strains were imported and reared on scientific lines in Pakistan. It is worth mentioning that poultry meat and eggs is playing a pivotal role in filling gap between demand and supply of animal protein in Pakistan.

Rate of growth remained comparative slow up to mid 1970s. Government announced following policy decisions to uplift commercial farming in Pakistan.

1. Declaration of poultry farming income tax free.
2. Ban on import of parent stock and incubators were withdrawn.
3. Leasing of state land for poultry farming business.
4. To facilitate poultry research especially disease control strategies, established Poultry Research Institutes at Karachi and Rawalpindi (1978).
5. To enhance poultry meat consumption two meatless days were announced.
6. Agricultural Development Bank of Pakistan offered loan for poultry business.
7. Federal Poultry Board was established to coordinate with poultry industry.

With these incentives, commercial poultry business started developing at a rapid rate which boosted the poultry business and emerged as a poultry industry.

1.1.2 Rural Poultry

Great improvement in household poultry is only possible if rural poultry keepers particularly women are educated by trained extension workers to adopt improved technologies. Using improved technologies, better genetic potential for growth and egg production will lead to successful household poultry. Selection from indigenous birds will help household poultry by identifying and selecting birds with a rapid growth rate, higher egg production and better health. Fertile eggs from such birds are used for further propagation. Introduction of suitable new dual purpose breeds of chicken having desirable qualities of production, disease resistance and adaptability to local environment.

1.1.3 Lyallpur Silver Black (LSB)

Lyallpur Silver Black (LSB) breed is well adapted to our local conditions having good disease resistance and produces about double the number of eggs in a year and 50% more meat than Desi birds in 12 weeks. LSB breed was evolved by crossing 4 breeds (White Leghorn × Desi & White Cornish × New Hampshire) at University of Agriculture, Faisalabad.

White Leghorn breed was used to enhance egg production potential of Desi birds. Whereas, White Cornish and New Hampshire breeds were used to improve meat production capacity of Desi birds. Productive and reproductive performance of LSB is compared with Desi in Table 1.1.

Table 1.1. Performance comparison of Desi with Lyallpur Silver Black (LSB)

Production Parameters	Desi	LSB
Egg production/year	73.0	150.0
Egg weight (g)	45.0	54.0
Body weight (g)	950.0	1350.0
Age at maturity (days)	212.0	180.0
Heat tolerance (°C)	43.3	43.3
Livability (%)	90.0	90.0

Source: Haq and Akhtar (2004).

1.2 Present Status and Future Trends

Poultry industry in Pakistan is second largest industry with an investment 564 billion rupees it provides direct and indirect employment to about 1.5 million people. This industry showed a steady growth of 10 percent during last decade and contributes a fair 1.3% share in Gross Domestic Product (GDP). Poultry sector's share in agriculture value addition was 6.3 % while in livestock value addition it contributed 11.2 percent during 2014-15 (Govt. of Pakistan 2016). Poultry sector is

playing an important role in fulfilling nations' animal protein requirements and contributes 28 percent of total meat production in Pakistan as shown in Table 1.2.

Poultry farming in Pakistan especially in Punjab is rapidly transforming from open sided houses to environment controlled housing of commercial birds. Most of broiler parent flocks are kept either in environment controlled houses or in cool northern areas of Pakistan. There are more than 6000 controlled environment houses in Punjab and are increasing rapidly. Number of conventional poultry farms decreasing establishment of environment controlled houses. Moreover, heavy investment for controlled environment housing has posed a threat to the small poultry farmers and it is feared that this trend might eliminate small poultry farmers from this sector in near future. Eelectricity shortage, increasing expenditures especially on poultry feed and limited facilities for diagnosis and prevention poultry diseases are some of problems being faced the poultry farmers.

Table: 1.2. Trends of poultry population, meat and eggs in Pakistan.

Type	Units	2011-12	2012-13	2013-14	2014-15	2015-16
Domestic Poultry	Million Nos.	79.68	80.87	82.08	83.32	84.58
Cocks	Million Nos.	10.10	10.38	10.66	10.95	11.24
Hens	Million Nos.	38.09	38.78	39.47	40.18	40.90
Chicken	Million Nos.	31.48	31.72	31.95	32.19	32.43
Eggs	Million Nos.	3,809	3,878	3,947	4,018	4090
Meat	000 Tones	106.51	108.62	110.79	112.99	115.24
Duck, Drake, Duckling	Million Nos.	0.54	0.52	0.50	0.48	0.46
Eggs	Million Nos.	24.13	23.13	22.17	21.25	20.36
Meat	000 Tones	0.73	0.70	0.67	0.65	0.62
Commercial Poultry	000 Tones	44.1	47.0	50.1	53.4	56.9
Layers	Million Nos.	34.82	37.25	39.86	42.65	45.64
Broilers	Million Nos.	597.02	656.72	722.39	794.63	874.09
Breeding Stock	Million Nos.	9.25	9.71	10.19	10.70	11.24
Day Old Chicks	Million Nos.	623.58	685.94	754.54	829.99	912.99
Eggs	Million No's	9,281	9,912	10,586	11,307	12,077
Meat	000 Tones	726.66	797.47	875.24	960.65	1054.46
Total Poultry						
Day Old Chicks	Million Nos.	655	718	786	862	945
Poultry Birds	Million Nos.	721	785	855	932	1,016
Eggs	Million Nos.	13,114	13,813	14,556	15,346	16,188
Poultry Meat	000 Tones	834	907	987	1074	1,170

Source: Govt. of Pakistan (2012, 2013, 2014, 2015, 2016).

1.3 Components of Poultry Industry

1.3.1 Poultry Breeding

Seed stock owners that maintain great grandparent, grandparent and parent stocks of commercial birds i.e. broiler and layer chicks. Poultry breeding companies also termed as primary breeders are pioneers who started breeding and improvement of birds for layer and broiler birds. There are less than two dozen companies worldwide who are maintaining seed stock of commercial broiler and layer chicks. These breeding companies use different breeding tools to evaluate performance of their flocks keeping in view the consumer demands in different regions of the world. These companies have teams of management specialists, geneticists, nutritionists and veterinarians to develop and evaluate commercial strains and management guides. Management guides provide standards for performance, nutrition, management and veterinary guidelines for specific strains that can be achieved by better farmers. At present, there are 14 million broiler parent stocks in Pakistan to produce commercial broilers.

1.3.2 Hatcheries

Hatchery business deals with incubation of hatching eggs to produce quality chicks. Breeding companies maintain their own hatcheries and get their eggs hatched and market the chicks by themselves. Hatchery business can be run by incubating hatching eggs from own farms or breeder farmers who pay according to the number of hatching eggs incubated @ Rs. 2.0 per egg. In Pakistan, there are about two hundred commercial hatcheries which produce about 1.2 billion chicks per year (Anonymous 2014). Broiler chicks are mostly sold unsexed but layer chicks are sold after sexing. Hatcheries provide facility of vaccination, medication or sexing.

1.3.3 Feed Services

Modern day birds' productivity depends on feed quality. Feed is most costly input in breeder, broiler and layer operations. It is estimated that 60-75% cost of production is on feed. Presently, 6.5 to 7.0 million metric tons of poultry feed is produced in Pakistan with an average feed conversion ratio of 1.8. Numerous rations for broiler, layer and breeder birds are produced in all three forms (pellets, crumbs and mash) by more than two hundred feed mills in Pakistan. Recently, high density feed is being manufactures by most of feed mills with feed conversion ratio of 1.55-1.60.

1.3.4 Layer Flocks

Laying hens are efficient enough that by consuming 100-110 g feed lay an egg of 58 g. Eggs produced by layer is called table eggs. A layer flock's life span can be divided into mainly two phases i.e. productive and non-productive, during productive phase these birds lay eggs and in non-productive phase they are either brooding or being reared. In Pakistan layer population was 42 million in the year 2016. Layer operation is comparatively costly operation as the farmers either

should brood and rear their own flock for about 18-20 weeks of age without any return or should purchase started pullets at a price of about Rs. 450-500 per pullet. Started pullet is young layer bird that has just started laying eggs. Biosecurity measures are very essentials for better production and less mortality in layer flocks.

1.3.5 Broiler Flocks

Broiler farmers purchase day old chicks from breeder companies, grow them for 5-6 weeks and market them. Most of broiler farming was in open sided poultry sheds but during last decade the broiler farming is transforming from open sided poultry houses to environmentally controlled houses. Open sided poultry houses decreased drastically in last decade in Punjab. Most of broiler farmers own their farms and some have rented farms in Pakistan. Recently contract growing concept is followed in Punjab where meat processing companies contract with farmers to produce broiler according to their required quality and standards to get premium prices.

1.3.6 Egg Production

Layer farming aims to produce table quality eggs for human consumption in Pakistan more than fifteen hundred thousand eggs were produced during 2014 out of which about 74% were produced by commercial layer farmers while 26% were produced from rural poultry birds. In 1960, eggs produced were from Desi birds and even now they have a reasonable contribution in table egg production. Commercial layers are mostly kept for first production cycle in Pakistan; recently increasing input costs have driven the layer farmers for molting their flocks. Molting/rejuvenation of poultry flocks is in practice for last couple of decades. Nowadays a fair number of farmers are molting their flocks. Layer farming is also transforming from conventional farming setup i.e. open sided litter floor flocks to controlled environment caged flocks. Farmers having laying capacity more than one hundred thousand birds in cages are found in Punjab and Sindh province. Layer farmers by practicing induced molting can keep layers for two or even three production cycles.

1.3.7 Poultry Processing

Poultry meat processing plants are relatively new and developing sector in Pakistan. Currently two poultry processing plants are in operation by large poultry companies. However, some poultry processing plants will start processing in near future in Pakistan. Accompanied with primary processing, further processing is also in process to produce variety of products as per consumer preference. Some processing plants purchase processed chicken from primary processors and market ready to cook/ready to eat products. Poultry processing has huge potential for development and expansion.

1.3.8 Shell Egg Packaging

Shell eggs (table eggs) are packed in egg boxes having 360 eggs and market accordingly. However, in large stores smaller packing of table eggs i.e. six or dozen eggs are also available which are mostly packed by suppliers on demand to stores.

1.3.9 Egg Processing

Only one egg processing plant is presently working in Pakistan. Operation at this plant starts from egg breaking, separating yolks and whites goes up to chilling, freezing and drying of whole egg, yolks or whites with or without added ingredients i.e. sugar or salts. Egg processing is still a virgin field in Pakistan and requires lot of struggle and support to popularize. This processing plant is producing for industrial level and other users. They sell their products in different packing's. Government should support this sector.

1.3.10 Product Marketing, Promotion and Advertising

Income of any enterprise is by the sale of outputs. Profitability of any products depends on two factors i.e. either to produce goods at lowest possible prices or to sale products at highest possible prices. To get premium prices marketing, promotion and advertising tools are employed in modern markets. Most of poultry and poultry products are not advertised due to live bird sale at conventional stores but the processed and further industries are using all tools of marketing i.e. they are promoting and advertising their products using all sources of media. Poultry industry sale trend is shifting from unbranded to branded products.

1.3.11 Packaging

Most of poultry products (meat and eggs) are packaged at the time of sale. But processed and further processed (ready to cook and ready to eat poultry products) are pre-packaged at processing plant and then marketed. Shell eggs are packaged in 30 dozen/egg box, however small consumer packaging of shell eggs is very rare.

1.3.12 Housing and Equipment Manufacturers

Environment controlled housing demands specialized housing construction companies, which provide consultancy services and poultry house construction. Most of the equipment used in poultry houses and allied industries are imported however limited local equipments are developed by local equipment manufacturers. Imported equipments are costly and require skilled/technical staff for maintenance. However, local equipments are cheap and easily available with technical assistance.

1.3.13 Vaccine, Drug, Chemical and Feed Additive Manufacturers

In Pakistan, local as well as multinational companies are doing their business of vaccine, drugs, chemicals and feed additives packing and marketing. Numerous

types of vaccines, drugs and feed additives are available in the market for various types of consumers. Public/private sector also prepare vaccines for poultry birds in Pakistan.

1.3.14 Private Laboratories and Consultants

Private laboratories and consultants are working in major production areas. Diseases diagnostic as well as quality control laboratories are also working under large production integrations in Pakistan. Layer and broiler farm consultants are more demanded by large enterprises where layer birds are kept in environmental controlled cage housing system or broilers in environment controlled houses.

1.4 Planning for Poultry Enterprises

Poultry enterprises planning should include size of business, site selection, water quality, feasibility studies, initial investment, source of investment, flock source, building type, stocking rate, consultant hiring and risk factors

1.5 Investment and Return in Poultry Farming

1.5.1 Cost of Producing Broilers

Live weight broiler production cost in Pakistan range is Rs. 100-110 per Kg and live weight broiler sale usually averages Rs. 120 to 130/Kg. Feed is major cost while other factor is day old chick cost which ranges from Rs. 15 to 65 which may also vary as per market condition.

1.5.2 Cost of Producing the Layers

1.5.2.1 Egg Production Costs

Production cost of layer eggs in Pakistan ranges between Rs. 60-70 per dozen. Feed cost is 60-70% while other cost factors include day old chicks, housing, labor and other inputs.

1.5.2.2 Feed Costs

Feed cost ranges between Rs. 300-340 for rearing cost while during production one layer can eat feed amounting to Rs. 1500-1600. Feed cost is probably one of the most variable cost of especially layer production due to seasonal variation in ingredient costs, as well as varying costs of transportation and electricity in case of home feed mixer farmers.

1.5.2.3 Feed Cost per Dozen Eggs

Feed cost ranges 60 to 70% of the cost of production of table eggs. Feed cost is the largest cost item, so it has an important role in total cost of production. Similarly, during rearing of layer birds feed the largest cost. As far as calculation of egg cost

is concerned it is calculated either as cost of feed per dozen eggs or cost of feed for producing egg mass in kilograms.

1.5.2.4 Replacement Costs

Replacement cost to produce pullets is the second largest cost of layer production operations. It may be rearing of new chicks, purchase of pullets or molting of spent hens for second of third laying cycle. To grow new layer birds is not an easy task it not only requires skilled labor but also requires breeding and growing facilities in terms of sheds and biosecurity arrangements. However, most of the farmers in Pakistan usually grow their own pullets but keeping in view the market prices of day old layer chicks and eggs, layer farmers decide to molt their flocks.

1.6 Use of Poultry and its Products

1.6.1 Source of Income

There is a quick return over investment in poultry industry. Broilers are ready to be marketed at 5 weeks age averaging 1.8 kg live weight. Hen starts laying eggs at 16-18 weeks of age and lays 280-300 eggs in a year. In recent years, poultry farming has shifted from conventional farming to large factory farming setups with huge investment. However, small and house hold poultry farming is still being carried out by farmers but these farmers are being replaced rapidly by larger environment controlled poultry farms. However, more than 2500 small farms were closed in Punjab province during last two years.

Nowadays broiler weighing 1.5 kg is being produced by feeding about 3.1-3.5 kg of feed. None of the meat can be produced so efficiently. A dozen of eggs can be produced by feeding 1.9-2.0 kg feed. Income from both broiler and layers flock is distributed throughout the year. There is quick turn-over of capital invested in poultry business. Capital invested in broiler production returns in about two months and laying flock starts return in about 20 weeks. Poultry farming is adopted as a large or small scale business. It is a full-time occupation on commercial farms and may be side business on small scale. Poultry farming is successfully managed by women and children.

1.6.2 Source of High Quality Protein

Poultry meat and eggs are essential foods highly demanded by customers. Poultry meat is appetizing and popular food. Eggs are highly digestible, nutritious and tasty. In future, the demand for high quality poultry meat and eggs seem to be very bright. They serve as binder agents in ice-cream. In backyard poultry, eggs and meat enhances nutritional status of family and raise family income by selling eggs and chickens round the year.

1.6.3 Research Use

Chickens are used extensively in biological research work as laboratory animals as they are cheap, readily available, reproduce freely and have sensitive metabolism.

1.6.4 Industrial Uses

Fertile eggs are used for vaccines preparation. Infertile eggs are used in preparation of animal feed. Egg white is used in pharmacy, paint industry, photography, book binding, leather tanning and textile dying. Egg yolk is used in preparation of soaps, paints, shampoos and finishing leather. Egg shells are used in mineral mixture for animal feed. Feathers are used in making millinery goods, pillows, cushions, insulation material and animal feed. Poultry dropping are used as an organic fertilizer and can also be used in fish ponds as a fish feed. Good quality animal feed can be prepared from poultry dropping by mixing with molasses. Poultry slaughter waste like poultry blood, offals and fat can be used in poultry feeds.

1.7 Egg and Meat Industry

1.7.1 Poultry Meat Industry an Overview

Poultry is second largest industry with investment of 564 billion rupees. It provides direct and indirect employment to 1.5 million people. Contribution of poultry industry in agriculture value addition contribution is 6.3 percent while in livestock value addition is 11.2 percent. Poultry meat contributes 28 percent of the total meat production. Poultry sector growth of 7-8 percent annually. Poultry meat industry showed increased per capita poultry meat consumption from 0.3 to 7.26 kg from 1965 to 2015.

1.7.1.1 Trends and Potential of Poultry Meat Industry

Poultry industry is rapidly shifting from open sided (conventional) poultry houses to controlled environment houses. At present, there are more than 6000 controlled environment houses in Punjab and the number is still increasing rapidly. However, due to heavy investment for controlled environment housing, has posed a threat to small poultry farmers and may eliminate them from this sector in future.

1.7.1.2 Poultry Development Policies

Poultry development policy revolves around improving regulatory framework; disease control; genetic improvement; Hi-Tech poultry production under environmentally controlled housing; processing and value addition; improving bio-security; need based research and development, farmers training and education.

1.7.1.3 Potentials of Poultry Meat Industry

It envisages poultry sectors growth of 10-12 % per annum. Processing plants in operation are K&Ns Poultries, Menu Chicken, Big Birds Poultry, Sabir's Poultries while some companies are starting processing in near future.

1.7.1.4 Per Capita Availability

In Pakistan, per capita poultry meat availability is 7.26 kg. Poultry may serve as savior under these circumstances due to better feed conversion ratio (FCR) 1.6 which is highly efficient compared with beef and mutton. FCR can be further improved by better management.

1.7.1.5 Trends of Poultry Industry in Pakistan

Poultry farming is rapidly transforming in environment controlled housing. Currently there are more than 6000 environment controlled houses (ECHs) out of 19713 broiler sheds in Punjab. In Lahore division, there are 3250 broiler houses out of which 2500 are ECHs. Broiler houses in Faisalabad division are 2986 out of which 300 are ECHs.

1.7.1.6 Weaknesses of Poultry Meat Industry in Pakistan

Weaknesses of poultry meat industry includes instability of inputs/outputs, vulnerable marketing system and seasonal variations in prices.

1.7.2 Egg Industry

At present in Pakistan per capita egg availability is 70. Only one processing plants are in operation (Al-Waha Egg Products International). Al-Waha egg products include dried egg white powder, dried egg yolk powder, dried whole egg powder, liquid egg yolk, liquid-egg yolk with salt, liquid whole egg, egg sugar mixtures, egg yolk sugar and egg breading.

Conclusion

Poultry industry in Pakistan like the globe is flourishing to meet the protein needs of the countrymen. Both eggs and meat industries are being run on scientific lines using most advanced technologies and sophisticated equipments. It seems that poultry industry will make breakthroughs in the production of meat and eggs.

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Chapter 2

Poultry Breeding and Selection

Muhammad Ashraf and Zaib ur Rehman[†]

Abstract

Commercial and rural poultry are raised having peculiar characteristics. Commercial strains of poultry selected based on more egg and meat production. Breeds having good potential are selected for production of next generations. Such breeding and selection procedures are required which ensure good potential from future flocks. This chapter deals with breeding, origin and domestication of poultry birds. Introduction of various classes and breeds of poultry also have been discussed in this chapter. Commercial broiler and layer strains have been discussed. Poultry breeding and mating systems are discussed which are helpful for breed improvement. Mechanisms of inheritance of qualitative and quantitative traits that are very important for any type of breeding plan have been discussed. Selection criteria for broiler and layer birds including goals of breeding have been written. Various methods of selection have been discussed. This chapter provides basic knowledge of poultry breeding and selection for improvement of their performance.

Keywords: Poultry Breeding, Poultry Selection, Breeds of Poultry, Breeding and Mating Systems.

2.1 Introduction

It is believed that modern poultry birds are originated from the following four wild species of fowl viz. Red Jungle fowl *(Gallus gallus),* Java Jungle fowl *(G. varius),*

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Grey Jungle fowl *(G. sonneratti)* and Ceylon Jungle fowl *(G. lafayetti).* It is likely that out of four wild species Red Jungle fowl *(Gallus gallus)* is the main ancestor. Four species are closely related and are known to interbreed. Pakistan and off-shore islands of Indonesia are the ancestral home of the present day domestic fowl.

2.1.1 Origin, Domestication and Development of Fowl

Poultry birds were spread throughout Western Asia and to shores of Mediterranean by 600 B.C**.** They were common in Italy by 400 B.**C.** and were introduced into Northern Europe by 100 B.C. Chickens were imported into America and Australia by early European explorers and immigrants (Muir and Aggery 2003).

2.1.2 Domestication

Our ancient history bears witness to the fact that the people of India were quite familiar with poultry birds such as duck, quail and turkey about 3200 B.C. Chickens were domesticated afterwards. Chickens were kept for cock fighting and fancy purpose instead of meat and eggs. Quails were kept as a hobby and cocks as a fun. Archeological evidences exhibit that chicken domestication started in Pakistan.

2.2 Different Poultry Breeds and their Characteristics

There are four major classes of chicken found all over the world *viz.* American, English, Mediterranean and Asiatic. Characteristics which are shown in Table 2.1.

Table 2.1. Distinguished characteristics of poultry classes.

Characteristic	American	English	Mediterranean	Asiatic
Body size	Medium	Medium	Light	Heavy
Purpose	Dual	Dual	Egg	Meat
Shell colour	Brown	Brown	White	Brown
Ear lobe colour	Red	Red	White	Red
Skin colour	Yellow	White	Yellow	Yellow
Feathers on Shank	No	No	No	Yes

Source: Haq and Akhtar (2004).

2.2.1 American Class

2.2.1.1 Rhode Island Red (RIR)

Origin of Rhode Island Red (RIR) breed is Rhode Island, England. This breed is a cross of Leghorn and Asiatic native stock and red Malay Game. Birds of RIR good meat-producers because bird breast is well-forwarded. Plumage color is dark red or brownish red with glossy appearance. Sickle feathers, tail coverts as well as main tail feathers also appeared black. Female bird possessed a slight black marking in region of lower neck feathers. Brownish red is usual color of this breed but brown, white or buff are also common. Single comb and Rose comb are varieties of RIR

and single comb variety is more popular. They have yellow skin and shanks, red earlobe and lay brown eggs. Standard weight of cock and hen is 3.8 and 3.0 kg.

Table 2.2. Important breeds of each class.

American	English	Mediterranean	Asiatic
Rhode Island Red	Orpington	Leghorn	Brahma
Plymouth Rock	Dorking	Ancona	Cochin
New Hampshire	Cornish	Minorca	Langshan
Wyandotte	Australorp	Spanish	Desi
Jersey Giant	Red Cap	Blue Andalusian	Aseel
Delaware	Sussex	Butter Cups	

2.2.1.2 Plymouth Rock

Plymouth Rock is well-famous breed of America. These are dual purpose birds having long and deep body. Comb type of these birds is "Single Comb". Body weight of mature bird is ranging from 3.5 to 4.5 kg. Plymouth Rock possess 7 varieties named as Barred, Buff, White, Blue, Silver-penciled, Partridge and Columbian. Plumage is grayish white; each feather crossed by almost black bars which straight, uniform in width and should extend down to skin. All feathers end with a narrow and dark tip which, with alternate light and dark bars, gives a bluish appearance to surface color. Commonly, black spots are present on shanks, predominantly in females. Barred Plymouth Rock and White Plymouth Rocks are famous varieties. White Plymouth rock is extensively used for broiler production.

2.1.1.3 New Hampshire

Body shape of New Hampshire bird is comparatively less rectangular as compared to RIR. Birds has well-developed plumage of chestnut color. New Hampshire birds are single comb while color of main tail feathers is black, produce more brown shelled eggs. Standard weight of cock and hen is 3.8 and 2.7 kg, respectively.

2.2.2 Asiatic Class

2.2.2.1 Brahma

About one-hundred year ago, Brahma breed was developed by India and exported to England and America. Brahma belongs to Asiatic Class as given in Table 2.2. Birds appeared massive and body weight of mature bird ranges from 4.0 to 5.0 kg. Light, Dark and Buff are varieties of this breed. Light variety is more popular weighing about 509 g more as compared to other varieties. They have pea comb. They possessed black hackle feathers with white edges. Dark Brahma males have greenish black hackle with white edges. Color of tail feathers, wing feathers and plumage in front of neck is black. Female head and upper neck color is silver grey and wingbows are of steel grey color with black linings. Black primary wing feathers has steel grey edge and the back of birds is also of steel grey color with the similar type of penciling as appeared on the body, breast and fluff of the birds. Beak, shanks and toes color is yellow.

2.2.3 English Class

2.2.3.1 Sussex

About 200 years ago, this breed was developed in England. Birds have longer and deeper body with broad shoulders. Birds possessed excellent fleshing qualities. Cock and hen standard weight is 4.0 and 3.1 kg, respectively. Light Sussex and Red Sussex are two popular varieties of this breed. Light Sussex plumage is similar to that of Columbian Wyandot. Lay well in months of summer. Plumage of Red Sussex is dark red except primaries and secondaries. Primaries having black lower webs with red narrow edges while secondaries having black upper webs.

2.2.3.2 Australorp

Australorp was principally developed for egg production in Australia. This breed showed good fleshing qualities which makes it dual purpose breed. These birds have long back. Body is deeper and closely feathered. Birds are single comb type and color of body is black. Australorp male were crossed with female of WLH to develop a hybrid "Austro White". This hybrid showed excellent laying properties with good vigour. Standard weight of cock and hen is 2.8 and 3.0 kg, respectively.

2.2.3.3 Orpington

This breed was developed in England. Birds of this breed having long and deep body with broad breast. Feathers of birds are loose as compared to breeds of American class. These birds have single comb. Buff, white, black and blue are varieties of Orpington. Body weight of mature birds is 4.5 kg. Buff Orpington is most famous variety as compared to other varieties. It was evolved from Golden spangled Hamburgs, Dark Dorkings and Buff Cochin. Shanks and toes are white.

2.2.4 Mediterranean Class

2.2.4.1 Leghorn

Leghorn breed was originated in Italy and is most important Mediterranean class breed given in Table 2.2. Leghorn breed is well-known in whole world due to high egg production. There are twelve varieties of this breed but only three varieties gain popularity. Popular varieties include Singe Comb Buff, Single Comb White and Single Comb Light Brown. Leghorn breed is active and small breed with neatest appearance. Shape of comb is quite important to Leghorn fanciers. Single comb of male should be of medium size and should stand erect, with five uniform, deeply serrated points. Front point of female comb should stand erect, but remainder of comb should gradually slope tone side. White, Buff and Brown varieties are subdivided further based on comb character, i.e., it is rose or single comb. All varieties have yellow beaks, skin, shanks and toes. Today, White Leghorns are most popular breeds in world for egg production. Mature birds weigh 1.6-1.8 kg.

2.2.4.2 Minorca

Minorca is heaviest and largest breed of Mediterranean class. This breed was initially named as Red-Faced Black Spanish. Bird has long and strong body, comb is larger, wattles are long and the color of earlobes is white. They have black

colored beak, shanks and toes. Minorca is good producer of white shelled eggs of large size. Skin color is white. Mature cock and hen weight is 4.1 and 3.0 kg.

2.3 Commercial Strains of Broilers and Layers

Important commercial strains of broilers are Cobb, Ross, Hubbard, Arbor Acres, Lohmann, Starbro and Indian River. Important commercial strains of layers are LSL, Babcock, Nick-Chick, Hi Sex, Hy-line, Super-Nick and Bovans.

2.4 Rural Poultry

Rural poultry is also known as backyard poultry. Rural poultry performance can be enhanced by introduction of good quality exotic breeds and by intensive selection.


Rhode Island Red


Plymouth Rock

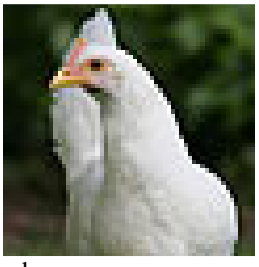

New Hampshire


Brahma


Sussex


Australorp


Orpington


Leghorn


Minorca

Fig. 2.1. Chicken breeds of various classes

2.5 Poultry Breeding Systems

Various mating systems are used in poultry breeding. Following is a brief description of procedures, advantages and disadvantages of each system.

2.5.1 Out Crossing

Mating birds of same variety but of different strains is called out crossing. Objective is to hold good traits already in one family line and to capture good ones form other ones or it may be an attempt to get rid of undesirable traits in one line and obtain only good ones from another line.

2.5.2 Grading up

This system involves mating of superior males with successive generations of breeding hens of same breed or variety. System continues until progenies produced approach quality of males used. To avoid disadvantages of inbreeding one cock should not be used for a number of times; however different cocks of same breed be selected. This method is of great importance for improving indigenous poultry.

2.5.3 Cross Breeding

Mating of pure bred males of a one breed with pure bred female of another breed is known as cross breeding. Cross breeding in chicken results in higher hatchability, fertility, faster weight gain, disease resistance and low mortality in chickens. Hybrid vigor by cross breeding is extensively used in broiler production.

2.5.4 Line Breeding

Line breeding is like inbreeding but involves breeding of birds less closely related. Mating of cousins or grand sire and granddaughters are examples of line breeding. It is chosen to conserve and perpetuate the good traits of certain outstanding birds. It tends to produce a homozygous genetic condition.

2.5.5 Inbreeding

It is mating of such closely related birds such as brother to sisters. Son to dam and sire to daughter. It is done primarily to intensify the degree of homozygosity. This practice has inconsistent results regarding different characteristics. Losses due to inbreeding includes, low fertility, stunted growth, poor disease resistance, appearance of deleterious genes phenotypically and low egg production.

2.5.6 Top Crossing

This system of breeding has been used successfully in livestock production and is finding in its place in poultry breeding. It involves mating of inbred males with females which are not inbred. Nickability of each line must be determined (Crawford 1990).

2.6 Inheritance of Qualitative and Quantitative Characters

2.6.1 Inheritance of Qualitative Characters

Qualitative traits have simple inheritance mechanism in which only one pair of genes is involved from which one is dominant over other, while some traits showed co-dominance also. Some important qualitative traits are egg shape, feather colour, comb type, egg shell colour, skin colour, ear lobe colour and eye colour.

2.6.2 Inheritance of Quantitative Characters

Traits such as egg production, egg size, growth rate and body confirmation are economically important and do not have simple inheritance as comb type or plumage color. These traits differ from individual to individual by almost imperceptible degrees over a wide range. There is essentially a continuous variation among individuals in population between the extremes. Traits that show this type of variation are known as quantitative traits. Often these characters are turned polygenic traits because many genes must affect the trait considered. These traits are of interest and such breeding systems be devised that will improve average flock performance in several quantitative characters at same time.

Some geneticists have attempted to measure potential improvement that can be made in quantitative characters by mathematical estimates of heritability of these traits. Heritability is defined as the proportion of variation observed in a quantitative trait that is cumulative effect of additive genes affecting that trait. To measure heritability, statistical analysis of genetic data is conducted to attempt to separate variation in a trait due to environment from that due to genetics. Presumably, a trait with high heritability could be improved rapidly by intensive selection, whereas less rapid improvement could be achieved by selection for traits with low heritability. Quantitative traits that seem to have relatively high heritability include body weight, feed consumption, egg weight, age at sexual maturity, egg shape, and shell colour. Lower heritability is reported for total egg production and feed efficiency. Traits with quite low heritability estimates include fertility and hatchability. However, despite an apparent low heritability, significant improvement may be made in many characters by selection techniques.

2.6.3 Heterosis

Performance of offsprings is improved than both parents when birds of different inbred lines, strains, or breeds are crossed is known as heterosis. This can be measured in both the sexes. Sometimes waiting for more records to come is beneficial as single record does not indicate individual real potential. But waiting too long would increase generation interval and reduce progress per unit of time (Bell and Weaver 2007).

2.7 Breeding for Meat and Egg Production

2.7.1 Breeding Plan for Broiler

Following breeds are mostly used for broiler production

2.7.1.1 Female Breed

a. New Hampshire

Females of this breed are used for broiler production due to high egg production with good hatchability, meat quality, rapid growth, fast feathering, early maturity and vigour. Females cross with males of another meat type variety to produce crossbred broiler chicks.

b. White Plymouth Rock

Females of this breed are used for the commercial broiler production. They are good layers. White feathering is beneficial for commercial processing.

c. Qualities of Female Line

Meat line female breeds must have good egg production with high hatchability. In addition, it must have good weight gain, best feed conversion ratio and best feed efficiency.

2.7.1.2 Male Breeds

a. White Cornish

They have short legs, broad body and wide muscular breast but these birds lay few eggs with poor hatchability

b. Light Sussex

This is a meat type breed with white skin. Male birds of this breed have more body weight gain, breast is wide and muscular. Breeding males are white skin broilers.

c. Qualities of Male Line

Male lines must have more weight gain, best-feed conversion ratio, with broad wide breast and muscular appearance. In addition to these characters it must be good producer with good hatchability. Light Cornish or dark Cornish are used for the meat line. Such varieties give the synthetic line having a broad breast, short legs and a plump carcass. White feather meat line is preferred because of easy processing in the commercial plants. Yellow and white skin colour if white skin is preferred then Sussex male line is crossed with New Hampshire which has white skin and white skin is dominant to yellow skin.

2.7.2 Goals of Breeding Policy

Selection should be based in highly heritable traits. Selection must be on the base of family record instead of individual base. Heterozygous individuals are culled.

2.7.3 Present Day Egg Production Lines

Egg production lines are used to produce egg type pullets to produce commercial eggs. Today all commercial White Leghorn lines of chickens are single comb. While Leghorn lines details are as under;

2.7.3.1 Single Line

Breeders use close flock mating and birds are selected from each generation. Select birds after egg production record of one year and may consider following characters as body weight, growth rate, growing liveability. Pullet quality, age at sexual maturity, egg weight, egg production, egg shell quality, interior quality of eggs and adult liveability.

2.7.3.2 Two Line Cross

Two-line cross increase heterosis i.e., male is selected for livability, large body size and female is selected for egg production, shell quality and interior quality of egg. Their off springs will show good livability, large body size, high egg production, good shell and interior quality.

2.7.3.3 Three Line Cross

Three lines are developed each with different qualities. Line 1 is crossed with line 2 and then their offspring's will be crossed with line 3.

2.7.3.4 Four Line Cross

Line 1 is crossed with line 2 and line 3 is crossed with line 4 then males from 1st cross and females from 2nd cross are mated to produce commercial pullets.

2.8 Selection and its Types

2.8.1 Selection

Selection may be defined as a force or process by which certain individuals in a population are preferred over other to produce next generation. This is an important tool for changing the genotype of a flock, herd or population. Selection is practiced at many stages in the life of the birds. Some birds are not allowed to be born. Culling may take place at any stage from birth till individual reaches the breeding age. Others are kept for several seasons but are culled long before reaching the old age. Still others are kept if they can produce any offspring. Stage at which selection can be practiced depends upon economic factors and convenience as well as when information needed for making choice becomes available. Selecting as early as possible and' selecting after having collected enough information may thus be a trade for improved genetic gain.

2.8.2 Types of Selection

2.8.2.1 Mass Selection

Mass selection is based on individuals own phenotype, on single or multiple records. It is an easy way of selection. Birds are ranked in descending order based on their performance and some of the birds that rank lowest are culled from breeding stock. This is used in selection for traits which are highly transmissible, e.g. growth rate. Yet limitations include trait to have a high genetic control and can be measured in both the sexes. Sometimes waiting for more records to come is beneficial as single record does not indicate real potential of individual. Too long waiting will increase generation interval and reduces progress per unit of time.

2.8.2.2 Family Selection

a) Pedigree Selection

Selection of poultry birds based on performance of their ancestors is called pedigree selection. It is likely to be used when individuals are young and have not yet expressed their own performance. But even if the animal has recorded performance, information on parents and other ancestors can help to improve our "confidence of selecting or rejecting them. It can also be used in case of traits not expressed in one sex only. Sometimes pedigrees are not available or performance of ancestors was not recorded or people are carried away with performance of some admired ancestors while sampling nature of genes limits our ability to exactly know which genes were transmitted to offspring.

b) Progeny Testing

It is used in selection of males especially when records cannot be collected on them for sex-limited traits such as egg production. A cock or cocks may for example be tested are mated each to a random group of hens and their progeny is raised till it expresses its performance that is egg production. As semen storage techniques allow semen to be preserved for number of months, semen from candidate cock is stored and used after the results are available after few months when sufficient pullets have been recorded. However, waiting too long may increase the generation interval, which is one of the major limitations of this method. Recording pullets would require an infrastructure and computation facilities for recorded information.

c) Selection on the Basis of Collateral Relatives

Individual’s selection on basis of information of other family members (other than offspring's and ancestors) may be done on same lines as the pedigree selection. Necessary precaution is not to over emphasize distant relatives. Nowadays all the sources of information are being used for estimating breeding values (genetic worth) of individuals and selecting them to be future parents. Computers made it easier to store large information and process it at a very fast rate.

2.9 Selection of Poultry for Eggs and Meat Production

There are many breeds and varieties of chicken. Many of them are of historical interest and are reared by farmers for recreation. Some are maintained by Government Research Station so that these breeds may be available to breeders if need arises. Others are kept by breeder to produce new commercial hybrid varieties. Certain of these hybrids are egg producers while others are meat and eggs. Farmer should purchase hybrids renowned for good performance.

2.9.1 Selection of Poultry for Eggs

Commercial hybrid layers should have better egg production, bigger egg size, better egg quality, early maturity, low rate of mortality and efficient feed conversion ratio for eggs.

2.9.2 Selection of Poultry for Meat

Commercial hybrid broilers should have better body confirmation, feed conversion ratio, growth rate, disease resistance and low mortality.

2.10 Mating Systems

Number of females to be mated to each male varies depending upon breed, age, health and sexual activity of male. In general, males of light breeds like Leghorns are more active and vigorous than males of heavier breeds such as White Plymouth Rock and Rhode Island Reds. Older males are usually capable of caring for fewer females than cockerels.

2.10.1 Pen Mating

This is a usual method of mating used for pedigree hatching wherein a group of hens can mate with a cock in a pen. Male to female ratio is 1:10 or 12 for light breeds and 1:8 or 10 for heavy breeds. In comparison to flock mating, fertility is lower in pen mating which is due to preferential mating i.e. male may mate more frequently with certain females than with others. Preference for mating is generally attributed to plumage colour etc. Mating pens size is usually 8 feet × 6 feet.

2.10.2 Flock Mating

It is a mass mating system wherein two or more males are mated with several females housed in a single pen. Male to female ratio is generally higher in this method i.e. one male for 12 to 15 females of light breeds and 10 to 12 females of heavy breeds. From pedigree hatching point of view, eggs cannot be identified for their parentage. Under this system, sometimes the aggressive males scare away other males preventing them from mating. Such aggressive males should be removed from the flock. This method also provides an opportunity for birds to mate

with males of their choice whereas there is no such choice in stud or pen mating. Fertility is generally high in this method therefore, more desirable for producing chicks meant for commercial purpose.

2.10.3 Stud Mating

In stud mating the male is kept separately in a coop or pen (2 feet ×3 feet) and females are picked up from the pen one by one and put into the coop. After mating, female is replaced by another female and so on. In comparison to flock or pen mating it involves more work and labor but this method has advantage that more offspring can be obtained from a sire of high merit. On the other hand, by this method it is possible to mate one male to many females. To ensure good fertility the hen should be stud mated at least once a week. This method results in higher fertility as compared to flock or pen mating. This method of mating can also be employed if birds are kept in cages.

2.10.4 Shift Mating

It is type of mating wherein sires are shifted in breeding pens. This method can be employed in breeding programs (family breeding) where breeding value of more number of males needs to be tested for locating superior males. At the same time by shifting male, a female can be mated with several males and her breeding worth can be evaluated more precisely. Major hindrance in shifting of males in a breeding pen during season is problem of accuracy of parentage of progeny since fertility is maintained for 2-3 weeks even after removing cock. This difficulty may be overcome by discarding eggs for one week after change of males. Main advantage of this system is that many males can be tested in a limited space. Pen mating does not differ from this system except males are shifted from one pen to another in a sequence.

Suppose 30 males are to be tested with a facility of 10 breeding pens. A group of females are housed in each pen. Put 10 males in pens on first March of a year. Collect eggs from 7/3 to 21/3 and set in incubator. Remove first set of males from pen on 15/3 and put second set of males(11 to 20) on 21/3 in pen and start collecting eggs from 28/3 to 11/4. Remove second set of males on5/4 and put third set of males (21-30) on 11/4.Start collecting eggs from 18/4 onwards. In the same manner, another set of males may be shifted. Gap between two sets of males will be of 2 weeks which insufficient. It has been observed that in presence of fresh spermatozoa old ones get inactivated. A minimum of four shifts would be required to obtain enough data for evaluating females. This type of mating generally used under di allele crossing.

3.10.5 Artificial Insemination (A.I.)

In this procedure semen is collected from males and females are inseminated. Major use of A.I. is in heavy birds whose fertility is generally low under pen mating. Nowadays, A.I. is being practiced on many broiler breeder farms with very good hatchability. However, it is also practiced when layer breeder is kept in cages.

Fertility can be increased by adopting A. I. as well as service of a valuable male can be extended. Practice of A.I. requires some training on the part of both operator and male. Method consists of two operations stimulating male to ejaculate semen and averting female cloaca.

3.10.5.1 Collection of Semen

Hold male in left hand, head extending under the arm. Massage with right hand the soft sides of its abdomen between gizzard and pelvic bones to stimulate ejaculatory organ. Fingers of right hand are outspread at the start of stroke but brought together at the end of strokes to converge on the vent. Stroking of male's back should be done moving hand in direction of bird's vent only. Such a stimulus causes trained male to avert or protrude vent region. When this occurs a quick motion of strokes will cause male to ejaculate. Squeezing pressure is applied by thumb and index finger inward and downward at a point just above die vent. Semen is collected by an assistant in an A.I. funnel by holding it under vent.

3.10.5.2 Precautions While Collecting the Semen

Males should be separated from females at least one week before an attempt is made to collect semen. Feathers around male's vent should be plucked off to obtain semen easily. Collection of semen may be carried out daily depending upon the need. However, thrice a week collection will give maximum number of spermatozoa over a long period. Semen contaminated with foreign material like urine and faeces should not be used.

Normally one should use fresh semen and keep it warm at body temperature and use it within an hour. Depending upon the concentration of spermatozoa it can be diluted in normal saline. It has been reported that 20 million spermatozoa per insemination (weekly) are required to get optimum fertility. Diluents for short term and long term storage of bird semen are available.

3.10.5.3 Quality of Semen

Semen has a milky thick appearance. Mixture of urine changes colour of semen to yellow. Normal pH range for semen is 7.3 to 7.8. Volume of semen varies between 0.40 to 1.80 cc depending upon breed.

3.10.5.4 Insemination

Pullet is held in left hand by an assistant head down with its back resting against person's chest in such a manner that feathers below vent can be pressed downward. At the same time the bird's abdomen is compressed gently but firmly with right hand. Thus, cloaca becomes averted. Pressure is applied to abdomen to a degree that vent region is forced to avert exposing opening of cloaca into vagina. Opening of vagina is at left side of vent. This compression will also aid in evacuation of faeces present in cloaca. When aversion is accomplished insemination instrument (Hypodermic syringe 1 cc capacity) is inserted about an inch into vaginal opening before applying pressure to eject semen. About 0.02 (1 drop) to 0.05 cc (2 drops) of semen is sufficient. Inseminate female once a week. One cock provides semen to inseminate 30 hens/week (Leeson and Summers 2000).

2.11 Fancy Breeds and their Importance

There are many fancy breeds; some most important fancy breeds in chicken are Black Minorca, White Bantam, Aseel, Buff Orpington and Cochin. Fancy birds are kept for show purpose/entertainment and have economic importance.

Conclusion

Commercial and rural poultry are raised having peculiar characteristics. Commercial strains of poultry selected on the basis of more egg and meat production. Breeds having good potential are selected for production of next generations. Such breeding and selection procedures are required which ensure good potential from future flocks.

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Chapter 3

Incubation Principles and Hatchery Management

Ahsan-ul-Haq and Awais Ihsan[†]

Abstract

More number of hatching eggs from breeder flocks requires precise technical input for production of quality chicks. Good sanitary conditions are required in hatchery. Incubators with recent advanced technologies provide precise incubations requirements resulting in more number of quality chicks. In this chapter, egg development and incubation process is described. Factors affecting fertility, hatchability and incubation requirements are discussed. Collection, selection, candling, setting, transfer candling, shifting of eggs, hatching and hatchery services have also been discussed. Hatchery building design, incubation methods, types and handling of incubator are given. Major problems in hatchery and their remedies are also discussed. Taking off hatch and hatch processing have been discussed.

Keywords: Incubation, Hatchery Design, Types and Handling of Incubators, Incubation Requirements, Hatchery Trouble Shooting.

3.1 Introduction

Incubation is a process in which a microscopic germ cell is being transformed into a chick, capable of walking, feeding and drinking. Incubation period (days) of different poultry birds are shown in Table 3.1. Different species of birds have different incubation period e.g., chicken egg hatch in 21 days, whereas

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eggs of quails, ducks, pheasants have 17, 28-30 and 28 days incubation period, respectively. During this period, suitable conditions are provided to the hatching eggs for best hatching results. Incubation is of two types, namely, natural incubation and artificial incubation. Natural incubation is commonly used for backyard poultry keeping in villages in most of the tropical countries of world. In this method, eggs are incubated with the help of broody hens. Most important thing in this method is the selection of a broody hen. It should be of medium body size to accommodate fair number of eggs and should be a good-sitter, quiet and free from ectoparasites. A nest bedded with clean, dry and comfortable litter is prepared for this purpose. Nest is usually placed in a dark area of the house with minimum disturbance. During incubation, hen should not be disturbed. Hens should be taken out at least twice a day for about 30 minutes for feeding and watering. The hen should be well taken care of and protected from predators. Depending on size of hen, 10-15 eggs can be placed under one bird. The best time of set hen is at a night as now she is more likely to settle down to her job. Besides, when eggs are put under the hens at night, the chicken are more likely to appear on the night of 21st day and will have whole night to rest and gain strength. In Artificial incubation, requirements of incubation are fulfilled by a machine called incubator. This method uses high modern and sophisticated technology with automation for maximum hatchability. This method of incubation has many advantages over natural incubation which includes possibility to set large number of eggs at a time, throughout the year with less risk of disease transfer. Incubation requirements are provided with their optimum levels to get maximum hatchability and minimum chances of infections. Automation of incubators saves time and labour.

Table 3.1. Incubation period of different poultry birds.

Poultry birds	Incubation period (days)
Chicken	21
Duck	28
Turkey	28
Pigeon	17-19
Peafowl	27
Quail	17
Geese	28-35
Pheasant	23-37
Falcon	28
Ostrich	42

Source: Haq and Akhtar (2004)

3.2 Development of Egg

3.2.1 Female Reproductive System

Female reproductive system consists of ovary and oviduct as given in Figure 3.1.

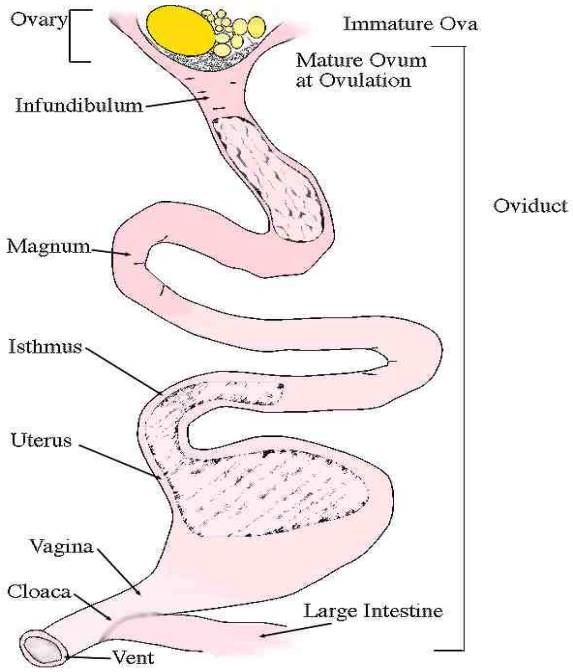


Fig. 3.1. Female Reproductive System of Chicken
Source: Haq and Akhtar (2004)

3.2.2 Ovary

Female chick has two ovaries. Left ovary in adult birds is functional while right ovary atrophies. An ovum from left ovary is received by infundibulum. Each ovum contains germinal disc where fertilization takes place.

3.2.3 Oviduct

Female chick has two oviducts. Left oviduct in adult birds is functional while right oviduct atrophies Oviduct is a coiled tube that extends to cloaca. Oviduct has following five distinct parts.

3.2.3.1 Funnel of Infundibulum

It is funnel shaped anterior portion, which receives ovum or yolk immediately after release. Infundibulum length is 9 cm which receives ovum from ovary. Ovum remains here for 15 minutes before moving to magnum.

3.2.3.2 Magnum

Largest portion of oviduct is magnum which is 33 cm long. It secretes thick albumen and developing egg spends about three hours in magnum.

3.2.3.3 Isthmus

Developing egg stay in isthmus is for about 74 minutes. It is 10 cm long in laying birds as given in Table 3.2. Isthmus secretes shell membranes.

3.2.3.4 Uterus

Uterus or shell gland secretes outer thin albumen and eggshell. It is 10-12 cm long in laying birds. Developing egg stays here for 19.5 to 20.0 hours as given in Table 3.2.

3.2.3.5 Vagina

It is terminal portion of oviduct and 12 cm long in adult hen. It holds egg until laid (Austic and Nesheim 1990).

Table 3.2. Oviduct parts and their functions

Parts	Length	Egg stay time	Function
Infundibulum	8- 10 cm	15-20 min.	Fertilization
Magnum	30-40 cm	3-4 hr.	Albumen secretion
Isthmus	10 cm	1-1.5 hr.	Shell membrane formation
Shell gland (Uterus)	10 cm	19.5-20 hr.	Shell formation
Vagina	6-7 cm	15 min.	Hold egg before it is laid

Source: Haq and Akhtar (2004)

3.2.4 Ovulation

Follicle stimulating hormone is produced by anterior pituitary which in turn causes ovarian follicles to increase in size eleven days before the first egg is laid. Ovary starts generating estrogen, progesterone and testosterone hormones. Progesterone induces hypothalamus to release Luteinizing hormone (LH) from anterior pituitary. LH causes release of ovum from ovary which is received by the infundibulum.

3.2.5 Pre-Laying Development

After fertilization in infundibulum ova transfer to magnum where it prepares itself for cell division. In isthmus cell divide itself into 8 cells. In shell gland cells divide up to 256 cells up to entrance to vagina. Cells arrange themselves into a single layer called blastodisc. Due to continuous cell division, further layers formed beneath blastodisc called as blastoderm stage. Centrally located cells of blastoderm form a cavity called Blastocele. Transparent detached area of yolk is called area pellucida while opaque and contact area of yolk is called area opaca. Blastoderm develop into two layers by gastrulation process which involves segregation of cells to form an inner layer Endoderm (Hypoblast) and a surface layer Ectoderm (Epiblast) (Bell and Weaver 2007).

3.2.6 Post-Laying Development

Mesoderm layer of cells develop in the center of Ectoderm and endoderm. During first 24 hours of incubation a distinct line called primitive streak develop by

thickening of ectoderm. A longitudinal groove "primitive groove" appears on primitive streak, which develop into Central Nervous System or spinal cord.

Ectoderm develops to nervous system, eyes, feathers, beak, claws, skin, mouth lining and vent. Endoderm gives rise to the respiratory, secretary and digestive systems. Mesoderm gives rise to bones, muscles, blood circulatory, reproductive and excretory systems (Bell and Weaver 2007).

3.2.6.1 Extra Embryonic Membranes

These are four in number and supply nutrients to developing embryo.

3.2.6.2 Yolk Sac

It comprises of mesoderm over a layer of endoderm, richly supplied with blood vessels, connected to vitelline membrane for provision of nutrients of yolk (48% water and 3.1% fat) to embryo. It secretes enzyme for yolk solubilization as nutrient.

3.2.6.3 Amnion

Transparent and non-vascular membrane, containing amniotic fluid, formed (2^{nd} or 3^{rd} day of incubation) around embryo tending to enter yolk. Fluid bath embryo, protecting it from dehydration, mechanical shock, temperature stress.

3.2.6.4 Chorion

Chorion with outer layer of ectoderm and inner layer of mesoderm surrounding extra embryonic sac fuses to the inner shell membrane of the egg. It helps later in completing its metabolic function.

3.2.6.5 Allantois

Allantois made up of endoderm, occupies space between amnion and chorion, having direct contact with shell membrane through capillaries, it serves as an embryonic respirators surface, deposits excretion of embryonic kidney, aid in albumen digestion as a nutrient and absorb Ca of shell for embryo structural needs.

3.2.6.6 Physical Act of Hatching

Spasmodic contraction of the chick causes reflection in muscles of back and neck. This reflection results in jerky movement of head in forward direction, which eventually contacts allantois and rupture it entering to air space. Air cell has air mixture containing 9% CO_2 and 9% O_2, which stimulates chick to break the shell at one point by striking shell with beak a process called pipping.

3.2.6.7 Mal-Positions of the Embryo

Right position of embryo before hatching is head towards right, beak under right wing and beak towards air cell/broader end. Malpositions are head towards smaller end, head between thighs, head under left wing, body rotated from its normal position, feet over the head, head over wing and body across the egg.

3.2.6.8 Critical Periods in the Life of the Embryo

There are mainly two most important critical periods, first is 42 hours of incubation (Heart begins to beat) and second at 20th day (Pulmonary respiration begins and lungs become fully functional).

3.2.6.9 Causes of Developing Embryo Mortality

First week =Cause is improper storage and infertility.

10-12 days=Nutritional deficiency in the breeder flock diet.

19-21 days = Improper temperature, humidity and ventilation of incubator.

There are four critical periods.

a. Period-1 (Pre-ovipositional Mortality)

When eggs are held under the hen too long or egg laid earlier cause embryo mortality. This factor either advances the embryonic development too far than the gastrula stage or either gastrulation has not been completed.

Large eggs take longer time than small eggs. Eggs with thick shells take longer time than those with thin shells. Eggs of poorer producer require longer period in the oviduct. Certain respiratory diseases cause eggs to be laid early. During period-I mortality is 0.6 percent as given in Table 3.3.

b. Period-II (3-5 days of Incubation. Early Dead Embryos)

During this period, there are two main reasons of death.

At 24 hours of the incubation primary blood vessel system develops. If not develop, it causes death on 3rd day of incubation. Second cause of death is non-adjustment of utilization of feed from simple carbohydrates to complex protein and fats, at the fourth day of incubation. There is excessive accumulation of CO_2, NH_3 and acetic acid in blood circulation leading to death of embryo.

Main reason of mortality is poor hygienic, storage conditions of eggs before setting, high incubator temperature and insufficient turning of eggs. Mortality -during this period may become higher up to 25 percent.

c. Period-III (10-14 days Mortality. Middle Period)

During this period mortality may be up to 50 percent. Main reason is deficiency of nutrients such as Riboflavin in breeder diet. Deficiency results in clubbed down, generalized oedema of the embryo, curled toes, crooked keel and beak, blood clots.

d. Period-IV (19-21 days Mortality, Late Period)

Main reasons of high mortality during this period are:

Early weakening of embryos, incorrect temperature, humidity and ventilation, of incubator. Rough and careless handling of the eggs during transfer from setter to hatchery (Jadhave and Saddiqui 2007).

Table 3.3. Mortality rate during critical stages of chick development.

Critical Stage	Mortality (%)
Period I	0.6
Period II	2.0
Period III	0.6
Period IV	3.0
Infertile	5.0
Pips	0.8
Total	12.0

Source: Haq and Akhtar (2004)

3.3 Collection and Cleaning of Hatching Eggs

Provide one egg nest for 4 or 5 hens. Number of nests should be increased during high temperature. Nest should be placed at dark area up to the height of tail of the bird. Nesting material should be dry and in good condition. Provide proper ventilation to the nests. Hatching eggs should be collected at least 6-8 times/days. Culled eggs should be separated during collection. Washing of hatching eggs may introduce microorganisms into egg and is not a good practice and excessively dirty eggs should be culled. Slightly soiled eggs are cleaned with a blade/sand paper.

3.3.1 Selection of Hatching Eggs

Hatching eggs should be of medium size i.e. 54-64 g average weight 57 g. Eggs should be oval shape. Eggs shell should be smooth and strong with 0.33-0.35 mm shell thickness. Eggs should be clean without cracks. Position of yolk should be in center without blood or meat spots.

3.3.2 Storage of Hatching Eggs

For one-week storage of hatching eggs temperature should be 59-60°F for longer storage temperature should be 50-55 °F. Relative humidity should be 55%. During storage, broader end of hatching eggs should be in upward direction.

3.3.3 Fumigation

It is a process in which through chemical reaction formaldehyde gas is evolved to kill harmful germs in an incubator, hatchery or farm. $KMnO_4$ and formalin are used for fumigation. For every 100 cubic feet volume, 17.5 g $KMnO_4$ and 35 ml formalin (40%) is used. This is called single strength (1X concentration). For different purposes concentration, can be increased up to 5X as shown in Table 3.4.

3.3.3.1 Method

Add 17.5 g $KMnO_4$ in an earthen pot in air tight fumigation chamber then add formalin and close door for 20-30 minutes preferably at 55 °F temperature.

Table 3.4. Formaldehyde fumigation concentration recommendations.

	Fumigation	Concentration	Time (min.)
i.	Hatching eggs after laying	3x	20
ii.	Eggs in setter (1st day)	2x	20
iii.	Chicks in hatchers	1x	30
iv.	Incubator room	1x, 2x	30
v.	Hatchery between hatches	3x	30
vi.	Hatchery room, chick room between hatches	3x	30
vii.	Wash room	3x	30
viii.	Chick boxes, pads	3x	30
ix.	Trucks	5x	20

Source: Haq and Akhtar (2004)

3.4 Hatchery Design

A modern hatchery can be divided in two major parts namely administrative side and works side. Administrative side consists of offices where records and correspondence is done here. It consists of inquiry office, switchboard room, a waiting room and working rooms for different offices. Works side comprises all rooms set aside for receiving and eggs setting, pre-fumigation of eggs, setters and hatchers, sexing, packing and dispatch of chicks, washing and sterilizing, stores, boiler house, workshops and garage. Rooms should be in orderly sequence to ensure minimum internal travel and crossing of lines of movement within hatchery.

3.5 Incubation Methods

Process of change of fertilized egg to a living organism capable of walking and eating is called incubation. Incubation is done by natural and artificial methods.

3.5.1 Natural Incubation

Natural incubation is a process of setting hatching eggs under the hen. Natural incubation is better on small scale for house hold purposes. A medium sized broody hen is required characterized by ruffled and loose feathers from under hen's wings and legs. It should be properly checked for parasites and to kill external parasites Neguvan can be effectively used. Deworming should be done to kill internal parasites. 12-15 eggs can be set under a broody hen. Dimension of broody nest should be (14" × 14" with 16" height) about 4" high from ground. Nest should be lined with clean nesting material and dusted with insecticide powder. Floor of nest should be saucer shape to prevent rolling out of eggs. Every day hen should be taken off the nest for exercise and feeding for 10-20 minutes at the same time. Eggs should be tested on 9th and 16th days and all dead in shell should be removed. As soon as hatch is off, unhatched eggs and nesting material should be removed. Nest should be dusted before adding new litter in it.

3.5.2 Artificial Incubation

All the necessary requirements of incubation are provided artificially through the help of machine called incubator and process is known as artificial incubation.

3.6 Types of Incubators

There are two types of artificial incubators i.e., small and large incubators.

3.6.1 Small Incubators

Small incubators are flat type incubators (these incubators are heated with oil) and electrically heated incubators (heat source is electricity).

These incubators are used for production of chicks on small scale. 50-500 eggs can be set in only single layer. Position of the eggs is flat. Ventilation is provided through natural means i.e. holes are provided for ventilation. Ventilation is affected by changes of internal temperature. Eggs are turned manually and individually. 3-5 turnings are required per day. Incubation temperature is as given in Table 3.5.

Table 3.5. Incubation temperature of small incubators.

Incubation time (days)	Incubation temperature (°F)
1-7	102.5 - 103.0
8-18	102.0
1-21	101.0

Source: Haq and Akhtar (2004)

3.6.2 Large Incubators

These are mammoth/cabinet/forced draft incubators and walk-in incubators. These incubators are used by commercial chick hatcheries for production of chicks on large scale. Their capacity ranges from 10,000 to 138,000. Incubator has two parts: setter and hatcher. Setter and hatcher may be separate or combined in an incubator.

3.6.2.1 Setter

This is part of incubator where fertile eggs set for 1-18 days. It has multiple trays for setting of eggs. Eggs are set with broader end up and pointed end down. These eggs turned automatically after each hour. Ventilation is provided through ventilators. Heat source is electricity and uniform temperature is provided with the help of fans and paddles. Temperature is maintained at 99.5°F in setter.

3.6.2.2 Hatcher

Eggs remain in hatcher for 19-21 days. Eggs should not be turned during this period. Its capacity is one third than setter. Temperature of hatcher is 98.5°F.

3.7 Requirements of Incubation

3.7.1 Temperature

Temperature of setter should be 99.5°F for first 18 days. As incubation proceeds ahead heat production of embryo increases, so during 19-21 days temperature of hatcher should be reduced to 98.5°F. Higher temperature results in small or weak chicks with unhealed navels, cross beaks, stubby down, stargazer, missing eyes and brain hernia. Lower temperature results in delayed incubation and sticky chicks.

3.7.2 Relative Humidity

Relative humidity is percentage of moisture relative with water content in the air. In setter, relative humidity is 83-85% (wet bulb reading) which increases in the hatcher. High relative humidity results in less evaporation of water from egg, hatching delayed and soft abdomen chicks. Lower relative humidity causes excessive loss of water from egg resulting in early hatching and dehydrated chicks.

3.7.3 Ventilation

Ventilation is incoming of fresh air and removal of foul gases. Embryo being living creature need oxygen for respiration and excretes carbon dioxide. Provide proper ventilation in incubator. CO_2 should be 0.03% above 0.5% CO_2 causes slight decrease in hatchability, 2% CO_2 causes marked decrease and at 5% CO_2 hatchability is zero.

3.7.4 Altitude

As altitude increases, hatchability decreases. At 2500 feet altitude from sea level hatchability is 85% (normal). Hatchability reduces to 74% at 3950 feet while at 7160 feet. altitude hatchability is 64%. Recommended level for attaining maximum hatchability should not be more than 2500 feet. from sea level.

3.7.5 Position of the Eggs

Broader end of eggs should be upward for establishment of pulmonary respiration of chicks into air sac of the egg. If pointed end of the egg is upward, it causes 50% dead in shells, due to difficulty of establishment of pulmonary respiration.

3.7.6 Turning of the Egg

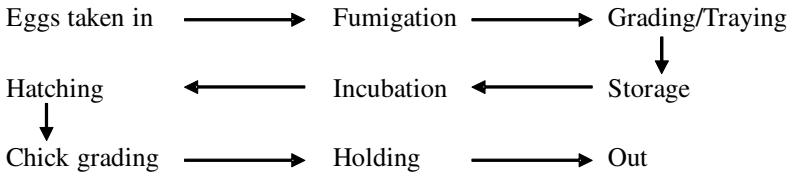
Turning should be done in opposite directions up to 40-45° to each side after each hour. Turning of the egg avoid sticking of embryo to the egg shell membranes and it provide uniform temperature to all sides of the egg in incubator.

3.7.7 Candling

Eggs are candled at completion of 18 days in the setter. Purpose of candling is to remove infertile eggs and dead embryos.

3.7.8 Design of Hatchery

There should be one way flow in hatchery so that hatching eggs may be taken at one end and chicks removed from other end. There should be no back tracking to reduce the risk of disease transmission.



3.8 Factors Affecting Hatchability

Factors affecting hatchability are feed, egg size, eggshell thickness, male to female ration, spiking, egg storage temperature, ventilation, setting eggs, turning, fumigation, hatchery hygiene and eggs from disease free flock. If embryonic mortality is very high continuously during hatching, then send chicks to veterinary pathology laboratory for proper diagnosis.

3.9 Hatchery Trouble Shooting

3.9.1 Too Many Clear or Infertile Eggs

Wrong proportion of males to females (check mating ratios according to breeder recommendation). Males undernourished (see that the cocks can get feed separately, otherwise they may allow the hens to eat all that is there). Interference among the males during mating (do not use too many males: always rear breeding males together: put up temporary solid partitions between breeding pens or inside large pens). Damaged combs and wattles among the males (see that housing is comfortable and that proper drinking fountains are provided for the breeding pens). Males too old (replace elder/aged males with young cock). Sterility in male or preferential mating in pen mating (replace another male). Eggs kept too long or under wrong conditions before setting (do not keep hatching eggs longer than 10 days: store them in cool, 50° to 60°F and at a RH around 75-80%).

3.9.2 Blood Rings: Which Indicate Very Early Embryonic Death

Incubator temperature too high or too low (check thermometer, thermostats and current supply. Follow the incubator maker's instructions). Incorrect fumigation procedure (ensure correct amount of fumigants. Do not fumigate between 24th and

96th hours after setting and keep eggs too long or under wrong storage conditions before setting.

3.9.3 Dead in Shell

Dead in shell are due to too high or too low incubator temperature (check thermometer, thermostats and current supply), eggs not properly turned (turn eggs regularly at least 3-5 times a day: always turn eggs in reverse direction each time, never in same direction) and faulty nutrition of breeding stock. If death losses are heavy in 10th-14th day (pay attention to farms, from where the eggs are collected: check that no deficiency in feed). Faulty ventilation of incubator (increase ventilation by normal means: additional O_2 is not needed at altitudes below 5000 ft. above sea level). Pullorum disease or other infectious disease (use eggs from disease free stock and assure sound hatchery hygiene).

3.9.4 Pipped Eggs Failing to Hatch

Insufficient moisture in incubator. Too much moisture at earlier stages (check wet bulb readings). Nutrition problem (check flock feeding).

3.9.5 Hatching Too Soon/ Hatching Too Late/Sticky Chicks

Incubator temperature too high or Incubator temperature too low.

3.9.6 Malformed Chicks

Incubator temperature too high or too low (check thermometer thermostats and current supply. Follow the maker's instructions). Eggs set incorrectly or not properly turned after setting (turn eggs regularly at least 3-5 times / day: always turn eggs in reverse direction each time and never in same direction.

There may be spreading chicks due to too smooth trays in hatchery and weak chicks due to overheating of incubator. Small chicks are hatched due to setting of small eggs (only set eggs of recommended sizes) and too little moisture in incubator. Heavy breathing chicks are produced due to too much fumigant left in hatcher and too much moisture in hatcher (maintain proper relative humidity). Low average temperature and poor ventilation during incubation (check thermostat) results in Mushy Chick disease. Disease is also known as Omphalitis or Yolksac infection. Uneven hatch is the result of setting eggs too diverse in age (set eggs at least once a week and never store hatching eggs longer than 10 days).

3.9 Taking off Hatch

Chicks need 21 days and 5 hours to be taken out from hatcher. Chicks are wet and exhausted, when they hatch out so, they need 4-5 hours for drying. Hatch should be taken out when more than 95% chicks are dry. Set eggs in incubator in such a way that hatch during taking off can be arranged in such a way that vaccination, dubbing or detoeing can be done in day time. Room temperature for keeping chicks

should not be less than 75°F. Room should be properly ventilated, so that chicks can breathe easily.

Conclusion

More number of hatching eggs from breeder flocks requires precise technical input for production of quality chicks. Good sanitary conditions are required in hatchery. Incubators with recent advanced technologies provide precise incubations requirements resulting in more number of quality chicks.

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Chapter 4

Poultry Housing and Equipment

Fawwad Ahmad and Muhammad Yousaf[†]

Abstract

Basic functions of housing are facilitation in managemental practices (bio-security, feeding, watering, stocking density, predator protection and weather protection) and provision of physical environment (temperature, humidity, ventilation and lighting) which are responsible for optimum production performance of poultry birds. For efficient production performance, housing systems like free range, semi intensive and intensive have been used for rearing poultry birds. However, intensive system is found most efficient one. Two main types of intensive housing system are open sided and environment controlled houses. These poultry houses are further classified into deep litter system, all slat system, slat and litter house, wire system, slat and wire system, deep-pit system and cage system. Cage system is mostly used for layer birds; various types of cages include reverse cages (Stair-step), flat deck cages and combi-cage system. Environment controlled poultry housing system is the most efficient type of housing, because in this system all the environmental factors are provided by artificial means and their range is precisely controlled according to requirements of poultry birds. Bird's requirements in terms of environment based upon its type, age, weight, feed and production status. Protection of birds from extremes of climate and precise control of environment is only possible in environment controlled housing system. For construction of such houses, selection of site and selection of appropriate equipments are also important. Site should be selected keeping in view availability of transportation, labor, electricity and water. Whereas, equipments selection according to performance, durability and economics.

Keywords: Poultry Housing, Housing systems, Open Sided Houses, Environment controlled Houses, House location, Construction, Insulation, Light, Gas, Water,

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Heating systems, Cooling systems, Ventilation system, Brooding, Rearing, Laying, Equipments, Economics.

4.1 Introduction

In poultry business capital investment is needed for housing poultry birds. It plays an important role for successful poultry farming. Two basic function of housing are facilitation in managemental practices and provision of physical environment (Austic and Nesheim 1990). Both factors are responsible for the optimum production performance of poultry birds.

4.1.1 Managemental Practices

Managemental practices associated with housing are:

4.1.1.1 Bio-Security

Bio-security practices like washing, cleaning, disinfection, fumigation, proper drainage, dead bird disposal pit and dipping pads for humans and transports are associated with designing and construction of poultry houses. A poorly constructed house may not facilitate intensive washing or fumigation or bio-security program.

4.1.1.2 Feeding

It includes provision of appropriate feeding space and application of manual as well as automatic feeding equipments to improve feed conversion ratio. Feeding cost is 60-70% of total cost of production in poultry farming and proper feeding requires appropriate housing. Installation of modern feeding equipments with housing modifications decreases feeding space associated with width of housing and number of feeding lines.

4.1.1.3 Watering

Selection of site having good quality water and implementation of manual as well as automatic drinking systems plays key role in successful poultry farming.

4.1.1.4 Stocking Density

Number of birds per square foot has a great impact on production performance and behavior of birds. Whereas, stocking density depends on type of birds and housing type. More number of birds can be kept per square foot in environmentally controlled poultry houses as compared to open sided poultry houses.

4.1.1.5 Predator Protection

A better constructed house and appropriate fencing helps to protect poultry bird from predators like dogs, cats, rat and disease spreading birds.

4.1.1.6 Weather Protection

Weather extremes adversely affect bird's performance which can be managed by appropriate housing (house which protect birds from rain, sunlight and cold wind).

4.1.2 Provision of Physical Environment

Physical environment related to poultry housing include house temperature, humidity, ventilation and lighting.

4.1.2.1 Temperature

Ambient temperature is an important factor which not only affects process of thermoregulation in birds but also affects feed consumption, weight gain and feed conversion ratio (Van Kampen 1981). Heat stress due to mismanagement of temperature results in increased respiratory rate, reduced feed consumption, low eggshell quality, reduced egg production and increased mortality (Reece *et al.* 1972; Scott and Balnave 1988). Comfortable temperature at which bird is not using any energy for the gain or loss of heat is called thermo neutral zone. For adult chicken thermo neutral zone is between 18°C to 23.9°C (Sturkie 1965), while for adult broiler it is 26°C to 27°C (Hel *et al*. 1991). Maintaining thermoneutral zone is conducive for optimum production performance. During 1st week temperature requirement is 95°F, which decreases by 5°F weekly until it reaches 75°F.

4.1.2.2 Humidity

Increased humidity level in poultry house aggravates adverse effect of temperature on birds performance. Humidity level in poultry house should range between 60 to 65%. Low humidity may cause dry, dusty litter leads toward respiratory problems. High humidity causes growth of fungus and protozoa (Haq and Akhtar 2004).

4.1.2.3 Ventilation

Function of ventilation is to control temperature in shed, removal of moisture, provision of oxygen, removal of toxic gases (practical limit of carbon-dioxide, methane, hydrogen sulfide and ammonia in shed is above 1.0, 5.0, 0.004 and 0.0025%). All physiological factors affected by temperature and humidity are indirectly linked with ventilation management (Bell and Weaver 2007).

4.1.2.4 Lighting

Lighting is associated with reproductive system of poultry birds. Lighting requirements vary with type and age of birds. For appropriate control of light in environment controlled poultry houses light trap/baffles are used.

4.2 Poultry Housing Systems

Poultry housing system are classified as free range, semi intensive and intensive housing systems. Intensive system is further divided into open sided, environment controlled, semi- environment controlled and prefabricated poultry houses.

4.2.1 Free Range System

In free range system poultry birds are kept in field areas so that they can consume herbaceous seeds, insects, crop waists and green forage etc. In this system protection from predators, infectious diseases and parasitic infestations is provided

to the birds. Poultry birds mostly kept in free range system are chicken, duck, turkey and ostrich. Shelter is usually provided by temporary roofing. Stocking density in range system is depending upon type of birds and field conditions. However, average stocking density of adult birds in this system is about 250birds per hectare (Jadhave and Siddiqui 2007).

4.2.2 Semi Intensive System

In this system, both range and housing facilities are provided to birds. Birds are kept in house for night or during hot period of day; they are provided access to open field. This system is mostly used for duck, turkey and ostrich rearing. Stocking density in this system is about 750 birds per hectare depending upon type of bird (Jadhave and Siddiqui 2007). Application of scientific managemental practices is not possible in this system which resulted into reduced performance of poultry birds in terms of weight gain or egg production. However, with increasing demands of organic poultry and pasture raised poultry birds this system is regaining its popularity. Due to increased price of pasture raised birds this system is now used for commercial poultry farming in several regions of world.

4.2.3 Intensive System

In this system birds are confined in house throughout their production period. Such types of housing system facilitate organization and concentration of flock into a manageable unit. Practices regarding provision of temperature, humidity, ventilation and lighting can easily be performed in intensive housing system. However, managemental practices are dependent upon housing type in this system. There are about three types of houses constructed under intensive housing system i.e. conventional houses, semi-environment controlled houses and environment controlled houses. Stocking density in such type of houses is range from 10000 to 25000 birds per hectare (Jadhave and Siddiqui 2007). Birds kept under this system perform better than those kept under range or semi- intensive housing system. Intensive housing system is widely used all over the world for commercial poultry farming due to its unique advantages like less land required, easy management, economical production, can be installed near market, sick birds easily detected and treated, maximum protection against rodents and climatic fluctuations.

Intensive housing system can be subdivided into various systems as given below.

a. Deep litter system
b. All slat system
c. Slat and litter house
d. Wire system
e. Slat and wire system
f. Deep-pit system
g. Cage or battery system

4.2.3.1 Deep litter system

In this system of housing birds are kept on floor. Both in the open sided or environment controlled houses, floor is covered with litter material such as rice

husk, wood shaving and sawdust. Depth of litter may vary from 4-5 inches in case of deep litter system. For chicks, the depth is kept about 2 inches which is further increases according to age and type of birds. Litter material gets decomposed after the mixing of dropping and bacterial action, at this stage this is also called built-up litter. Such litter carries some use full growth factors. With excessive mixing of dropping this built-up–litter is further converted into fertile manure. Manure is removed from house after disposal of flock which is 1.5 month in case of broilers, 6 months in case of grower and about one year in case of layer or breeder. However, this duration depends upon housing type and litter condition. In case of excessive moisture and disease outbreak due to dampness of litter, it can be partially or completely replacing at any time.

4.2.3.2 All Slat System

In this system of housing birds are kept on floor without provision of litter material. Slated floor is designed to accumulate droppings in pit under the floor. This system required less floor space as compare to deep litter system. Hen requires 1.0 foot^2 floor space in all- slat system as compared to deep litter system which is 1.75 feet^2/bird.

4.2.3.3 Slat-and-Litter House

In such type of houses both the litter and slat system are applied together. These houses are developed mostly for layer and meat type breeder birds. Birds kept in slat and litter house produce more eggs, required less labor and showed more fertility than those kept in all slat houses. Whereas, floor space requirements per birds are less than deep litter house but with higher initial investment than deep litter house.

4.2.3.4 Wire System

In such type of poultry housing systems, sloping floor is built with wire fabric. Both A shape or V shape floor are developed for directing eggs towards side walls or in the center of poultry house. Floor slope is kept about 1.5 inches per running 12 inches. Egg nests are provided to birds, whereas sloppy floor facilitate collection of eggs. Mesh size is usually kept 1 inch by 2 inches. However, smaller mesh size reduces incidence of sore feet in birds.

4.2.3.5 Slat and Wire System

In such type of housing system both slat and wire system are combined, just like combining deep litter and slat system. Ratio of slat and wire floor will be kept 60% and 40%, respectively. Slat is usually kept 1 to 2 inches wide and 1 inch apart. Whereas, welded wire mesh size is kept 1 inch by 2 inches. Slat and wire floor are constructed in sections to facilitate cleaning and removal of droppings. Slat is kept about 30 inches above floor.

4.2.3.6 Deep-Pit System (High-Rise Houses)

Manure handling in poultry houses is an important aspect to be considered while designing poultry housing systems. On an average a layer bird produces about 41 to 45 kilos of fresh droppings during 52 weeks of age while consuming about 42 kg of

feed. Fresh dropping contains about 75 to 80 % moisture. To overcome problems of manure handling, deep-pit housing system is a better option, because it provides drying and protected accumulation of dropping for a long period.

In this system, double story sheds are constructed. In upper portion, birds are kept in cage or on slate floor whereas; lower portion is kept for accumulation of manure. Ventilation system is installed in lower portion for ventilation as well as drying manure in case of environment controlled houses.

4.2.3.7 Cage System or Battery System

Cage system is advance shape of wire net floor system. In this system cages are developed with straight or sloppy floors and these cages are fixed on each another. Sloppy floor is developed for layer birds, whereas, smooth floor is kept for broiler birds. Cages are also equipped with automatic feeding and drinking system. For layer birds, mechanical egg collection system is also installed with cages. In case of manual cage system, manual feeders, drinkers, and manure collection trays are installed with cages instead of automatic manure removal belts. Floor space requirements are three time less in cage housing system as compares to deep litter system. In automatic cage system in environment controlled house the space provided per layer is 0.60 ft^2.

4.2.3.8 Types of Cage System

a. Reverse Cages (Stair-Step)

These cages also called as California cages, because these are first developed in California. In this system, manual feeders and drinkers are attached outside cage and cages are arranged step-wise in two or three tiers on a stand. In this system about two times more birds are kept in a house as compare to deep litter housing system. Proppings directly fall on ground and manually removed from shed.

b. Flat Deck Cages

Flat deck cages are of two types one is called single tier flat deck, this type is usually used for chicks up to 8 weeks of age. Sometimes such cages are also equipped with automatic heating system along with 3/4 of cage roof and side walls in each block covered with metal sheet to provide brooding area. Trough feeders and drinkers are attached in each block. Second type of flat deck cages is multi-tier cage system. In this system, each compartment of cage is equipped with manure collection system and cages are installed on the top of each other. However, in both single tier and multi-tier flat deck cages birds are kept for eight week of age, this system is also used for rearing of quails after little adjustment of feeding, drinking systems and changing mesh size of cage netting.

c. Combi Cage System

In this type of cage housing system birds can be raised from day one to the end of their production cycle. Such systems are available for broiler and layer birds. In this type of cages adjustable feeding and drinking system are installed with cages. Additional wire net frames for side walls and floor are provided. The farmer can manage flock in same cage during different stages, instead of developing, brooding,

growing and laying houses separately. Such type of cages could be single or multi tiers depending upon their degree of automation and housing types. For example, in an environment control house, a cage system equipped with automatic feeding, drinking, manure handling and egg collection system could be of six to eight tier. However, special care is required for designing of ventilation system of such house.

4.2.3.9 Advantages of Cage Housing System

Advantages of cage housing are more birds in less space, in combi cage system brooding, growing and laying can be done in same house, reduces labour cost, facilitates managemental practices, easy medication and vaccination, prevents egg eating, reduces egg contamination, reduces chances of egg breakage, reduces chances of diseases related to litter contamination like coccidiosis and worm infestation and improves feed efficiency.

4.3 Open Sided and Environmentally Controlled Housing

4.3.1 Open Sided Poultry House

Open sided poultry house based on natural ventilation and lighting. Light supplementation during night is supplied through artificial light sources. Open sided house is not efficient to achieve optimum genetic potential of birds. However, its performance can be enhanced if it is constructed under following rules.

4.3.1.1 Selection of Site

Open sided poultry house should be constructed in areas where weather conditions are not too hot neither too cold, because such type of house cannot cope with extreme of climatic conditions.

4.3.1.2 Direction of House

Direction of open sided poultry house is kept East to West in hot areas and North to South in case of cold areas. This helps to avoid penetration of heat in shed in hot areas. Whereas, sunlight in cold areas should be used to warm up the shed.

4.3.1.3 Width of House

Width of open sided poultry house should be 30 to 35 feet. Exceeding width may result into poor ventilation conditions in poultry house.

4.3.1.4 Height of House

In cold areas height of poultry house should be 8 feet. Whereas, in hot area height of ceiling from the floor should be 12 feet.

4.3.1.5 Length of House

Length of open sided poultry house may range from 100 to 200 feet. It is also depending upon the availability of land and type of equipments to be used. In case

of installing automatic chain feeding system in open sided poultry houses farmer should consult with equipment manufacturer regarding house length.

4.3.1.6 Roof Shape and Insulation

Open sided poultry house roof should be kept sloppy with about one feet extension from external walls for proper drainage of rain water. Furthermore, roof of house should be properly insulated both for cold and hot climatic conditions, because in cold weather insulation helps to maintain internal house temperature and in hot weather it protects the penetration of heat in the shed.

4.3.1.7 Foundation

Foundation should be strong enough, so that it can support structure adequately. While constructing foundations for shed, type of soil and further construction plans should be kept in mind.

4.3.1.8 Floor

Type of floor depends upon type of soil; in case of saline soil concrete floor is recommended. Whereas, in sandy soil birds can be raised without concrete floor. However, for proper disease control and bio-security implementation concrete floor is the best choice.

4.3.1.9 Door

Door of open sided house could be installed on either end of house. Door should be made of metal frame with wire mesh so that they can facilitate ventilation.

4.3.1.10 Side Walls

In open sided house about ¾ of side walls are kept open. Requirements for opening of side walls depend upon type of birds, age of bird and climatic conditions. For appropriate provision of open area side walls should be equipped with some durable curtains. These curtains could be equipped with wench and pulley system, so that size of open area could be adjusted according to requirements.

Open sided houses work well only if outside environmental conditions remain favorable. Whereas, in case of adverse climate, such type of houses fails to protect birds. Especially in case of ceasing of natural air flow resulted into increased house temperature, suffocation and increased ammonia level in the shed, which ultimately led towards the onset of stress in birds. Similarly, in hot weather conditions direct flow of hot air over birds causes discomfort or even mortality in birds kept under open sided poultry house. To avoid such problems semi environment controlled house is supposed to be best option instead of conventional open sided houses.

4.3.2 Semi Environment Controlled House

Semi environment controlled house based upon the installation of lighting system, fans, pads, foggers and mechanical curtains. This house is designed to get maximum advantage of natural environmental conditions to save electricity during mild weather conditions. However, in hot climate such house can be converted into environment controlled house from open sided house by closing the open sides with

well insulated light proof curtains. After conversion, artificial lighting and ventilation systems start working to provide desired light and ventilation to birds. Building construction of semi environment controlled house is kept similar to open sided house regarding length, width, height, opening of sides. However, doors in such house are installed in side walls whereas fan and pads at front and back sides of house.

4.3.3 Environment Controlled Houses

Environment controlled houses are designed to provide physical environment through artificial resources in order to provide of precise environmental conditions in terms of temperature, humidity, ventilation and lighting, which are conducive for optimum production performance. Another reason for developing environment controlled houses is to organize large number of birds in a minimum space, so that managemental practices can be performed easily and efficiently. Environment controlled houses are constructed without windows; there ventilation system is based on exhaust fans, air inlets and cooling pads and environment controllers. Temperature in such houses is maintained by electronically controlled brooders. Lighting in such houses is provided by artificial light sources like, incandescent, fluorescent, compact fluorescent or light emitting diode. Intensity and duration of light hours is controlled by lux meter, electronic timers and computerized light management systems. Various types of rearing systems are practices in environment controlled houses like deep litter system, cage system and slat system. Automatic feeding and drinking system reduce cost of labor and enhance feeding and water efficiency. Initial cost of construction is higher in such houses as compared to open sided and semi environment controlled houses; however, overall profitability by keeping the birds in environment controlled houses is higher than conventional houses.

4.3.4 Prefabricated Environment Controlled Houses

Prefabricated or factory-built housing system is getting popular in poultry farmers, companies provide complete setup of housing and equipments. Lots of problems related to housing construction and synchronization of equipments with locally developed houses can be solved with prefabricated houses.

Provision of accurate insulation, appropriate static pressure, suitable ventilation, feeding, drinking and lighting system remains the responsibility of a single supplier, which makes it easier to claim the guarantee if something goes wrong within guarantee period. Installation of factory build houses is easier than houses developed by local contractor. Furthermore, these houses can be replaced at any other destination if farmer faces any topographic or social change in surrounding. Pre-estimation of housing and equipments is more accurate in factory build housing as compare to a contractor's estimate.

4.4 Selection of Site for Poultry Housing

Selection of site for poultry housing is an important factor, which has a great impact on overall success of poultry farming. Various important points are discussed below for selecting a suitable place for poultry farm business.

4.4.1 Water quality

Water is required for drinking, sanitation, disinfection, vaccination, and evaporative cooling system. In bird's body water is vital for digestion, execration, circulatory system, thermoregulation and vision, therefore, most important point for site selection is availability of suitable water. Site selected with bad water quality needs installation of water purification plants which increases production cost and reduces profit margin. Poor quality water may cause total failure of poultry business.

4.4.2 Better Soil Quality

Soil quality is important from construction point of view, saline and sandy soil is not good for construction of poultry farm building. Soil should be compact enough that it can give strength to foundations and reduces chances of dampness in building after construction.

4.4.3 High from Surrounding Areas

Level of land selected for poultry farming should be high from surrounding area. This will reduce damages chances by rain and flood. Furthermore, farm land height from surrounding areas will also facilitate construction of proper drainage system.

4.4.4 Having Good Drainage System

One of the most important factors for selection of site is availability of proper drainage facility in area. During washing and disinfection, lots of chemical are being applied in process. Drainage of water with such toxic substances in surroundings not only causes social issue but also is a threat to farm bio-security.

4.4.5 Availability of Electricity

Electricity is an important component of poultry farming epically in case of environment controlled housing. Selection of site without electricity facility could be an extra burden for farmer. This will increase fixed cost along with running cost of poultry farm operations.

4.4.6 Away from other poultry farms

Distance between two poultry farms should be at least one kilometer. Therefore, during selection of site for poultry farm one should visit surrounding area to find out any other poultry farm. Such site should not be selected where other poultry farms are already constructed.

4.4.7 Away from Urban Areas

Distance from urban area is impotent from social and bio-security point of view. Although government did not allowed construction of poultry sheds near to urban areas. However, expansion of cities sometime resulted into reduction of gap between human population and poultry farms. In such circumstances, farmer should be aware of cities expansion trend to avoid any current or future collapse.

4.4.8 Availability of Road / Easy Access

Availability of road and easy access is important issue for selection of site. Constant supply of feed, marketing of egg and meat, easy approach for labour and other technical staff are linked with easy approach to the farm. Therefore, farmer should select site close to road. Never buy land for farm if the road is not easily accessible or you need to barrow land from another owner to reach at your farm, this may end up in deserter.

4.4.9 Availability of Gas

Some poultry installations required gas supplies like, electric generators, dead bird disposal system and gas brooder etc. Therefore, availability of gas connection at the site is a better option to avail.

4.4.10 Near to Market

Site for poultry farm should be close to poultry markets, so that farmer could have an easy access to feed source, poultry egg and meat market, medicine market, equipment market and technical backup like doctors, electricians, debeakers, vaccinators and bio- security providing companies. This will not only reduce cost of availing such facilities but also will allow him a quick and easy backup.

4.5 Construction of Poultry Farm Building

Basic tips for construction of open sided poultry house have already been discussed in this chapter. However, with increasing trends towards environment controlled housing system, some important considerations for construction of poultry farm building are given below.

4.5.1 Land

Land requirement for an environment control house based upon space requirement of birds and the space required for the various supporting components of a poultry farm. Space requirement for birds is further based upon the type of bird (layer, broiler or breeder) as well as system of housing (deep litter system, slat system, manual cage system or automatic cage system). On an average about 1.5 Acre land is required for a single story environment control house along with all its supporting structures. On the same space a double story poultry house could also be constructed, where farmer can raise 30000 to 60000 broiler or layer birds.

However, purchase of three Acres land is be a better option for the start of an environment control poultry farm. On this land a farmer can raise about 120000 to 180000 broiler or layer birds, depending upon extent of automation and system of rearing. Space requirement for breeder stock are more than broiler or layer birds, breeder stock is mostly raised in deep litter system. Therefore, about 72000 layer breeders and 35000 broiler breeder could be raised in same area. Farmer should always keep in mind farm extension while purchasing land.

4.5.2 Direction of House

Direction of environment controlled poultry houses depends upon climatic conditions and direction of air flow. In hot areas, east-west direction could be more beneficial. Because roof insulation is comparatively easier and economical as compare to insulating the walls. However, in cold areas, environmentally controlled houses can be erected in any direction. Another important consideration regarding direction of environment controlled house is the direction of wind flow. Direction of fans installed in house should not be against direction of natural air flow. This reduces fans efficiency and increases ventilation cost.

4.5.3 Length

Length of environment control house may vary from 400 to 560 feet. Important thing needs to consider for adjustment of length, is the type of equipments going to be installed in the building. Mostly equipment companies have a standard length for feeding and drinking systems, which is calculated on the base of number of birds, type of birds and maximum operational capacity of electric motors and pressure controllers. Similarly, types of inlets vary in size and they required a specific distance for installation which may affect length of house. It is, therefore, recommended that farmer should consider type of birds, number of birds and equipment specifications for estimation of poultry house length.

4.5.4 Width

Width of environment controlled poultry house ranges from 40 to 65 feet. In an environment control house width is depending upon number of fans and pads, which are adjusted width wise. Whereas, fans and pads number are calculated based on type of birds and number of birds in the shed. Second consideration for adjustment of width is number of feed and water lines or the type and lines of cage system going to be installed in the shed.

4.5.5 Height

Height of environment controlled house in case of deep litter system is kept about 7.5 to 8.0 feet. However, in case of cage rearing, house height is adjusted according to cage height, which may vary from 8 to 24 feet. In case of manual cages, height is kept about 8 feet, whereas, in case of automatic multi deck cages, height of shed may vary from 12 to 20 feet or more.

4.5.6 Foundation

Environment control houses may be single story or double story which required different strength of foundations. However, foundation must be solid enough that it could bear structural load and avoid dampness.

4.5.7 Floor

Floor type in case of deep litter system should be moisture proof and easy to clean. Plain concrete floor are recommended for environment control houses. However, slat floor in case of deep-pit system and raised floor in the form of platform are also developed in case of two or three tier cages. Under slat and between raised floors, sub- floor is developed for accumulation of manure. Sub-floor needs more strength, because it needs periodic washing and disinfection. In case of multi-tier cage system, floor should be solid enough, so that frame structure of cage system can easily be grounded, epically towards manure disposal end. A deep pit is developed in floor, at manure collection side of automatic cage system for installation of manure collection belts. This pit should be two feet away from fans wall and right underneath projection of manure belt, so that dropping could easily be collected and removed from shed. Although cage system is equipped with level adjustment system, even than floor for cage house be smooth and leveled.

4.5.8 Roof

Roof of environment control house should be well insulated, solid and leak proof. Over hanged roof is not required in case of environment controlled house, because side walls are kept completely closed. However, an appropriate slope on the roof is required for drainage of rain water.

4.5.9 Walls

Various construction patterns are applied in poultry house construction. In case of single story house, bricks walls are developed, in this case the walls should properly leveled, straight and solid enough to support the roof. A frame work structure is recommended in case of double story poultry house. In this system, main structure is based on solid concrete pillars, whereas bricks walls are developed between pillars. Catching windows or emergency ventilation windows may also be installed in side walls. Windows should be air tight and well insulated.

4.5.10 Air Inlets (Ventilator)

Air inlets and exhaust fans (36 inches diameter) are installed on the side walls of environment control houses length wise for the provision of ventilation during cold weather. Inlets are located one foot below the roof where the shed height is about 8 feet. In case cage system, special inlets with two directional air flow system may be adjusted in the middle of walls. Distance between the inlets depends upon the number of inlets calculated for a specific flock.

4.5.11 Fan and pad

Fan and pads are installed on front and rare walls of environment control house for tunnel ventilation during hot weather. Number of fans and pads needed to be mounted, depends upon ventilation requirements of a specific flock, fan and pads specifications regarding their operational capacity. It is therefore, recommended that both front and rare walls should be constructed with the provision of open space required for pad and fan installation.

4.5.12 Doors

Door of environment controlled house should be well insulated and air tight. About three to four doors are recommended in side walls of a poultry house. Doors should be sized keeping in mind handling of equipment and birds (catching / transportation).

4.5.13 Insulation

Insulation is the most important factor in environment controlled housing. Insulation of roof, ceiling, walls, windows and doors play an important role both in hot and cold climatic conditions. Insulation value of house is estimated based on environmental temperature, bird's heat production, area of house for heat loss per bird and rate of air exchange.

4.5.14 Supporting Structures

One of the most important things needed to be considered is appropriate estimation of supporting structures including feed store, drainage, passages, dipping pits, generator room, spare parts store, administration offices, labour colony, kitchen, wash room, weighing bridge, disposal pit and boundary walls, etc. Feed stores should be big enough to store feed for a desired storage period. For construction point of view feed store should be damp proof and well ventilated. All components of farm building should be high enough from ground level and attached with well-defined drainage system. Appropriate passages should connect the various component of farm, so that farm operation could be carried out properly in rainy season. Dipping pits should be constructed at the main entrance for vehicles and visitors. Dipping pits should also be constructed at the entrance of each shed. Generator room should be far enough from the production shed, so that entrance of smoke and noise could be reduced. Negative pressurized system is used in environmental control houses; it is therefore, recommended that generator room should be constructed in front of exhaust fans to throw away the toxic fumes away from shed. A small workshop along with a store for spare parts should be constructed at farm for repair and maintenance of farm's equipments. Weighing bridge and dead bird disposal pit are also important component of poultry farm. Weighing ridges are installed near the main entrance after the dipping pits for vehicles. Administration offices, labor colony, washroom and kitchen should be arranged according to the size of farm operations and staff's requirements. Boundary wall is important from bio-security point of view; it should be strong and

high enough that it can prevent the entry of rodents and predators along with entrance of unauthorized persons. Another important thing is distance between boundary wall and front/rare walls of shed should be 15 to 20 feet, in order to facilitate ventilation system.

4.5.15 Layout Plan for Poultry Farm Building

For an efficient lay out plan of poultry farm building, boundary walls should not be close to front or rare walls, administrative block, labor colony, kitchen and main feed store should be kept away from sheds to avoid direct contact of visitors and vehicles with birds and there should be two entrances for washroom, one towards main entrance and other towards shed's side. Dipping pit for vehicles should be close to main entrance, small feed delivery room (with feed bin or underground hopper) should be constructed near the front or rare walls of shed and generator room along with control panel room should be towards fans side of the shed. Distance between two sheds should be 100 feet and avoid developing brooding, growing and laying sheds at same farm. Always keep direction and distance between sheds in a way that ventilation system should not scramble with each another. All components of poultry farm including sheds should be high from ground level, well connected to drainage system and attached with each other through washable passages.

4.6 Role of Insulation in Environment Controlled Housing

Major function of an environment controlled house is to provide environmental conditions (epically house temperature) close to optimum requirements of poultry birds. Such houses are developed both for hot and cold climatic conditions. During cold weather insulation protects the heat lost from the shed during brooding and improves the brooder's efficiency. Whereas, in case of adult birds, insulation helps to maintain house temperature through heat produced by bird's body. With proper insulation, a farmer can maintain house temperature close to 75°F even the outside temperature is -20°F. During hot climate insulation reduces penetration of heat inside shed. This reduces increase of house temperature and facilitates cooling system to perform better. Hence, we can say that insulation of roof, ceiling, side walls and end walls is essential. In case of environment controlled houses, insulation of doors and catching windows is also recommended.

Insulation is measured in terms of R-value, which is ability to resist transfer of heat through a material. To be a good insulator a material must contain a large number of small, isolate dead air spaces present in its each cubic inch. Moisture acts as a conductor of heat and it adversely affect R-value of insulating material. Therefore, better insulator material should not absorb moisture. Insulating materials like polystyrenes and polyurethanes do not absorb moisture. Whereas, materials such as cellulose, fiberglass and various wool products absorb moisture. In case of moisture absorbing insulating materials, additional sheets of vapor barrier (materials which resist the moisture absorption) should apply. Materials such as aluminum foil and

various types of polyethylene films are adequate vapor resisting materials. Other materials such as plywood and general framing lumber, bricks, concrete, and masonry blocks not considered as good vapor barrier. Vapor barrier must install towards warm side of insulation because low temperature cause condensation of air moisture, which cause wetting of insulation and reduces its R-value.

Insulation requirement for a poultry house depends upon the environment condition of its location. Farmer should be aware of natural climatic conditions before construction of poultry house, so that insulation requirement could be properly addressed during construction of sheds. Insulation requirements during different climatic conditions are given in Table 4.1.

Table 4.1. Insulation requirements under different climatic conditions.

Climate Type	R-Value	
	Ceiling	Side walls
Hot ($\Delta t < 30°F / 17°C$)*	9.0	6.0
Medium (Δt 30-50°F / 17-28°C)*	12.0	8.0
Cold ($\Delta t > 50°F / 28°C$)*	20.0	14.0

*Δ = *difference between inside and lowest outside temperature.*
Source: Bell and Weaver (2007)

Factors other than the environmental temperature, involved in estimation of R-value are type of birds and their heat production, size of flock (depend upon number of birds in same house) and ventilation rate.

4.7 Light (Electric), Gas and Water Fitting in Poultry Houses

Automation in feeding, ventilation, manure removal and egg collection has increased the use of electro- mechanical equipments in poultry farming. Electricity supply is highly important to run automatic equipments at farm.

4.7.1 Electricity at Farm

Uninterrupted electric supply for 24 hours is needed for environment controlled poultry farms. Any mistake to calculate electricity load may cause short circuit in electric wiring which may cause an electric failure for entire system. With the high density cage housing system a shed may have 100,000 to 180,000 layer birds in it. Under these circumstance failure of ventilation system even for a half hour may cause high mortality rates. To regulate electricity and automation special electronic control panels are used along with two generators of good quality. Electric load required at farm by adding up watts of all electric equipments installed at farm. This will help to arrange electric wiring, for example single phase wiring for equipments works on single phase current and three phase wiring for its respective equipments. This will help to calculate generator capacity for backup electric supply. Buy generator having 10% additional capacity of actual requirement.

4.7.2 Light Fitting at Farm

After electricity arrangement for farm equipments, installation of lighting is next important step. To estimate lighting requirements and electric wiring for lighting, terminology related to lighting management is given below.

1. Foot candle: If one watt incandescent bulb hangs on a height of 7 feet and its light falls on 4 square feet area, the light intensity on each square foot will be one foot candle. One foot-candle equals 10.76 lux.
2. Lux: A lux of light intensity is equal to one lumen per square meter. One lux is equal to 0.0929 feet candle.
3. Lumen: A lumen is a standard of measurement of light intensity from electric bulbs of various types and sizes from a specific distance on a specific area.

Lumens per Watt

Lumens of light produced per watt of power are as follows:

Incandescent	20 lumens per watt
Mercury Vapor	55 lumens per watt
Fluorescent	65 lumens per watt

Although watts of required illumination at farm can be calculated from above definitions, better way to calculate electric requirements for lighting is to use lux meter, because different sources of light produces different lumens per watt.

4.7.3 Gas Fitting at Farm

Gas is mostly used for brooding or to produce electricity at the farm. Before applying gas connection for farm one should calculate gas requirements. To calculate gas requirements at farm, add gas requirement for kitchen, offices, gas brooders and gas operated electric generators. Just like the generator back up for electric supply, farmer may arrange portable gas cylinders to store gas at farm in case of emergencies. While dealing with gas fitting at farm, one should be careful about pressure of gas required by different equipments. Use of pressure regulators with gas brooders and gas operated electric generators enhances equipment efficiency and reduces chances of and misshape. Always keeps fire extinguishing at farm while having gas operated equipments.

4.7.4 Water Fitting at Farm

Calculation of water requirement is important before installing water system at farm. For this purpose, the farmer should consider the water requirements of flock at adult stage, emergency storage capacity and water required for cooling system. Water fitting includes water pumps, water lines and storage tanks. Always keep spare water pumps at farm. Underground fitting of water lines reduces change of water temperature due to hot or cold climatic conditions. Water tank is to maintain water temperature.

4.8 Heating and Cooling Systems

4.8.1 Heating Systems

Heating systems at farm are used for brooding purpose. Various type of brooders (heating systems) are available for heating the poultry house like electric brooder, gas brooder, coal brooder, diesel brooder and wood brooder.

1. Electric brooder: Electric brooders are based on electric heater, electric fans and thermostats. Electric brooder may be radiant brooder if fan is not installed in it and electric heater is controlled by manual or digital thermostat. If fan is also installed in an electric brooder, both fan and heaters are controlled by electronic thermostat, then brooder is called hot air electric brooder.
2. Gas brooder: In gas brooders heat is generated by gas heaters (gas burners) and provision of gas in theses heaters is controlled by electric gas valves. Electric gas valves are further controlled by electronic thermostats. Various types of gas brooders include radiant gas brooder, direct air brooder or indirect air brooders. Radiant gas brooders based on radiant gas heaters, electric gas valves, auto ignition switches, flame sensors and electronic thermostats. In direct air gas brooding system heat is produced by gas heater and fan is used to throw hot air in shed directly or by ducts. Gas valves are used to control gas pressure in the heater, whereas electronic thermostat is used to operate gas valves and fan operation according to required temperature. In indirect hot air gas brooding system, gas heaters is used to heat metallic pipes installed and air move inside hot pipes and thrown in shed through fan, so that no direct fumes enter in shed, rest mechanism of this system is similar to direct air brooder.
3. Diesel brooder: Diesel and kerosene oil brooders are also available in market. In such brooders, oil injection pumps are used to supply fuel to burners. In such type of brooders, in direct hot air brooding system is applied. Diesel or kerosene oil burner is used to heat metallic pipes or drum, whereas, fan is used to drive hot air in shed through polythene ducts or metal pipes. Sensors are installed in shed. Fuel injection pump and fan are controlled through electronic thermostat to maintain shed temperature.
4. Coal or wood brooder: In coal or wood brooding, indirect hot air brooding system is used; these brooders are usually installed outside shed. Coal or wood is burned up in a furnace to heat the metallic pipes installed on upper side of furnace. Fumes are drive out through a chimney at about 20 feet high in the air. Electric fan is used to drive air through the hot pipes into shed. Electronic heat controlling system is adjusted with coal or wood brooder; heat sensors are installed in shed at different locations. Operation of hot air delivering fan and blower fan (fan fixed with furnace) is controlled through electronic temperature controller based upon the temperature requirement and response of heat sensors installed in shed. However, coal or wood is manually loaded in furnace. Operational cost of coal or wood is comparatively lower than other heating systems.

4.8.2 Cooling Systems

There are two common systems used for cooling in poultry house. One is fogging system and other is fan and pad system. In both cases, evaporative cooling mechanism is used. In fogging system, a fine mist of water is produces by forcing water through fine jets. Fine mist is directly employed over birds, which keep birds wet and helps keep them cool. Foggers do not lower temperature in house unless they are used with fans. Use of high speed fans with foggers helps reducing house temperature. While using fan and fog system for cooling the house, one should be careful about the relative humidity in atmosphere. Fan and fog system did not work well in case of high humidity. Fog and fan cooling system is mostly used in conventional open sided and semi-environment controlled poultry houses.

Another system of cooling is fan and pad. This system is used in environment controlled poultry houses. In this system, slow speed exhaust fans are installed on one end of poultry house and cooling pads are places on another end of shed. A negative air pressure is generated in the shed through exhausted fans. Air can enter in the shed through cooling pads. Water is sprinkled on the cooling pads for evaporation. Evaporation causes the pads to become cool which reduces the air temperature passes through it. Electronic controller with temperature and humidity sensor is used to operate fans and water flow on pads, to maintain temperature and humidity in house.

4.9 Ventilation System

Ventilation is the most important managemental factor in poultry farming. A main function of ventilation in poultry house is provision of oxygen, removal of toxic gases and removal of moisture and maintenance of environmental temperature. Oxygen and level in the shed should not be less than 19.6%, carbon dioxide should be less than 0.3% and level of ammonia should not be more than 10 ppm. Whereas, moisture level in shed should be 55 to 65 %. Ventilation requirements for a poultry house depends upon age of bird, number of birds, weight of bird, type of bird, type of insulation, environmental moisture and temperature.

Ventilation in open sided poultry house is conducted by keeping width of shed less than 35 feet. In case of semi-environment controlled houses. High speed fans or desert coolers are used for ventilation. Whereas, in case of environment controlled houses, ventilation is mostly done through negative pressurized ventilation system. There are two main systems of ventilation.

4.9.1 Positive Pressure Ventilation System

In this system of ventilation fans or evaporative coolers (desert coolers) are placed inside walls, these fans force air into poultry house. Openings are provided through which air is exhausted from house. Air openings are regulated to generate a positive pressure. Positive pressure distributes air homogeneously in shed.

4.9.2 Negative Pressure Ventilation System

Negative pressurized system is further divided into three ventilation systems

4.9.2.1 Tunnel Ventilation System

In this system, slow speed exhaust fans are installed on one end of poultry house and evaporative pads are places on another end. After completely sealing house, air in shed is exhausted. Fresh air is allowed in shed through a specific area of cooling pads. A static pressure is maintained by adjusting amount of exhaust air and pad area. Static pressure is further applied to control air speed in house. This system is mostly used in environment controlled houses build in hot climate.

4.9.2.2 Minimum Ventilation System

In this system, exhaust fans are installed on side walls of shed and air-inlets are installed on both side walls about one foot below ceiling. Mechanical opening of air-inlets is to generate required static pressure. In this system, static pressure is controlled to regulate speed of air coming through inlets.

4.9.2.3 Transitional Ventilation System

This system is applied in mild environmental conditions, negative pressure is generated by combined opening of pad and inlet. Where, both front and side walls fans are operated as per requirement. House temperature and moisture is controlled through controlling of water pump used for wetting evaporative cooling pads.

4.9.2.4 Combi-Ventilation System

This system is basically combined installation of fans, pads, inlets and side fans in poultry house. In this system, all three types of negative pressurized systems are applied in same house. Specially designed environment controller is used in this system. This controller is joined with temperature and humidity sensors and it can control water pumps, number of fans to operate, duration of operating fans and opening of inlets. Environment controller is programmed to maintain inside house temperature both in hot, cold and moderate climatic conditions. Such system is used in poultry house developed in area of variable climatic conditions. Minimum ventilation requirements for broiler are 1.25 cfm/lb body weight. Minimum ventilation requirements for layer birds are 1.5 cfm/lb body weight (Bell and Weaver 2007). Rule of thumb is to provide 0.012 cfm/lb of body weight of chickens in house for each 1 °F of temperature.

4.9.3 Calculation of Number of Fans for Tunnel Ventilation

Birds in the shed = 30000
Type or bird = broiler
Weight of bird = 4.4 lb
Exhaust fan capacity = 21000 cfm
Number of fans = No. of birds × weight of bird (lb) × ventilation required/ lb bodyweight / capacity of exhaust fan
Number of fan = 30000 × 4.4 × 1.25 / 21000 = 7.85 or 8 fans

4.9.4 Calculation of Evaporative Cooling Pad for Tunnel Ventilation

Number of fans = 8
Area of cooling pad = 6.5 feet. × 2 ft. = 13 feet^2.
Capacity of exhaust fan = 21000 cfm
Required air speed from pad = 250 fpm
Number of cooling pads per fan = (Capacity of fan / required air speed from pad)/ area of cooling pad in ft^2= (21000 / 250)/ 13
= 84/13
= 6.5 Evaporative cooling pads per fan
Total pad required for 30000 birds shed = No. of fans× no. of pads per fan = 8 × 6.5
= 52 Evaporative cooling pads required
Calculation of fans and inlets for minimum ventilation
Rule of thumb: one square inch in let area is required for each 4 cubic feet of air.
Minimum ventilation requirement at 40°F = 48 cfm / lb body weight
Number of birds = 30000
Body weight per bird = 4.5 lb
Capacity of exhaust fan = 21000 cfm
Number of fan required = No. of birds × weight of bird (lb) × ventilation required/lb body weight/ capacity of exhaust fan
= 30000 × 4.5 × 0.48 / 21000
= 64800/ 21000
= 3 fans
Ventilation required by the flock is = 64800 cfm
Area of in let required = 64800/4 = 16200 square inches
Area of inlet = 12 inches × 24 inches = 288 square inches
Number of inlets required (1 ft × 2 feet) = Area of inlets required in square inches/ area of one inlet in square inches = 16200/ 288
Number of inlets required = 56.25 or 57

Air speed passing through inlets is controlled by static pressure. For better mixing of incoming cold air, air velocity should be about 600 feet per minute (FPM).

All the above calculations are based on a shed having length = 400 feet, width = 45 feet and height 8 feet. Total area of shed is 18000 square feet and has capacity for 30000 broiler birds @ 0.6 square feet/bird. Ventilation requirements of different type of birds in same shed can be calculated by values given in Table 4.2

Table 4.2. Floor space requirements of different types of birds.

Type of birds	Space required per bird (Cubic feet/bird)	Bird weight in lb	Birds number in shed of 18000 feet^2
Broiler (on floor)	0.60	4.40	30000
Layer (Two tier caged)	0.75	3.30	24000
Broiler breeder (on floor)	2.10	8.80	8571
Layer Breeder (on floor)	1.50	3.30	12000

Source: Daghir (2008)

Note: Average weight of birds may vary for different strains, always consult breeder manual for the precise calculation of ventilation.

In case of tunnel ventilation system number of fan may also be calculated based upon air speed requirements in shed (Daghir, 2008). Recommended air velocities in tunnel ventilated house are given in Table 4.3.

Table 4.3. Air velocities in tunnel ventilated houses.

Type of bird	Air Speed (FPM)*	Air Speed (m/s)**
Broiler	450 – 540	2.50-3.00
Pullet	315 – 405	1.75-2.25
Broiler Breeder	405 – 540	2.25-3.00
Commercial Layer	450 – 540	2.50-3.00
Turkey	450 – 540	2.50-3.00

**FPM= foot per minute*

Calculation of number of fans based upon the airs speed are given below

Length of shed = 400 feet
Width of shed = 45 feet
Height of shed = 8 feet
Air speed required in shed = 450 feet per minute
Cross section area of shed = width x height = 45 × 8 = 360 square feet
Ventilation requirement at 450 fpm air speed= 360 × 450
= 162000 cubic feet / minute
Capacity of fan = 21000 cfm
Number of fan required = 162000/ 21000 = 7.7 or 8 fans

Note: required ventilation can be provided by operating the fans through timers.

4.10 Brooding, Rearing and Laying Equipments

4.10.1 Brooding House Equipments:

4.10.1.1 Brooder

Brooder is used to provide heat during brooding phase. Various types of brooders are available in market based upon different types of fuels. There are two type of brooding systems used during brooding phase.

a. Colony Brooders

For colony brooding small scale electric; coal or wood brooders are used. These brooders are manually operated. Brooding capacity of such brooders ranges from 500 to 1000 birds. In this brooding system small groups of birds are raised.

b. Continuous Brooders

These brooders deliver hot air directly or by air ducts in brooding area. These brooders include gas brooder, coal brooder, wood brooder and diesel brooder. Brooding capacity of such brooders ranges from 5000 to 60000 chicks.

4.10.1.2 Chick Guard

Chick guards are used to separate chicks in different colonies and to keep them close to sources of feed, water and heat. Chick guards are 8 feet long and 1.5 feet high metallic sheets are joined together to develop a boundary wall around brooder. Chick guards are expanded/removed as soon as chicks get familiar with feed, water and heat source.

4.10.1.3 Small Feeders and Drinkers

Small round plastic feeders or trough feeders along with manual drinkers having small plats are places near heat source in case of colony brooding system. Whereas, in continuous brooding system, small plastic feeding trays are spread throughout the brooding areas and height of nipple drinkers lines are reduced to chicken level. Water lines consist of nipple drinker are attached with water pressure regulators, which maintain water pressure in nipples according to age of chicks. In automatic trough or pan drinkers, suspension valves or float valves are used to regulate water flow in drinkers. One small round feeder or drinker is for 25 chicks during brooding.

4.10.1.4 Trough Feeders

Troughs that are 3.5 feet in length, four inches wide and about 2-3 inches deep, attached with a reel over the trough to keep the chicks out of the troughs. These are mostly used during brooding in conventional or semi- environmental controlled houses. One trough feeder is used for 40 chicks during brooding.

4.10.1.5 Brooding Cages

In case of cage brooding, small trough/round feeders and nipple drinkers are used. In brooding cages, adjustable frames with small mesh size are used to keep chicks inside the cage. Along with side walls frames, plastic sheets having small mesh size are used on floor of cages to facilitate comfortable standing of chick in cages. Now a day's special cage system is available in market for broiler and layer birds, in these cages birds can raised right from brooding till end of their production cycle.

4.10.1.6 Artificial Lights

Light bulbs and light timers are used during brooding to provide a specific light intensity and duration to chicks.

4.10.1.7 Exhaust Fans

Slow speed exhaust fans are used for minimum ventilation during brooding period.

4.10.1.8 Inlets

Mechanically operated air inlets are used during brooding to provide required ventilation to chicks. During brooding sometime ventilation is conducted by using exhaust fans, and passing air through evaporative pads without wetting them.

4.10.1.9 Climate Controllers

In case of environment controlled housing, programmable climate controllers are also used during brooding to operate heating and ventilation devices. These controllers are also used for lighting management during brooding.

4.10.2 Growing/Rearing House Equipments:

Selection of equipments for growing period based upon their cost, performance and durability is important, because most of equipments used during growing may use in laying period as such or with a little adjustment. Equipments used during growing are given below:

4.10.2.1 Water Drinkers

There are different types of drinker which can be used during growing as well as laying period. These include round drinkers, bell drinkers, trough drinkers and nipple drinkers. Round drinkers have 4 to 6 litter's water capacity and are used in conventional poultry houses. There serving capacity is about 25 birds per drinker. One bell drinker is used for 100 birds. Whereas, one nipple drinker is used 10 to 15 birds. Trough drinkers are used @ one liner inch per bird. Nipple and trough drinkers are used both in deep litter system and cage system during growing and laying phases. Water meters and water proportioned pumps are also adjusted with drinking system. Water meter is used to measure water supply to flock. Whereas, water proportioned pump/ injector is used to supplement water soluble medicines, vaccines, vitamins and minerals in drinking water.

4.10.2.2 Feeders for Growing Birds

Various type of feeders used during growing period are as under:

a. **Tube feeders:** These are large tubes about 8 to 16 inches in diameter and about 1.5 to 2 ft. long, at bottom a large pan is suspended into which feed flows from tube. Tube feeders are suspended from ceiling and are used in conventional poultry houses having capacity of 25 birds per feeder.

b. **Automatic Pan or Tube Feeders:** These feeders consist of a pan and automatic feed transfer mechanism. Pan or tube feeders further attached with feed hopper through feed delivering pipes. Electric motors attached with auger system delivered feed form main feed bin to small hopper, and from small hoppers to pan feeders. Serving capacity of an automatic pan feeder is about 60 to 64 birds. Automatic trough feeders used in deep litter system is filled with chain or auger system. Whereas, trough feeders used in multi-tier cage system are filled with mechanical feed filling hoppers. These hoppers are further filled by feed bins through auger system.

c. **Trough and Chain Feeder:** Feed trough goes around poultry house in a close circuit and a feed hopper is attached with it at the end. Chain run in trough with an electric motor, which drag feed from feed hopper to trough.

d. Feed Bin: Bulk feed bin is used from brooding till end of production. Size of feed bin is based upon daily feed requirement of adult flock along with one week storage capacity of daily feed consumption**.** Actual capacity feed bin capacity is based upon feeding requirements of adult flock.

e. Feeding Time Controllers: Electronic controllers are used in mechanical feeding system. These controllers are used to atomize feeding quantity and timing by controlling operation of feed delivering motors.

4.10.2.3 Environment Controlling Equipment

In case of hot climatic conditions exhaust fans along with evaporative cooling pads and controllers are used for tunnel ventilation system during growing phase. Whereas, in case of cold climatic inlets are used with exhaust fans for ventilation.

4.10.3 Laying House Equipments

4.10.3.1 Feeders and Drinkers

Feeding and drinking house equipments are generally same as growing house equipments. However, equipments number may increase according to feeding and water space requirements of birds at different ages. In case of cage birds, feeders and drinkers are already installed on the basis of adult bird's requirement. Therefore, these feeding and drinking equipments can be used both for growing and laying stage of poultry birds.

4.10.3.2 Nest

Nest is specifically laying house equipment. Each nest is about 12 inches wide, 12 inches high and 16 inches deep along with 3-4 inches perches. For broiler breeder, slightly larger nest is used. In laying house, a combined nest having 10compartments is used for 50 birds. In case of cage housing system, cages with slope are used as roll away nests. Individual roll away nests with collection belts are also used in deep litter poultry housing system for egg collection.

4.10.3.3 Environment Controlling Equipments:

Environment related equipments like fans, inlets, evaporative pads and lighting systems are basically calculated and installed based on laying house requirements. These equipments are operated as per requirements during brooding, growing and laying stage.

4.11 General Farm Devices

Temperature controller is used to operate heating or cooling system to maintain required range of temperature within the limits. This device has alarming system to alert farmer in case of any problem of heating or cooling equipment. Moisture controller is used for controlling the operation of humidifiers and dehumidifiers in order to maintain required humidity level in shed. Light controller is used to

maintain duration and intensity of light in shed. Supplementation of artificial light along with natural light can be managed by this equipment. For manure handling and removing steel drag, trolleys, loaders, belt and loaders are used at farm. Electric devices used for electricity regulation at the farm are transformers, generators, uninterrupted power supply Units (UPS) and electric panels. There are various equipments which are used in offices or sheds. These equipments include, computers, printers, tables, chairs, racks, exhaust fans, air conditioners, refrigerators, weighing balances, automatic syringes, spray pumps, dissection box and fire extinguishers. Selection and quantity of such equipments is based on the size of flock and type of housing system.

4.12 Farm Monitoring Equipment

Farm monitoring equipment are used to evaluate performance of equipment installed at farm which includes

4.12.1 Temperature Meter

Manual or electronic thermometers are used to monitor temperature. Infrared thermometer is used to check temperature of birds, floor, walls, ceiling and electric motors. Thermometers are used to evaluate performance of heating and cooling devices and their controlling mechanisms. Temperature is monitored on daily basis in poultry houses.

4.12.2 Hygrometer

Hygrometer is used to monitor the relative humidity inside and outside shed. Moisture level in the poultry house should be checked every day.

4.12.3 Lux Meter

Lux meter is used to measure intensity of light. Light intensity in should be checked every week, because dust in the poultry house may accumulate on light source and reduces its efficiency.

4.12.4 Avometer

Avometer is used to measure speed of air in feet per minute (fpm). Some avometers also have additional functions to measure volume of air in meter per second (m/s), Kilometer per hour (Km/h) or cubic feet per minute (cfm). Damaged fan belt, fan pulley and dust on fan blades reduce its efficiency, which can be checked by using avometer. Performance of all fans installed at farm should be checked once in a month. Formula for conversion of fpm into cfm is as under

$$\text{CFM} = \text{FPM} \times \text{Area in Cubic Feet.}$$

4.12.5 Static Pressure Meter

Alteration in efficiency of fans, excessive opening of ventilators or any cracks in building results in reduction of required static pressure in building. Static pressure meter should be used at farm every time when ventilators are adjusted for a required static pressure and air speed. Reduction in static pressure is also indication of poor fan's performance. It is therefore, advised to use avometer along with static pressure meter to ventilation system precisely.

4.12.6 Volt Meter

Volt meter is used to measure voltage available at farm and availability of voltage to each of electric equipment. In case of three phase wiring there should be equal voltage on all three phases. Drop of voltage on any phase may damage electric motors. It is therefore, recommended that volt meters should be permanently installed at farm on all three phase lines. A portable volt meter should also be kept at farm to measure voltage at equipment side.

4.12.7 Ampere Meter

Ampere meter is used to check electric load of various electric equipments installed at farm. A regular checkup of feed delivering motors and exhaust fans motors is important. Over loading or malfunctioning of these equipments may result an increase of their amperes utilization. Efficiency of exhaust fan can also be checked by its electric consumption in amperes and its air delivering capacity. For example, a fan motor takes 2.5 amperes and deliver 20000 cubic feet of air per minute will be better than a fan which takes 3 amperes for the same amount of air.

4.12.8 Carbon Dioxide Meter

Carbon dioxide in shed should not exceed more than 1% or 10000 ppm. Therefore, availability of CO_2 meter especially in high density cage layer house is very important. Daily check of CO_2 level in shed is important for optimum production of layer birds kept in environment controlled cage housing system.

4.12.9 Ammonia Meter

In environment controlled deep litter housing system estimation of ammonia is important factor for managing ventilation of poultry birds. It is, advised to ckeck ammonia level in adult laying birds and broilers during finishing stage daily. Ammonia level in poultry house should be less than 0.0025% or 25 ppm.

4.12.10 Insulation Meter

Insulation meter is required to measure insulation (R-Value) of poultry house. Excessive moisture and condensation alter insulation values of poultry house. Insulation is an important factor for calculating minimum ventilation requirements of birds kept in an environment controlled poultry house. Therefore, availability of insulation meter is important for precise calculation of ventilation requirements.

4.13 Economics of Poultry Housing

Economic of poultry housing deals with estimation of cost of housing and equipments on the production of poultry bird. Over all economics of poultry bird is based upon its cost of housing, cost of equipments, cost of chick, cost of feed, cost of labour, cost of fuel and cost of medicine. For calculating cost of housing and equipments, information required is as under

4.13.1 Type of Bird and Space Requirements

Type of birds includes broiler, layer, broiler breeder or layer breeder. Floor space requirements for each type of bird is different for example, in an environment control house space requirements for broiler, layer, broiler breeder and layer breeders are 0.6, 0.75, 2.25 and 1.5 square feet / bird respectively.

4.13.2 Size of Flock:

Requirement of area and equipments is also based upon size of flock for a specific bird. Area of shed and its construction cost is calculated on basis of floor space requirement of a specific bird. However, in multi-tier cage housing system, more number of birds can be raised in same area as compared to floor housing system.

4.13.3 Various Components of Farm Building

Area specifications (length, width and height) and cost of construction per square foot area of various components of poultry farm is required to calculate total cost of construction of poultry housing. Floor space requirement for different type of birds is required only for construction of poultry sheds. Whereas, construction cost of other essential components of poultry farm building should also be included in calculation of cost of housing for a bird.

4.13.4 Annual Depreciation

Annual depreciation rate for buildings is 5% per annum and in case of equipments it is 20% per annum. For calculating cost of housing per bird, after calculating the total cost of construction, annual depreciation rate is calculated and then it is divided by total number of birds served in the house during a year to calculate cost of housing per bird. Similarly, after calculating total cost of equipments installed at farm, annual depreciation of equipments is calculated to calculate cost of equipment per bird. Dividing annual depreciation rate by number of bird's server per year will give rearing cost of bird. An example of calculating cost of housing is given in Table 4.4 and equipments are given in Table 4.5.

Table 4.4. Cost of housing per bird for a flock of 30000 broilers (Year 2015).

Type of House	Environment Controlled House			
Type of Birds	Broiler			
Floor Space Requirement	0.6 ft^2/Bird			
Flock Size	30000 birds			
Housing Specifications	Length	Width	Cost/ft^2	Cost of construction
a. Shed	400	45	400	7200000
b. Office	10	10	800	80000
c. Feed store	20	20	400	160000
d. Labour room	10	20	400	80000
e. Equipment store	10	10	400	40000
f. Wash room	6	10	800	48000
g. Generator/ Electric panel room	6	10	400	24000
h. Total cost of Construction	= (a+b+c+d+e+f+g)			7632000
i. Annual Depreciation @ 5%	= h × 5/100			381600
j. 6 flocks, 30000 birds/flock raised	= (6 × 30000)			180000
k. Housing cost/bird	= i/j			2.12

Table 4.5. Cost of equipments per bird for a flock of 30000 broiler birds.

Cost Feeding System:	Requirement (No.)	Cost of Equipment
Feeding lines	3	
Feed hopper	3	
Feed pan per line	158	
Total number of pans per house	468	
Number of birds per pan	64	
Total feeding system cost		**1250000**
Cost of nipple drinking system:		
Water lines	4	
Nipples per line	625	
Total number of nipples per house	2500	
Number of birds per nipples	12	
a. Drinking system cost		**535000**
Cost of ventilation system		
Fans required	8	
Number of pads (6.5ft*2ft*0.4inch)	52	
Number of Inlets	58	
Number of wench	2	
Control panel	1	
b. Total cost for evaporative cooling system		**977000**
Miscellaneous Equipments		
Energy savors	140	28000

Refrigerator	1	32000
Automatic syringe	1	8500
Generator	1	600000
Cost of heater	1	400000
Cost of transformer	1	300000
Wiring of electricity and water		200000
Water pump	2	15000
Lux meter	1	15000
Air velocity meter	1	10000
Infrared thermometer	1	5000
wet blub thermometer	1	1000
Office equipments, manure and feed handling equipments		200000
c. Total cost of miscellaneous equipments		**1814500**
d. Total Cost of Equipments	(a+b+c+d)	4576500
e. Depreciation of equipment	= e × 20/100	915300
f. Birds rear in one year	= 6 × 30000	180000
g. Equipment cost per bird	**= f/g**	**5.08**

Conclusion

Poultry housing layout, water quality, construction, insulation, feeding, watering systems, brooders and modern poultry instruments contributes a great in modern day poultry units. Each of these has its due importance for economic production of meat and eggs. Proper housing system and equipments quality aid in poultry production.

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Chapter 5

Poultry Farm Management

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Abstract

Poultry farm management is a prerequisite for running poultry enterprise in a successful manner. Special care is needed for purchasing good quality chicks and similarly good brooding is required for better production performance. Farm practices like feeding, watering, ventilation, vaccination, debeaking, lighting, shifting of birds, weighing are routinely practiced to fetch better economic output. Farm records and feasibility reports are also necessary for poultry farming business.

Keywords: Brooding, rearing and production practices, feeding, molting, feasibility reports.

Introduction

Proper prebrooding and postbrooding management practices will ensure better brooding of chicks. Proper floor space, feed, quality water, vaccination, medication, temperature, relative humidity, ventilation, disinfectation, sanitation, debeaking, weighing and shifting are prerequisites for successful poultry farming. Flock management during winter and summer season requires due consideration. Nowadays cage farming is preferred by poultry farmers due to efficient production performance and more profit margins. Proper light intensity and duration, feeding methods, induced molting techniques, computers and feasibility reports have important role in poultry farming.

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5.1 Preparation for Receiving the Baby Chicks

Special practices and measures that are performed before chicks arrive at a farm to take proper care with a good start are termed as pre-brooding practices/measures.

5.1.1 Pre Brooding Management

Pre brooding management means various measures for brooding of newly hatched chicks before arriving at a farm which are dicussed below.

5.1.1.1 Selection of Shed

Select shed for brooding carefully which should be isolated from other sheds. It should be at least 80-100 ft. away from other sheds. It reduces chance of infection. Fence or boundary wall save birds from predators.

5.1.1.2 Cleaning

Newly built shed requires little cleaning/disinfection with proper fumigation. If shed was occupied by a flock, special care must be taken for its cleaning.

5.1.1.3 Litter Removal

First of all, remove all cages, drinkers and feeders from shed as they would prove a hurdle in litter removal. Equipments should be cleaned, washed and disinfected. Litter removed should be dumped far away from shed to reduce contamination risk.

5.1.1.4 Dusting, Web Removal and Repair

Once litter is removed, next priority should be removal of spider webs that bloom up here and there on walls. Remove dust sticking to walls. Flying birds usually find their way into sheds and build themselves nice and comfortable nests in the ceilings. These too should be removed. Next comes repairing. All cracks, crevices/gapes in walls, floors or ceilings should be filled up. All leakages, in gas or water pipes should be repaired and sealed. Electric short circuits should be repaired. All supplies should be checked. Walls should be cemented plastered at least 2.0-2.5 feet. from ground to reduce chances of microbial growth.

5.1.1.5 White Washing

After, cleaning and repairing, next step is white washing, this too would not only bright the shed, but also disinfect it especially if chemicals like $CuSO_4$.

5.1.1.6 Washing and Disinfection

Once cleaning, repairs and white washing have been done, it is best to wash whole shed and if possible give it second washing using some detergent, with water. Shed may then be disinfected with a strong disinfectant such as quaternary ammonium compounds or phenols. Walls plastered (2.0-2.5 feet) too should be disinfected preferably with boiling water because it is powerful and economical.

5.1.1.7 Equipment

Equipments earlier removed should be scrubbed clean with brush and later on sprinkled with some disinfectant such as $KMnO_4$. Once clean, they may be dried in sunshine and then transferred to sheds before fumigation.

5.1.1.8 Fumigation

Next on the agenda would be fumigation. For this purpose, formaldehyde gas is most suitable, at strength of 3X. 40% formalin + $KMnO_4$ in an earthenware can be used for fumigation (1X = 17.5 g $KMnO_4$ + 35 ml formalin for 100 $feet^3$).

5.1.1.9 Clean and Disinfect the Ground

Remove debris, burn feathers and grasses should be sprayed with disinfectant.

5.1.1.10 Time

Shed cleaning and disinfection is recommended at least a week before arrival of chicken. All pathogens cannot be eliminated; survivors may multiply on chicks, feed and waste. A shed left empty may wipe out pathogens as nothing is there to multiply on.

5.1.1.11 Supplies

i. Litter: Rice hulls or sawdust (soft wood) is usually used as litter material.

ii. Feed: Usually ground maize (with less than 12% moisture) is offered to day chicks which because it is easily digestible and its high fiber content reduces pasting problem. However, offering feed to day old chicks is also in practice.

iii. Fuel: Sufficient stock of diesel, wood, coal is to be maintained at farm.

iv. Spare parts: Specially, if away from main city, store required spare parts.

5.1.1.12 Equipment Testing

Never forget to check functional capability of brooders. Burners should be controlled properly: gas or electric supply should be proper. Similarly, hover and wire netting should be nice clean and disinfected.

5.1.1.13 Chicks Arrival

Chicks arrival early in the morning is preferred to take care properly. Counting of chicks is recommended. In cold weather brooders should be turned on at least 10 hours before arrival to warm up the shed. Place chick guard 2-3 ft. from brooder edge and increase area weekly and remove it after few weeks when they learn heat source. This reduces cannibalism and increase feed utilization. Litter should be two inch deep with double layer of newspaper paper on it. Usually upon arrival flushing is done using sugar solution. Feeders initially is not required, feed may be spread on brooding paper. Antibiotics may be administered for 3-5 days to reduce early chick mortality. At the end of day, replace upper layer of papers which could have become wet. Manager should be present and ever alert. Closely regulate shed and brooder temperature. Carefully observe the chicks during brooding period for proper management (Brown 2010; Prasad 2010).

5.2 Brooding Requirements and Rearing of Young Stock

5.2.1 Litter and Paper Materials

During brooding, type and condition of litter material is very important. There are many types of litter material such as sawdust, rice hulls and wood shaving. Provide litter material which is more absorbent and less costly. In Pakistan, mainly rice hulls are used; it is cheap and has poor absorbing power. Sawdust is a good litter material having high absorbing property but somewhat costly. Brooding paper or newspaper is used during first week to offer feed on floor system. If litter is too much dry there is a tendency to increase respiratory problems. If litter becomes too wet, increases chances of respiratory problems, worm infestation and coccidiosis.

5.2.1.1 Properties of Good Litter Material

Good litter should be good absorbent, light in weight, having medium size particles, inexpensive and easily available. Cover floor with about 2 inches of the material. Do not use a litter treated with an insecticide/herbicide preservative.

5.2.2 Chick Guards

Chick guards are necessary to confine day-old chicks to the heated area and to concentrate the feeders and waters within small areas. They are also helpful to keep out draft and cold air. A chick guard made of cardboard or metal sheet with 15 to 18 inches height should be placed around the hover. Chick guard will need to be farther from stove, normally distance should be about 30 inches (76 cm) in winter and 36 inches (91 cm) is summer. As soon as chicks learn source of supplementary heat, guard must be expanded to allow a greater area inside them. Start increasing floor area on 3rd day. Chick guards are used up to 6-9 days and then removed.

5.2.3 Floor Space Requirement

Growth and feed conversion are related to floor space per bird, more you crowd birds, poorer the results. Recommended floor space is given in Table 5.1.

Table 5.1. Floor space for each chick during 5 or 6 weeks of age.

Type of bird	Floor space per bird		
	Ft²	m²	Birds/m²
Broiler	0.500	0.050	20.0
Leghorn egg type pullet	0.758	0.070	14.3
Leg horn breeder pullet	0.850	0.079	12.7
Leghorn egg type cockerels	1.000	0.093	10.8
Meat type breeder pullet	1.000	0.093	10.8
Meat type breeder cockerels	1.250	0.116	8.6

Source: Haq and Akhtar (2004)

5.2.3.1 Effect of Reduced Floor Space

Provision of less floor space to flock may decrease feed consumption, growth rate, feed efficiency and increase mortality, cannibalism and breast blister.

5.2.4 Temperature and Lighting

Temperature is one of the most important requirements of brooding. Temperature should be properly controlled during winter and summer months. Sufficient heat should be provided in winter month to avoid chilling while excessive heat should be minimized in summer months to avoid overheating. Thermo-regulatory mechanism of young chick is not equipped for maintaining normal body temperature when chicks are exposed to high or low temperature. Young chicks when exposed to such an abnormal temperature for even a short time will develop intestinal disturbance, which are manifested by diarrhea. In brooding chicks, it is desirable to provide range of temperature so that chicks may have some choice in selecting temperature more suitable to them. It is difficult to recommend any brooding temperature applicable to all type of brooders and in all conditions. However, 95°F plus minus 5°F temperature at 6 inches distance outside canopy and 2 inches above top of litter is satisfactory for chicks at first week of age. Brooder temperature should be reduced by 5°F weekly according to age but not beyond 75°F. Chicks placed under brooder locate heat source being surrounded by chick guards.

In case of brooding of breeder flocks, to male chicks of 2-3 days provide, 2-5°F more temperature than required for females, remembering that they have hatched a few hours earlier than females and subjected to additional operation of dubbing, toe clipping along with beak trimming. Keep birds comfortable all the times. High brooding temperature causes dehydration, pasting, reduced feed consumption. Due to dehydration, there will be electrolyte imbalance and thus no uniformity in growth. Low temperature causes chilling, respiratory problems, and increases feed consumption that disturbs feed conversion ratio. Temperature of breeder chicks should be determined with accurate thermometer and controlled with reliable thermostat. Behaviour of chicks will provide best guide for measuring temperature. If chicks are uniformly spread in brooder area it means temperature is comfortable for chicks. If they are too far out, temperature is too high, if under the brooder then temperature is too low. If chicks are on one side of brooder it means that they move to avoid cold draft coming from opposite side. Meanwhile chicks to be provided 24 hours light through energy savers or light emitting diodes fitted at 6 feet height.

5.2.5 Ventilation

Ventilation is supply of fresh air (oxygen) and removal of metabolic and toxic gases from shed such as CO_2, CO, NH_3. Ventilation should be properly controlled; ventilation is harmful for birds. Main problem in cold environment is removal of moisture from house because bird's droppings contain approximately 75-80% moisture, so considerable air exchange is required to keep brooding area dry. Excessive moisture, NH_3 and CO is removed during brooding of chicks. This condition can be controlled in moist climate by having open front brooder house,

which may partially close with curtains in cold weather. In cold weather when chicks are brooded in tightly close brooder house with fuel burning stove. CO_2, CO gases may increase in concentration to a point which is fatal to chicks. Poisoning can occur when air contains about 0.01% CO. In acute cases symptom of this poisoning is gasping, head thrown back, spasm and death. When poisoning is slow only a stunted growth and unthrifty condition can occur.

The injurious effect of CO poisoning is caused by asphyxiation, which results from combining of CO with haemoglobin of blood and thereby destroying ability of blood haemoglobin to carry oxygen to tissues. In winter ventilation is increased to remove moisture produced by poultry as they grow in size, more cold air is drawn in from outside and some supplementary heat should be provided to heat this extra volume of cold air. In winter, ventilation which keeps brooder house reasonably dry would assume an ample supply of fresh air. Be careful temperature should not be maintained at expense of ventilation. An air flow of 2 cubic feet per minute per 100 chicks will be enough during brooding period. Proper ventilation is necessary for O_2supply and removal of metabolic products such as CO_2, NH_3 and CO. Removal of moisture and heat is important in determining ventilation rates.

5.2.6 Humidity

Relative humidity (RH) in brooder house may vary from 30-75% without any harmful effect but 65% is ideal one. Try to maintain 65% relative humidity. Extremely high or low humidity will not give better results. High humidity will cause damp litter, which will help in the multiplication of microorganisms. Parasitic infestation chance increases for coccidiosis disease. Very low humidity will cause poor feathering and dusty litter, which will cause permanent irritation in respiratory tract that, can lead to respiratory problems. Try to keep litter dry avoid excessive dampness. Droppings contain 75-80% moisture which causes high humidity especially in winter. Sunlight is powerful disinfectant, as well as good source of vitamin D which is required for bones development. In cold weather, litter becomes wet very soon, so to control this open window and allow sunlight entrance in shed. It will not only keep the litter dry but also act as a disinfectant.

5.2.7 Sanitation

During brooding care should be taken regarding sanitation as chicks are very sensitive to diseases. Many disease organisms may be transferred with chicks from hatchery if brooder house is not properly clean, losses due to mortality can increase. A brooder house should be thoroughly cleaned and well disinfected before starting brooding at least one week before the arrival of chicks. Spray formalin 40% (1:12 formalin: water) in brooding room. Keep separate attendants in brooder houses and do not allow them to move in other sheds. Keep visitors away from brooder house and take care of visitors/attendants dress when they enter into brooder house. Damp litter and sick birds cause spreading of diseases. So always keep litter dry. Scatter an absorbent such as superphosphate on litter over dropping. It not only acts as absorbent but also as a preservative for making a good fertilizer after mixing with droppings. Frequent change of drinkers place will help to keep

litter dry. Stir litter otherwise it will become lumpy and wet. Separate and treat sick birds. Dispose off dead birds in disposal pit or incinerate them. Adult birds should not be mixed with young chicks. Many disease organisms are filth born and unless brooder rooms or houses are reasonably cleaned, losses from mortality may increase. Thoroughly clean and disinfect brooder house before starting brooding or at least one-week before arrival of chicks (Sreenivasaih, 2006).

5.2.8 Flushing and Supplements

After receiving chicks first of all flushing is done to provide energy source (3% sucrose solution) as well as to clear digestive tract. For this purpose, use 250 g sugar/gallon of water followed by vitamins and essential amino acids in water/feed.

5.2.9 Feeding and Drinking

Feed should be offered 4-5 hours after flushing and water be provided 24 hours.

5.2.10 Broad Spectrum Antibiotics

During first week use any one broad-spectrum antibiotic for 5-7 days to reduce chances of infections.

Furazolidone	15-20 g/bag feed
Furazole	80 g/bag
Furasole	1 teaspoon/gallon water
Tribersin	1 ml/gallon water
Trimodin	1 teaspoon/gallon water
Erythro FZ	1 teaspoon/liter water

In winter use medicine through feed and in summer mostly through water.

5.2.11 Vaccination

To reduce chances of disease outbreaks following vaccines must be used in addition to other vaccines as per recommendation of Pakistan Poultry Association.

From	7-10 days	ND eye drops
From	10-14 days	Gumboro eye drops
From	22-25 days	ND 1/2 CC (sub-cut)
From	30-32 days	Gumboro in drinking water
From	6-8 weeks	Fowl pox (wing web)

5.2.12 Debeaking

Process of cutting 1/3rd of upper beak (1/8th of an inch of upper beak) and making it blunt so that feather picking habit can be controlled is called debeaking. Debeaking is necessary to prevent cannibalism, toe picking, vent picking and feather picking. It is done at the age of 07-10 days of age. Prospects and consequences of debeaking are given in Table 5.2.

Table 5.2. Pros and cons of debeaking in poultry.

Advantage	Disadvantage
Cannibalism problem is reduced.	Birds lose weight for 1-2 weeks.
Feed efficiency is improved.	Growth rate is reduced for long period.
Live ability is better.	
More uniformity of birds in the flock.	

5.2.13 Avoid Predators and Pilfering

Control predators like mice, mongoose, dog and cat. These can be controlled by traps and using chemicals. Their control is necessary because they can waste feed and transmit many diseases. Avoid pilfering by making sudden visits to farm.

5.2.14 Weighing

Birds kept under brooding are weighed on weekly basis at random to know their growth and assess feed supply from time to time.

5.3 Shifting and Housing of Pullets

Growing or rearing period follows brooding up to sexual maturity of birds. It is about 12 weeks in case of laying strain. How well a bird is grown will greatly determine how it does in laying house. Performance of laying birds depends upon the efficient management during this critical period, regarding housing, feeding, watering, temperature, ventilation, sanitation, lighting and disease control. Poor quality pullets at maturity will always perform below breed's standard of egg production, egg quality, feed conversion and size of egg.

5.3.1 Housing Management

Mostly young pullets are removed to rearing houses from brooding houses at 6-8 weeks of age. But nowadays in modern poultry rearing this practice is no longer used. Birds are left in brooding house until they are 10-12 weeks of age, then they are moved to growing house and laying is complete there. Keeping birds in brooding house for entire life or transfer of birds to permanent laying houses at young age reduce stress and chances of disease out breaks.

In Brood-Grow house, birds are kept in same house during brooding and rearing period while in Grow-Lay house birds are moved at 10 weeks age to permanent-laying house. However, in Brood-Grow-Lay house birds are kept in same house from one day of age until end of laying. In Partial-Cage-Rearing birds are brooded on floor up to 6-8 weeks then moved to cages for rearing and laying while in Complete-Cage-Rearing birds are brooded in battery brooders, kept in cages for rearing and laying period.

5.3.2 Floor Management

In Litter Floor system floor is completely covered with litter while in Slat and Litter Floor system a portion of floor is covered with slats. In this system, feeders and waterer are placed on slats to concentrate droppings there. In All Slat Floor system birds are kept in a house having slats over entire floor.

Table 5.3. Floor space requirements during rearing (litter floor system).

Line	Floor space / bird ft^2	Floor space / bird m^2	Birds/m^2
Mini Leghorn pullets	0.8	0.07	14.3
Leghorn pullets to 18 weeks	1.0	0.09	11.1
To 22 weeks	1.5	0.14	7.1
Medium size pullets to 18 weeks	1.2	0.11	9.1
To 22 weeks	1.7	0.16	6.3

5.4 Cage vs. Floor Management

Broilers, layers and breeders are kept on floor for efficient production however; cage system is also used effectively in layers. Cage rearing was introduced in Pakistan about thirty years back however during last decade cage rearing of layer birds was very much popularized and there is a geometric shift in layer farmers towards cage management after the adaptation of environment controlled housing. However, in case of broiler and breeder birds still needs a long way to go and for them most popular management is floor management. Main reasons for which may be small life span of 35 days in broilers and difficulty in mating and unavailability of skilled labor for artificial insemination. Despite these factors there are examples of cage rearing in broiler as well as breeder cage management. Floor and cage space requirements during rearing are given in Table 5.3.

5.4.1 Management of Pullets on Floor

Criteria of a laying hen are set on ability to produce eggs economically. One must start with a healthy pullet to ensure good productive performance during laying period. As layer beings to produce eggs, ability to do her job well will depend on management. Good management comprises of proper environment, modern and adequate equipments, proper light, balanced nutrition and timely vaccination. All these result in improved livability, endocrine activity, reproductive performance and ultimately in good and economical egg production.

5.4.1.1 Laying Period

Layer bird matures at 16-20 weeks of age with 1250-1300 g of live weight. At peak production (28-29 weeks of age) its live weight should be 1500 g. Layer birds may be kept from 20 to 72 weeks of age or even in cage system.

5.4.1.2 Selection

In order to obtain good production yield during laying period, a healthy flock must be selected. Moreover, the flock should be uniform with respect to age and weight.

5.4.2.3 Preparing for Pullets

i. Cleaning

While moved from a growing house to a laying house just prior to sexual maturity, young pullets must be given a clean start. So, usual routine of cleaning house and equipment, disinfection and sanitation must be made a part of management program.

ii. Litter

A cleaned house needs new litter. Litter be dry, easily available, free of mold and economical. Add about 3 inches in summer and 4 inches in winter months. Commonly used litter materials includes saw dust, rice hulls and sand.

iii. Nest Preparation

A good, dry, dust free nesting material should be used to avoid egg breakage. Nests should be open about a week before first eggs are laid, so that pullets get accustomed to them. Nesting material should be cheap, absorbent and possess cushioning ability. Nests are placed at dark place.

iv. Automatic Equipment

Be sure that all automatic equipments are in working condition. For example, stand by generator, bulbs, fans and valves of automatic waterers.

5.4.2.4 Space Requirements for Layers

i. Type of Floor

When covered with litter, floor may be either of mud/bricks or concrete. Concrete is easier to clean and maintain and is recommended. Chance of disease transmission to new flock is also reduced.

ii. Floor Space Requirements

Larger the bird, more the floor space is needed. It also depends on type of floor as layers on slats or wire require less space than those on litter floor. Required floor space per birds is 1.00-1.25 sq. ft.

iii. Feeders

Keep bottom of feeder at same height as backs of birds. About 20% more birds can eat from same feeder space provided by a round pan as compared to that provided by a straight trough. Feeding space requirement per bird is 3 inches on trough.

iv. Drinkers

Many type of drinkers are used in floor type layer housing. Some are automatic trough type or circular, other have running water, pans, cups and nipples. Since pullets drink more water at high temperatures, therefore while planning for drinkers, plan for maximum water requirement. Drinking space of 1.25 inches / bird is required.

5.4.1.5 Nests

i. Single Compartment Nests

It is preferred by most poultry men to keep commercial layers on floor. Provide one nest hole for each five pullets to have an ample space during high egg production. Sufficient nest will aid in prevention of floor eggs. Hens will use these nests better if placed crosswise in shed. For laying birds, nest should be 12" wide and 14" deep.

ii. Community Nests

They are occasionally used as 1 for 35 hens. A compartment of 2'× 8' feet in size has a hole at each end for birds to leave and enter. Bottom should be 24 inches above floor.

i. Roll Away Nests

In these nests wire bottom is sloped so that eggs roll to a compartment in back. When used in a litter floor house, bottoms should be 24 inches above floor (Bell and Weaver 2007).

5.4.1.6 Feeding Program

Layer birds are fed chick starter (ration No. 1 or 11) from 1st to 8th week of age; ration number 2 or 12 (chick grower) from 9th to 20th week of age and ration number 3 (layer mash) or 13 (layer crumbs) from 21st week onward.

i. Change in Feeding Program

To fulfill laying requirement ration number 3 or 13 (with 17% CP and 2700 M.E.) is offered to birds. In order to avoid over-weight problem, feeding is regulated in a way that an amount of 5 gm per week is added 71+5 g feed by start of laying at 20th week of age and at peak provided @ 110 g feed/day.

5.4.2 Management of Layers in Cages

In case of layer management, cage system is best one, however, with respect to health and production, cage system is better than floor system. Cages are mostly used in environment controlled houses.

5.4.2.1 Laying Cage Size

Although height of most laying cages is quite similar (16 inches) at rear of cage, size of floor area is highly variable. Some common floor dimensions (width × depth) are as follows:

Width × depth (inches)

10 × 16
12 × 16
12 × 18
14 × 18
16 × 18
24 × 36 (colony cages)
24 × 48 (colony cages)
49 × 36 × 24 cm (height × depth × width) for two birds

There are different types of pullet cages according to number of birds. In Single bird cage one or two pullets are kept in a cage while in Multiple bird cages two or more pullets are placed but not more than eight. Colony cages are suitable for holding 20-30 pullets.

Laying cages are of different types cages according to number of birds. In Single deck one tier cage cost is high. This type is used only in warm climate where house consists of nothing but a roof. Double deck cages are popular because upper deck of offset, allowing droppings to fall through wire mash on house floor without touching lower deck. Triple, four and five deck cages are also common. Tilting dropping boards installed below the top cages cause manure to fall in to the area. Flat deck cages are also called wall to wall houses. Cages are placed closed together without distance.

Table 5.4. Floor space of caged Leghorn at different stages.

Hen (White Leg Horn)	Brooding Stage (0-5 Weeks) $(inches)^2$	Rearing Stage (6-18 Weeks) $(inches)^2$	Laying Stage (Above 19 Weeks) $(inches)^2$
1) Floor Space			
Mini Leghorn	20	36	48
Standard Leghorn	24	45	60
Medium Leghorn	28	54	70
2) Feeder Space			
Mini Leghorn	1.6	2.0	2.4
Standard Leghorn	2.0	2.0	3.0
Medium Leghorn	2.2	2.7	3.3
3) Water Space			
Mini Leghorn	0.60	0.80	1.25
Standard Leghorn	0.75	1.00	1.50
Medium Leghorn	0.80	1.20	1.70

5.4.2.2 Floor Material

Floor material is made up of fabric wire, which should be welded. Mesh size is usually ½ inch and floor should be covered with paper for first 2 weeks.

5.4.2.3 Feeder

Trough feeder is usually used during brooder.

5.4.2.4 Temperature

House temperatures should be maintained at 70-75 °F. If temperature is above this range, dehydration occurs. Feed intake is also low due to high temperature. In case of hot weather, temperature can be maintained by plantation around the sheds and spray water on roof. Due to high temperature, feed consumption of chicken is reduced. So, increase nutrients level is feed. Artificial heating can be provided in cold weather if needed.

5.4.2.5 Construction Style of Floor

Floor of cage is constructed in such a way that egg cannot stay at the laying point. So floor wire of cage should be sloppy.

5.4.2.6 Water

In case, birds use more water as compared to floor birds. Supply more water in cage management due to restricted area allocation for birds.

5.4.2.7 Transfer Pullets to Laying Cages

Between 12-14 weeks of age, transfer pullet to laying cages earlier to settle.

5.4.2.8 Automatic Drippings Collector

In laying cages, use automatic egg collector. It consists of 2-4 inches wide belt, which cause movement of eggs to collection point.

5.4.2.9 Prevention of Feed Wastage

Feed loss in cages is more and low light intensity reduces feed wastage. Don't overfill feed in trough. Proper debeaking reduces feed loss.

5.4.2.10 Poor Egg Shell Quality

Egg shell is of poor quality at the end of laying year. It is still common in summer months, vitamins requirement for egg production increases during high egg production. Major vitamins are A, D, E, K, thiamin, riboflavin, pantothenic acid, niacin and vitamin B_{12}.

5.4.2.11 Major Problems

In cages, major problem is more flies. To control this problem, frequently clean droppings. Successfully fly control problem is possible by keeping droppings dry, encouragement of beneficial insects that consume parasites, immature and mature flies. Spray of Neguvon on litter dropping and better sanitation reduces flies.

5.5 Raising Broilers, Layers and Breeders

5.5.1 Broiler Management

Broilers are chickens kept for meat purpose to meet protein requirements. Broilers have inherited ability to grow rapidly and attain 1.5 kg of live body weight by consuming 3.0 kg feed within 5 weeks. Broiler production is becoming very

important aspect of poultry production because of scarcity of meat. Before starting any business keep in mind cost and return from business.

5.5.1.1 System of Broiler Keeping

Most practical program for broiler rearing is all in all out system. In this system broiler chicks of one age are at farm at same time. All chicks are housed on same day and later sold on the same day. After this there is a gap when no chicks are on the farm. This gap breaks the cycle of any infectious disease.

5.5.1.2 Housing

Broiler houses are also termed as brooder houses because broilers are sold at 5-6 weeks age. Usually two types of broiler houses are commonly used.

i. Open Sided Houses

Open sided houses are non-insulated with three solid walls and remaining side closed with wire netting. Usually curtains are used to open and close this open side. In humid and hot zones where temperature and humidity are very high all the year, use of open houses is recommended.

ii. Environment Controlled Houses

Such houses are light proof and artificial light is used in the building and ventilation is by exhaust fans. Temperature and humidity are automatically controlled.

iii. Size of Broiler House

Broiler house size depends upon the number of broilers to be housed and housing system.

iv. Depth and Length of the House

Open sided houses should be 30 feet wide. It may be of any length whereas environmentally controlled houses should be 40-50 feet wide and 200-400 feet long.

5.5.1.3 Feeding

Broilers have inherited ability to grow rapidly and it became ready to be market in just 5 weeks. This is due to their better feed consumption and conversion. Provide quality feed in right amounts. Before feeding chicks, keep in mind nutritional requirements. Provide 2″ trough space up to 5 weeks and 3″ until market time. Provide 20 % less space/bird when circular pans are used. One pan/3.3 chicks should be provided.

5.5.1.4 Antibiotics

Broilers are more susceptible to diseases so use some broad spectrum antibiotics to chicks to prevent the early chick mortality. Provide antibiotics from 3-7 days of age. If flock is healthy then stop antibiotic supplementation after 3 days.

5.5.1.5 Water

Water is most important factor in broiler management. Broiler body contains about 70% water so the birds should be provided ample amount of water to keep this amount 70% constant. Water is also essential in digestion, absorption, metabolism and temperature control. Water should be free from any kind of contaminations and also it should not be salty because salty water may cause salt poisoning. Provide two chick founts for every 100 chicks at the start of brooding period. Later each broiler should have 0.75 inch (2 cm) of drinker space when troughs are used. Provide 20% less space/bird when circular pans are used. Provide 1-gallon drinker for 25-30 broilers. In environment controlled house one nipple drinker is provided to 10-12 birds.

5.5.1.6 Vaccination and Disease Control

Vaccinate birds according to vaccination schedule prevailing diseases in the area. Vaccination schedule for broilers as given in Table 5.5.

Table 5.5. Vaccination schedule for broilers.

Age (Days)	Vaccination	Method
07	New Castle Disease	(Eye Drops)
10-14	Gumboro	(Eye Drops)
16-17	Hydropericardium	1/2 cc I/M
22-25	New Castle Disease	1/2 cc I/M
30-32	Gumboro	Drinking water

5.5.1.7 Special Care

Do all vaccinations at proper time. Pay special attention to sanitation always provide broad-spectrum antibiotic during first week to reduce chance of early chick mortality. Then use any coccidiostat at the end of 3rd week to reduce chance of coccidiosis especially during high humidity season or wet litter conditions. Always remember that vaccines and medicines are not free meal so use them judiciously only when needed.

5.5.2 Layer Management

Criteria of a laying hen is set on her ability to produce egg economically. One must start with a healthy pullet to ensure good productive performance during laying period.

5.5.2.1 Laying Period

Layer bird starts egg laying mostly at 16 weeks age and may be kept up to 72 weeks of age. However, in cage system, hens are also kept for longer durations.

5.5.2.2 Selection

In order to obtain good production yield during laying period, a healthy flock must be selected. Moreover, the flock should be uniform with respect to age and weight. Floor space requirements are given in Table 5.4.

5.5.2.3 Preparing for the Pullets

i. Cleaning

While moved from a growing house to a laying house just prior to sexual maturity, young pullets must be given a clean start. Usual routine of cleaning house and equipment, disinfection and sanitation must be made a part of management program.

ii. Litter

New litter is added in a clean and disinfected house. 3 inches litter is added in summer and 4 inches in winter months. Commonly used materials as litter include saw dust, rice hulls, sand and crushed corn cobs.

iii. Nest Preparation

A good, dry, dust free nesting material should be used to avoid egg breakage. Nests should be open about a week before first eggs are laid, so that a pullet gets accustomed to them. Nesting material should be cheap, absorbent and possess cushioning ability. Keep nest at dark place.

iv. Automatic Equipment

Be sure that all automatic equipments are in working condition. For example, stand by generator, bulbs, fans and valves of automatic waterers.

5.2.4 Space Requirements for Layers

i. Type of Floor

When covered with litter, floor may be either of mud/bricks or concrete. Concrete is easier to clean and maintain and is recommended. Chance of disease transmission to the new flock is also reduced.

ii. Floor Space Requirements

Floor space depends on type of floor as layers on slats or wire require less space than those on litter floor. Required floor space per birds is 1.50-1.75 ft^2.

iii. Feeders

About 20% more birds can eat from same feeder space provided by a round pan as compared to that provided by a straight trough. Feeding space requirement is 3 inches on trough.

iv. Drinkers

Many type of drinkers are used in floor type layer housing. Some are automatic trough type, some are circular while other has running water, pans, cups and nipples. Since pullets drink more water in high temperatures, therefore while planning for drinkers plan for maximum need. Drinking space of 1.25 inches/birds be provided.

5.5.2.5 Nests

i. Single Compartment Nests

It is preferred by most poultry men to keep commercial layers on floor. Provide one nest hole for each five pullets to have an ample space during high egg production. Sufficient nest will aid in prevention of floor eggs. Hens will use these nests better if placed crosswise in the house. Place floor of lowest tier, 24 inches above floor. For laying birds, nest should be 12" wide and 14" deep.

ii. Community Nests

They are occasionally used as 1 for 35 hens. A compartment of 2' × 8' feet in size has a hole at each end for birds to leave and enter. Bottom should be 24 inches above the floor.

i. Roll Away Nests

In these nests wire bottom is sloped so that eggs roll to a compartment in back. When used in a litter floor house, bottoms should be 24 inches above floor.

5.5.2.6 Feeding Program

Layer birds are fed chick starter (ration No. 1 or 11) from 1st to 8th week of age; ration number 2 or 12 (chick grower) from 9th to 15th week of age and ration number 3 (layer mash) or 13 (layer crumbs) from 16th week onward.

i. Change in Feeding Program

To fulfill laying requirement ration number 3 or 13 (with 16% CP and 2750 M.E.) is offered to birds. Feed is offered according to Layer Management Guide/ Manual. During production hens are provided feed @ 110 g/day.

5.5.2.7 Weekly Culling

Under weight, emaciated, inferior, crippled and deformed birds should be removed from flock during growing period, because they do not perform well in laying houses.

5.5.2.8 Sanitation and Bio-Security Measures

Bio-security principles and sanitation measures are most important managemental practice during rearing of laying strain, to avoid any disease outbreak in flock during this critical period. These points require due consideration; separate caretakers should be employed in each unit or house, before start of rearing period growing house should be properly disinfected, add clean litter to the house and keep the litter free from moisture, keep equipment clean and different disinfectants and sanitizers should be used after 3-4 days in house and in proximity. Keep rodent (rat) and wild birds (sparrow) away from growing houses because they transmit many pathogenic organisms, used litter material and dead birds should be kept away from house, vehicle used for feed delivery be kept away from growing house. Daily visit should be performed with respect to flock health.

5.5.2.9 Vaccination and Disease Control

Disease outbreak during rearing period not only causes mortality but also greatly depresses performance in laying houses and so causes great economic losses. Follow proper vaccine schedule during brooding and rearing period to control outbreak of disease like ND, Infectious coryza, laryngotrachietis, fowl pox and Marek's. Proper management of litter reduces the chances of parasitism.

i. External Parasites

Birds be checked for presence of ecto-parasites after very 3-4 weeks. Lice, mites and flies should be controlled by using DDT (1:8 ratio of DDT: ash), Coopane powder and Ecofleece.

ii. Internal Parasites

Internal parasites are Round worm (Ascaridia galli), Caecal worm (Heterakis gallinarum), Capillaria worm (Capillaria obsignata) and Tape worm (Raillietina sp.). These should be controlled by using different dewormer like Piperazinc powder (1 g/kg of feed), Rintol (1 g/kg of feed), Albendazole, Oxyclozamid and Systamax.

5.5.2.10 Record Keeping

To keep all sorts of record is another important practice during growing period. Record keeping tells us about what happened in past and help us to plan for future business. During rearing records regarding source of flock, vaccination, medication, feed consumption, body weight, culling and mortality are maintained.

5.5.3 Breeder Management

Birds from grandparent flocks are kept as breeders to get progeny to produce meat or eggs. There are two types of breeder parents.

5.5.3.1 Meat Type Breeders

Meat type breeders are those which produce straight line the broiler chicks. These are hybrid of two breeds. From female line *Plymouth Rock* or *New Hampshire* is used and from male line *White Cornish* is used for the production of white skin broiler and light Sussex is used for the production of yellow skin broiler.

5.5.3.2 Egg Type Breeders

These breeder parents produce commercial pullets those lay white or brown-shelled eggs for human consumption. Breeder parents, producing pullets which lay white eggs, are developed from cross of different strains of pure white leghorn. Breeder parents, producing pullets, which lay brown-shelled eggs, are hybrids of Rhode Island Red (male line) and barred Plymouth Rock (female line).

i. Rearing Methods

These are methods of rearing the breeder parents.

a. Sexes Reared Separately

It is recommended to rear cocks and pullets separately until 21 weeks of age and then mix 12 cockerels with 100. At sexual maturity (about 22-24 weeks) reduce No. of males to 9-11/100 females.

b. Sexes Intermingled

Keep sexes separate for first week, during this period beak trimming is done and smaller cockerel chicks will get a good start.

ii. Housing Systems: Same as in layers please refer to section 5.3.1.

iii. Floor Management: Same as in layers please refer to section 5.3.2.

iv. Target Weight

Target weight of broiler breeder male is 3.0 kg and female weight is 2.5 kg at 23 week of age for sexual maturity these targets can be achieved by suitable feeding and lighting programme. In case of layer breeder flock, target weight at sexual maturity for male and female should be 1.5 kg and 1.3 kg at 20 weeks.

Table 5.6. Body weight recommendation with respect to feed (Hubbard).

Age (weeks)	Weight of male (g)	Weight of female (g)	Feed consumption of male (g/day)	Feed consumption of female (g/day)
7	850	725	43-50	45-55
8	970	825	45-53	50-60
9	1090	925	48-55	55-65
10	1210	1025	50-58	60-70
11	1330	1125	53-60	63-73
12	1450	1225	55-63	65-78
13	1580	1315-1340	58-65	68-80
14	1710	1405-1455	60-68	73-85
15	1845	1500-1570	63-68	78-88
16	1985	1600-1685	68-75	83-93
17	2130	1700-1800	73-80	85-98
18	2280	1800-1915	80-88	88-103
19	2430	1900-2030	88-95	93-108
20	2580	2000-2145	95-103	98-110
21	2750	2155-2290	103-110	100-118
22	2950	2290-2450	110-118	103-115
23	3180	2450-2650	118-125	105-118

Source: Haq and Akhtar (2004)

v. Number of Breeder Males Required

Number of breeder males to start should be determined by each company's experience. Under normal circumstances 12-15 breeder males/100 females should be started and brooded. This will normally provide 10-11 healthy and vigorous breeder males per 100 female housed. Too many males in the

breeding pen reduce fertility. Correct ratio of males and females depend upon size and type of birds involved. 100 pullets require more males on slats, slats-and-litter than on all litter floors. Male to female ratio does not affect frequency of male mating.

vi. Feeding and Watering Management

a. Feeding Management

Proper amount of feed should be given to birds to meet body needs and to control body weight, follow feed restriction if required as already discussed. Old feed should not be left in feeders. Upper rim of trough should be approximately level with bird's back. In order to avoid feed wastage trough should be filled only one-fourth full. Set time clock for more frequent feedings as it increases feed consumption. A drop in feed consumption may be an indication of a disease problem or poor feeding.

b. Grit Feeding

Grit/any calcium source is necessary for bones and strong eggshell. To avoid economic losses due to eggshell problems, grit/calcium supplementation alleviates eggshell problems.

c. Water Management

Water consumption is highly variable for all types and ages of chickens depending upon ambient temperature, humidity, density of feed and amount of feed restriction. But during rearing period if all these conditions are good then water should be given to birds 30 minutes before and 1.5 hours after feeding and after every 2-3 hours water is given to birds for 20 minutes. According to our environment ad-libitum water is more suitable.

d. Automatic Drinkers

Automatic waterers are used and water level is maintained through valves. V-shaped trough is also used but depth of trough should not exceed from 1.3 cm. There may be accumulation of debris in depth and there will be more chances of disease out breaks. Always keep waterers clean: wash them daily Keep water level as high as possible during the first days. In order to avoid spoilage, maintain lower water level in drinkers. Check height of automatic waterers and adjust to height of back of birds. Wet litter must be removed. The area around the water should not be wet because due to wet litter there are more chances of parasitic infestations.

vi. Average Body Weight

Average body weight must be according to recommended body weight of breed. Weight losses due to transportation or other stress factors may alter average weight. Good uniformity in growing period is a pre-requisite for good production. 80% or more of pullets should be within 10% of average recommended body weight of flock.

vii. Methods to Control Body Weight

There are two methods to control body weight of breeders up to target weight.

1. Quality restriction
2. Quantity restriction

As body weight is main criteria, in case of breeder flock restrict quality (protein and energy) of feed or quantity of feed or restrict both quality and quantity of feed. When birds are underweight then improve quality of feed by adding different amino acids for proteins or by adding fat. Increase quantity of feed by increasing amount of feed offered daily or both operations can be done simultaneously. To increase birds weight, make weight groups of birds.

viii. Measuring Weight Progress

Take individual weight of 100 birds at intervals to determine uniformity and average weight of flock. When birds are not uniform (80% of birds within 10% of average) cause may be overcrowding, disease, poor debeaking or inadequate nutrient intake. During growing period, weight birds one week before a ration change is planned. If they are not at desired weight, change of ration is not recommended. When proper weight for age is accomplished, a change to less dense ration may be made. Weight birds before they are moved. Do not weight them for at least 2 weeks after moving. A two week delay in weighing will allow birds to adjust to their new housing and return to a normal body weight.

ix. Culling

Males having leg defects or other undesirable traits should be culled from flock to maintain uniformity. Inferior, crippled and deformed birds should be removed from flock during growing period.

x. Sanitation

Sanitation measures includes strict security, no visitors, lock the premises, dry litter and regular disinfection.

xi. Record Keeping

Proper record are maintained for daily feed intake, feed consumption, live body weight, medication, vaccination, mortality and unusual flock symptoms.

5.5.4 Male Breeder Management

Importance of males in breeder flock cannot be neglected. They do not only contribute their half of the genes to newly hatched chicks but they are also responsible for hatching egg fertility.

5.5.4.1 Brooding

In hot weather or after a long journey provide then water to avoid dehydration. To maintain a good health, temperature should be one degree higher than for female.

5.5.4.2 Rearing Methods

i. Separate Rearing

Where possible rear males separately until 23 weeks of age. Advantages of separate rearing are maintaining recommended weight easily, easier to maintain uniformity and better control on sexual maturity.

ii. Rearing Males Mixed with Pullets

Where separate rearing facilities are not available it is advisable to rear males with the pullets from around 6-8 weeks. In mixed rearing. Feeding males and female separately is recommended.

5.5.4.3 Floor Management

Clean and dry litter is necessary if breeders are to be kept on floor. 6 birds are kept per m^2 (1.8 ft^2/bird, 1.9 for pullets and 2.1 for breeder male for standard strains) at rearing stage. While, 4.5 birds/m^2 are kept during production period (1.75 ft^2/bird for Leghorn and 3.0-3.25 ft^2 for meat type breeders).

5.5.4.4 Feeding and Watering

Feeding program during growing period is same for male and female. Feeding Space: 8.75 cm space is required for one male bird on through feeders. Adequate fresh water supply is important to breeder flock and demand increases greatly as ambient temperature rises. With through type waterers provide a minimum drinking space of 2.5 cm per bird.

5.5.4.5 Weight Control

Excessive weight at maturity must be avoided. Try to maintain recommended weight according to breed i.e. in broiler breeder males weight at maturity is 3.3-3.5 kg. In layer breeder males, weight at maturity is 1.5-1.7 kg. In overweight or underweight control it by changing quantity and quality or feed and make different weight groups of males. Feed according to their weights. Body weight of broiler breeder is as given in Table 5.6.

5.5.4.6 Special Care of Breeder Flock

During 26-34 week bird mostly become heavy due to poor management of lighting and feeding. They must be supplied proper light and feed. So for getting good production manage feeding as given below:

Weight (g) at 26th week		Feed (g/bird/day) 26th week
Male	3815	120
Female	3135	140
Weight (g) 34th week		Feed (g/bird/day) 34th week
Male	3950-4310	130
Female	3350	170

5.5.4.7 Feeding after Peak Production

Reduce feed gradually after peak production (3-4 g) per week in such a way that it reaches 135-140 g at the end of production. Sudden change in production causes negative effect. From 26-34 weeks increase feed in small quantities (4-5 g/bird/week). Sudden supply of full feed will increase the body weight.

5.5.4.8 Lighting

Lighting duration should be 10 hours at 24th week. It should be 12hrs at 25th week. After that increase light at the rate of ½ hrs/week till it reaches 16-17 h then fix it.

5.5.4.9 Culling

Individual unproductive and inferior pullets should be removed from laying house. Remove birds with a hook about once a week. Do not catch entire group to remove cull birds. Such handling generally will reduce egg production in entire flock. It is not difficult to select laying from non-laying birds. Chart for selection and culling of breeder flocks is shown in Table 5.7.

Table 5.7. Selection and culling chart for breeder flock.

Character	Select	Cull
Health and vigor	Vigorous, active and good capacity	Weak, sluggish, under sized and lacking capacity.
Comb and wattles	Full. smooth glossy bright red	Shrunken, dull, dry, pale and scaly
Eyes	Prominent bright eyes	Not bright
Vent	Large, moist, smooth	Small, dry, round
Pubic bones	Thin, flexible and well spread	Thick, hard, closed together
Abdomen	Soft, pliable	Contracted firm with coarse skin.
Pigments	Bleached vent, eye rings, ear lobe, beak & shanks	Yellow pigments, on shanks. Eye rings, ear lobe and beak.

Source: Haq and Akhtar (2004)

5.6 Causes of Poor Performance of Layer and Breeder Flocks and their Remedies

Poor performance of poultry flocks can be attributed to numerous factors of layer and breeder flocks are discussed separately in following subsections.

5.6.1 Main Causes of Poor Egg Production

Improper production results in economic loss. Whereas, good production means less cost more profit. There are three factors affecting the egg production.

5.6.1.1 Genetic Factors

Egg production is genetic factor with 15% heritability.

a. Sexual Maturity

Age at sexual maturity is 25% heritable. Sexual maturity should be at proper age with proper live body weight.

b. Rate of Laying

Number of eggs per clutch is characteristic of each individual bird and rate of laying is highly heritable in White Leghorn.

c. Broodiness

There are breed differences with respect to amount of broodiness among laying flock. It is believed that a sex-linked gene and at least one autosomal gene are involved in broodiness.

d. Uterine Prolapse

This is also genetic character and mostly uterine prolapse occurs in the bird due to genetic factor and cause low egg production.

e. Persistency of Production

First laying year includes period from commencement of laying to cessation of egg production, proceeding to onset of first complete cycle.

f. Moulting

Early moulters are usually poor layers whereas late moulters are good layers.

5.6.1.2 Environmental factors

There are several environmental factors that affect rate of lay and total number of eggs produced by a flock during the laying year.

a. Date of Hatch

With respect to market approximate date or season of year when chicks are hatched is of great importance. In some cases, chicks hatched during January and February may start laying during July or August which affects production.

b. Location

Three strains of pullets of same breed showed that difference in egg production due to location and environment were more consistent and significantly greater than the difference due to strain.

c. Temperature

At high temperature birds consume less feed which will affect egg production. At low temperature birds use energy to maintain the body temperature and egg production is affected.

d. Smoke

Pathological findings showed congestion hemorrhage in ovaries, trachea, lungs and intestine. Kidneys enlarged by 1.5 to 2.5 times than normal due to smoke. So, egg production is dropped and death or disease can attach by more smoke.

e. Noise

Due to noise age at 1st egg may slightly be delayed. When their egg production was subjected to noise it was 20 % less than that of controls. But no difference occurs in egg shell mineral content.

5.6.1.3 Management Factors

Egg production might decrease due to followings;

a. Housing

Due to improper housing birds have permanent stress and low egg production.

b. Water

Fresh and clean water should be provided because feeding and watering have strong correlation. If watering is not proper, then less feed intake and low egg production can result.

c. Light

Light should be according to required duration and intensity, which is 16-17 hours (¾ foot candle) during production. Avoid fluctuation during production. Never decrease light during production.

d. Shifting of the Birds

Birds be shifted to laying house 3-4 weeks before start of egg production.

e. Improper Feeding, Watering and Floor Space

Les floor space cause cannibalism, injury and stress and can reduce egg production. Less watering and feeding space results in less consumption of feed and water which reduce egg production.

f. Culling

This includes sick, small and cannibalistic birds and birds out of production. It these birds are more in number; this will reduce egg production. Culling should be done in layers regularly specially at 15-20th, 30th and 45th weeks of age.

g. Imbalanced Ration

Major causes of poor egg production are due to improper nutrition, toxic feed and poor feed intake (salt, vitamin D, calcium, protein and phosphorous). For normal egg production, bird's requirements are as follows;

Protein requirement	7.00 g/bird/day.
Ca requirement	3.75 g/bird/day.
M.E. requirement	260-270 Kcal/bird/day

h. Diseases

Diseases like Infectious bronchitis (IB), Fowl cholera, Coryza, New castle disease (ND), Avian influenza, Mycoplasma gallisepticum affects production performance of birds.

i. Parasites

Parasites have severe effect on egg production. The birds should be free from internal and external parasites. Do regular deworming for this purpose. Different medicines are used to control parasites.

J. Mortality

Mortality affects production of the flock which may be controlled through proper management, vaccination and medication.

k. Other Changes on the Farm

These changes are in labour, feed manager and vaccination programs. During production, any one of them can affect production performance.

l. Stress on Birds

Stress also effect on bird's performance. Try to eliminate all kinds of stresses (Daghir 2008). General causes of stress in layers are given in Table 5.8.

Table 5.8. General causes of stress in layers.

1.	Coldness	2.	High temperature
3.	Vaccination	4.	Transportation
5.	Debeaking	6.	Diseases
7.	Feed change	8.	Appearance of stranger.
9.	Electric failure.	10.	Change in lighting schedule.
11.	Predators	12.	Delay in feeding and watering

5.6.2 Major Reasons of Poor Performance of Breeder Flock and their Remedies

5.6.2.1 Genetic Factors

If a bird has a poor genetic potential like poor feed efficiency, poor growth rate, less resistance to diseases, bird performance will be poor. A bird should have a genetic potential to grow fast have acceptable body conformation, be resistant to diseases. Chicks should come from disease free breeder. Chick quality at hatching influences performance of birds at later stages. So, a broiler should have the genetic potential to be efficient in converting feed into meat.

5.6.2.2 Effect of Pre-Brooding Management

Extra care should be taken during pre-brooding and brooding to avoid any disease outbreak in early life of chicks. Following factors can affect the performance of breeder chicks.

a. Un-Hygienic Condition

Hygiene and sanitation is very important to control the early chick mortality so if proper measures are not adopted regarding sanitation early chick mortality may causes great Economic loss. Disease outbreak in a flock not only causes high mortality but remaining flock cannot achieve standard production targets.

b. Old Litter

Old litter contains lot of microorganisms and it is not viable to take risk by using old litter in case of breeder flock. Used litter increases chances of diseases out breaks.

c. Temperature

Temperature is one of most important factor during brooding which affect growth of small chicks. Any abnormal temperature cause stress on to birds which in turn causes disease outbreaks. Abnormal temperature reduces feed intake, depresses growth and feed conversion ratio of birds.

d. Improper Handling

Improper or rough handling during vaccination, debeaking and dubbing increases stress in chicks and affect their growth. They should be handled in proper way in young age.

e. Control

If brooding room is new then only spray with any disinfectant will suffice the purpose. In case old brooding room then remove old litter, wash equipments by dipping in $KMnO_4$ solution, also wash water tank with $KMnO_4$ repair the building fill cracks, repair the electricity, sui gas connections and wiring. White wash house including $NaOH/CuSO_4$ which kills microbes. Temperature of house should be 95 °F before arrival of chicks. Brooder should be started at least 10-12 hours before arrival of chicks.

5.6.2.3 Brooding and Rearing Problems

Some managemental problems include followings.

a. Temperature

Temperature should be 95 °F when the chicks are first placed in brooder house. Chicks should be confined near heat; temperature may be reduced by 5°F for each week. Excessive heat causes dehydration, poor feed intake and more water intake of birds. Low temperature will cause chicks to huddle together and some may become smothered. During brooding provide 2-3 °F more temperature to males. Avoid smoke in house during brooding which can cause respiratory problems.

b. Ventilation

Excessive moisture, NH_3, CO and CO_2 are required to remove otherwise they affect health of birds. Improper ventilation also helps in diseases outbreak. So, use exhaust fans for proper ventilation.

c. Early Chick Mortality

It is very common managemental problem that is seen in first two weeks of life of chicks and it is due to pasting, starvation and poisoning.

i. Pasting

It may be due to overheating of chicks or due to infection. To overcome pasting flushing is done.

ii. Starvation

This problem is seen when chicks are received from a very far distance. Symptoms are loss of weight, emaciation and death during first week.

Control

Chicks must be fed after 16 hours of hatching. Feeding space should be proper. Proper lighting and temperature should be provided.

iii. Litter Poisoning

Wet litter allows molds to grow and cause NH_3 poisoning and Coccidiosis. Keep litter dry to control litter poisoning.

iv. Cannibalism

It is habit of vent picking and toe picking. It may be due to less water, feeding and floor space. It may also be due to deficiency of different nutrients. For control of cannibalism separate affected birds, reduce light intensity and keep birds busy by hanging grasses.

v. Floor Space

If floor space is improper then feed intake will be less, growth rate will be poor and disease outbreak will be more. Birds are always in stress. Therefore, proper space should be provided at each stage of birds.

vi. Predators

Rats and mice can cause heavy losses. They eat feed and transmit diseases.

Control

For rodents control store feed properly. Remove all wastes of birds and seal all cracks and openings. Rodenticides may also be used for this purpose i.e. Boremethalene zinc phosphide.

vii. Injuries

Injuries may occur during sexing, cannibalism and dubbing. During sexing injuries like broken legs, wings, damage of rectum and cloaca may occur. If wounds increase in size it may cause septicemia and death may occur. Dubbing results in injuries of comb.

viii. Pilfering

To avoid stealing by workers sudden checks must be made at farm. For control of this bad habit proper record and checking is necessary.

ix. Hatching Time

Hatching time should be proper according to breed of birds. Early hatched chicks are weak and smaller in size while late hatched chicks are also weak, lazy and more prone to diseases.

Control

Temperature, relative humidity and ventilation of incubator should be proper and use clean eggs for hatching.

x. Feed, Water and Medicine Poisoning

Sometimes salt in feed especially when fish meal is used increased salt level which may cause salt poisoning. Fungus infected feed is also a cause of poisoning. Over dose of the medicines also cause poisoning in birds.

Symptoms

Liver and kidneys are inflamed and damaged. Hemorrhages on breast and thigh muscles are noted in case of feed poisoning. Water deposition in abdomen of chick is sign of salt poisoning. For control flushing is done to remove poison from body.

5.6.2.4 Production Stage

i. Target Weight

Our target is to produce healthy and quality parents. For this purpose, weight of broiler breeder should be 3.5 kg for male and 2.9 kg for female at 24 week of age. Target weight for layer breeder should be 1.5 kg for male and 1.260 kg for female at 20 week of age.

ii. Feeding

Controlled feeding is necessary for maintenance and growth. Over feeding affect fertility, hatchability, weight gain in male and females and egg production in layers.

Vitamins should be given along with water to control stress. If feed is sub-standard, production efficiency will be affected. Vitamin B-complex. pantothenic acid, riboflavin and vitamin E should be especially provided.

Factors affecting feed efficiency are quality of feed, temperature, rate of egg production, health and weight of layer

iii. Lighting

To obtain optimum age and weight at sexual maturity and production, the influence of day length and light intensity is very important. Sexual maturity is also influenced by light stimulation. It is major factor which affects necessary physiological changes, which stimulates the ovulation. Always provide recommended light duration and intensity. Never decrease light during egg production. Provide 16-17 hours of light per day during this critical period. Provide light intensity of ¾ ft. candle at bird level during laying period. Avoid decreasing light time and intensity. Do not use dim light at night.

iv. Male and Female Ratio

Keep under normal circumstances 12-15 breeder males for 100 breeder females.

v. Broodiness

Broodiness almost has been removed in most of strains but it can cause problem in broiler breeder and brown egg shell layer breeder flock. Factors which enhance broodiness must be eliminated. For controlling this problem frequency of egg collection must be increased and proper nesting managemental practices must be followed.

vi. Management of Male

Male is more important than female because half the germplasm of newly hatched chick is transferred from the sire. If there is some problem with males (nutrient deficiency, over and underweight) it can cause great loss to males. If not managed properly, farmer cannot get production up to the mark. For getting good production at 24^{th} week age male must be only 30% heavy than female. At mid and end of production it must be 8.4% heavy than females. During breeding period, males must be carefully watched and inferior male must be removed. There is proof that male mate with certain females and if a particular male become unable to mate his matching females she will not take another male until he is removed from flock. Do not catch males with one leg. Catch them carefully by both legs. Handling of male by one leg may permanently injure birds. Males exercise is necessary to maintain proper weight, and strong legs. Male must jump to get feed from feeder. Feeding some grain in litter in afternoon induces scratching worth with exercise. Sometimes competition in feeding is also helpful in exercise. As bird ages during laying cycle there is natural reduction in fertility. A serious economic situation may be produced. Hatches may be poor. Some poultry men replace old males in a flock with a set of new and younger ones after about two-third of egg production period are over so due to this, fertility increases but it can affect peck order. Males set up a social order as do females; more timid males must be adequately produced. Be sure they are getting enough feed to maintain

recommended body weight. If underweight you should add cockerel feeders to the pen to increase the male feed consumption.

vii. Hatching Eggs Care and Management

Maintaining quality of hatching eggs is of vital importance. Eggs should be gathered from nest at least four times a day. During period of extremes in temperature more collection is advisable. Frequent egg gathering is necessary to prevent egg contamination from bacteria. Farm workers are urged to disinfect their hands before each collection. Nest egg should be picked up with clean hands. One of the poorest practices is to pick floor eggs, dead birds and nest eggs at the same time. Keep nest clean and in good condition. Use clean plastic trays or new fiber trays to prevent disease transmission. It is advisable to grade the eggs during or after each pick up. Imperfections, in shell shape and size must be kept away from hatching eggs. Hatching eggs should be sanitized immediately after each collection. Spray the eggs thoroughly with eggshell sanitizer i.e. Quaternary Ammonia. In case of Formaldehyde gas, it should be done at temperature of 75 ºF or higher and at relative humidity of 75% or more. Cool hatching eggs gradually. Eggs should be stored in a temperate below threshold of embryonic development. For short time storage egg room temperature should be 60-65°F (16-18°C). When eggs are held for more than 14 days the temperature should be towered to 56°F (13-14°C). Relative humidity of air should be maintained at 75-80%. Keep egg room as clean as possible and disinfect periodically. Always place eggs with large end up. Keep egg room clean: disinfect the room twice a week.

vii. Vertically Transmitted Diseases

Vertically transmitted diseases are Salmonella, Mycoplasma, Avian Leukosis and Avian Encephalomalacia. It is recommended to control diseases by regular laboratory testing and removal of carrier birds.

ix. Hot Weather

Prior to high temperatures, it is advisable for male to be allowed to gain little extra weight and fleshing as they will surely lose condition in the high temperature and will produce poor semen quality which can reduced fertility.

x. Health

Main diseases of breeder are Marek's disease, Bronchitis, Infectious Bursal disease, Fowl pox, NewCastle disease, Avian Encephalomyelitis and Avian Influenza.

Key points for healthy production are to maintain premises free of potential disease hazards, proper dead bird disposal, disease diagnosis and vaccination.

5.7 Light Management

5.7.1 Lighting for Broilers

In broilers light intensity and duration is not as important as in case of layer or breeders. Only that amount of light should be provided to birds so that they can move, see, eat and drink properly. For this purpose, provide 40 watt bulb/200 ft^2 area for 24 hours.

5.7.2 Lighting for Layers and Breeders

Light intensity as well as duration affects age at sexual maturity. Thus, lighting management during brooding is an important responsibility of manager of a layer and breeder farm because if duration of light period is less it causes late maturity. If duration of light period is more then it causes early maturity of bird due to which egg size remain small for several months and chances of prolapse also increases. Light provided during rearing is 10-11 h, which give satisfactory results. In most cases, natural day length is provided to birds but in light proof houses during rearing period light is also provided in regulated means by artificial source. In growing houses where natural daylight is provided, light period should be adjusted with change in day length. Do not increase light duration during rearing period.

5.7.2.1 Duration of Light for Pullets

If chicken hatched between 1st March to 31st August (in season) then provide 24 h light for first 3 days. Provide natural light up to 15 weeks. Then provide 10 h light during 16 weeks of age and 12 h light during 17 week of age. Then increase 30minutes light time per week until 16-17 h.

If chicks hatch between 1st September 28 February (out season birds). Then provide 24 hrs light for 1st 3 days. Then determine day length at age of 20 weeks. Add 7 hrs in it for 1st week, and then decrease the light by 20 min/week until 19 weeks of age. At 20 weeks supply, at least 10 hrs light and during 21 week provide 12 h light. After 21 weeks of age increase 30 minutes time/week until 16-17 h light is achieved, this target will continue till end of productive life birds.

5.7.2.2 Intensity of Light

High or low intensity of light affects age and weight at maturity and ultimately performance of birds in laying house. It should be 2 feet candle during brooding, ½ foot candle during rearing and ¾ foot candle during laying.

5.8 Management of Flock during Hot and Cold Climates

5.8.1 Poultry Farm Management in Hot Climate

Chick is warm blooded with high metabolic rate. Overall performance of chicken either for meat or egg is governed by the interaction of two important factors.

5.8.1.1 Genetic Constitution

A bird can full fill its genetic potential only when it is treated with sound management practices.

5.8.1.2 Environment

Extreme summer and winter are quite detrimental for birds. Summer heat is one of major important environmental factors that all farmers of tropical countries experience among their flocks. At environmental temperature of 32°C higher results heat stress leading to production losses. When temperature of 35°C or more persists, farmers can suffer many problems.

i. Problems due to High Temperature

High temperature in poultry results in high mortality, low feed intake, reduced egg production and size, poor eggshell quality, increased respiratory rate, reduced resistance to diseases, reduced fertility and Nervous signs.

ii. How the Effect of High Temperature Can Be Reduced

a. Construction of Poultry House and Management

Construct buildings for keeping in view climate of the area. Site of building should be appropriate. Long axis of house should be from east to west and sides should face north to south in hot areas to prevent direct sunshine. Convection ventilated housing is usually suitable for temperature in tropical areas. Normal body temperature of chick is 41ºC and relative humidity requirement is 65%. Interior Apex should not be less than 4 m to reduce air temperature at bird level. Roof overhead should be extended at least 0.8 m to limit solar gain though sidewalls. Lateral ventilation opening should comprise 60% of wall area. Roof should be insulated with fiber glass blanket or polyurethane sheet. White washing of roof with a good coat of line or aluminium painting will reduce temperature by about 10 ºF. Spray water on birds and roof of shed during hottest part of day. Plantation around shed also helps to reduce temperature inside the shed.

i. Ventilation

Heat disseminated from bird along with environmental heat cause a server threat to birds. Heat built up in sheds be eliminated out quickly otherwise heat stroke may result. Eliminate heat by installing fans and exhaust fans.

ii. Litter Depth

In summer, it should be decreased from usual recommended level. Litter should be raked properly. Some farmer use sand as litter.

iii. Floor Space

In hot season floor space should be more because more heat will be produced when recommended space is used. This heat produces more stress problems in addition with environment heat. It is advisable to reduce stocking density by

increasing floor space allowances. Floor space requirements (m^2) for broiler, layer and breeders are 7.0, 4.5 and 3.4, respectively.

Feed Consumption and Utilization

a. Feed

Ration energy content is prime factor in controlling feed intake, because birds eat primarily to satisfy their need for energy. During hot season the feed consumption usually reduces due to lower maintenance energy requirement. Reduction in feed intake is 3.6% per degree increase between 22 and 32 ºC. It could be related to age and genotype of birds. Energy level should be reduced; protein, calcium, phosphorous and all other important vitamins level in ration should be increased in extreme hot season. 17 gm protein and 270 kcal (M.E.) energy must be provided daily to each layer bird. Calcium requirement increases during hot weather, due to reduced feed intake and low blood supply to egg forming, system. Calcium and Phosphorus balance effects survival time during heat stress. Daily phosphorous requirement of bird is 225 mg but excess should be used during heat stress. In growing layer, chicks potassium requirement increases with increase in temperature being 0.4% at 25.7°C and 0.6% at 37.8°C. In hot weather, requirement of vitamin C increases. Provide more vitamin C as it helps to reduce effect of heat stress. During high temperature 200 mg/kg feed of Vitamin E is associated with immune response, in addition to maintaining integrity of the circulatory system. Vitamin E absorption and metabolism is elevated at 37°C compared to 24°C. Antibiotics, coccidiostat and growth promoters can be used.

b. Water

Water consumption is increased at higher temperature in comparison to normal season (22°C). Water consumption at 32°C and 37°C was 2.0 and 2.5 times higher respectively. Therefore, provide the cool, clean and fresh water.

Feed	Water
Normal (75°F)	1:2
When (95°F)	1:4

Ice block should be added to water at extreme hot temperature period. Cool butter milk can also be provided to bring down the stress. Antistress vitamin like vitamin C 1 to 2 g/20-liter water (½ tea spoon/5 gallon) can be helpful. More number of waterers should be provided. Use of molasses, can also be helpful.

c. Effects of Heat Stress on Health of Birds

Disease resistance of birds decreases in summer season so diseases can outbreak in hot season e.g. ND. Infectious Bronchitis, Infectious Bursal Disease. Heat stroke is most common in summer season which can cause brain hemorrhage. Symptoms of heat stroke are high body temperature, comb colour changes from red to bluish red and brain haemorrhages. To overcome this problem, use cold water tub at farm and dip suffered bird in tub especially bird head. It is helpful to remove this problem. Hot humid weather provides ideal

circumstances for coccidiosis and coryza. Adopt preventive measures to reduce mortality due to these conditions.

Precautions

Strict sanitation and disinfection with proper vaccination schedule be adopted.

5.8.2 Poultry Farm Management during Cold Climate

5.8.2.1 Influence of Winter

A high metabolic rate is observed in chicks, which are warm-blooded. Each bird has a genetic potential according to which it exhibits its productive performance. This genetic potential which has been gifted to birds by nature shows its full swing only when it is treated with a proper approach of managemental practices. Birds are unable to withstand or combat extremes of weathers. Very hot as well as very cold weather usually affect birds' performance. Extremely hot above (37°C) or extremely cold below (25°C) weather is lethal for bird's performance.

Open houses are best places where birds perform up to peak but in winter season, there is a headache of providing proper heating and ventilation. Birds suffer stress during winter. This stress must be lifted to let the bird exhibit its productive potential. During cold weather, birds become more prone to respiratory infectious diseases like Coryza and C.R.D. There will be poor weight gain in broilers and reduced egg production in layers. Certain precautionary steps must be taken, to reduce winter stress.

a. Brooding

i. Proper Brooding Practices

It is imperative to provide proper brooding practices especially in cold climate to get long range results. It is the only way which can make the bird exhibit its full genetic potential.

ii. Chilling

If the low temperature prolongs constantly rather frequently, there is a strong chance that the birds tend to be chilled. Situation is pretty much dangerous in young chicks and may lead to congestion of lungs and death.

iii. Suffocation and Trampling

During cold nights, evidence of over-chilling lies in fact that they tend to huddle together to warm themselves. Death occurs due to suffocation and trampling or piling. To eradicate this severity, increase bulbs or wattage/brooders.

iv. Electric Failure

Electric failure may cause the problem. To fight with this problem Petromax light or stoves must be kept ready. Preventive arrangements must be made for chance if smoke starts arising from stoves.

v. Cool Breeze

To cope with lashes of cool breeze entering poultry house, double curtain, one inside and one outside must be provided.

vi. Starvation of Chicks

In winter season, starvation of chicks occurs due to poor visibility of chicks resulting from drawn of curtains during day time. They find difficulty in locating the feeders. Lights should be on to combat this situation. At night if temperature is low birds do not come out of brooder, therefore feeders must be placed close to birds or preferable half way inside brooder.

b. Some Common Measures

Other measures for all ages of birds including broilers and layers are given below.

i. Dry Litter

Litter may also become a source of heat during winter. This must be properly exploited. Provision of dry litter with 2-3 inches thickness would serve purpose. It is also very essential to put a fresh litter. It is also advocated that litter must be regularly stirred and periodically lime powder must be mixed with to absorb moisture present there and to alleviate the ammonia smell. Eggs may become soiled in case if there is much moisture in litter material. It can also lead to outbreak of coccidiosis. To avert it, avoid flow of water form drinkers. If litter material is wet, then replace it with fresh dry litter.

ii. Energy and Protein

During winter season, grains must be replaced by 50% maize to increase the energy content. Energy, protein and vitamins must be present in diet in proper proportion.

iii. Feeding during Winter

To generate more heat in bodies of birds, some extra feed i.e. 5-10 g per bird must be offered during cold winter days.

iv. Water Consumption

Due to cold environmental temperature, water consumption is affected. Therefore, it is advocated that luke warm water, matching with room temperature must be provided to birds during very cold weather.

c. Most Common Diseases Related to Cold Weather

i. Coccidiosis

It is a managemental disease which outbreaks after 3rd week of age. Chicks and growers are much prone to this disease. Winter provides most suitable environment for spread of disease. Only preventive measure is to keep litter dry as much as possible by stirring periodically or using some other means.

ii. Chronic Respiratory Disease and Coryza

Chicks of all ages are prone to these diseases but growers and young pullets are more susceptible. Prevent them by improving sanitary and hygiene conditions.

iii. Feed Toxicity

It is very usual in rainy season. This must be checked timely otherwise it will lead to drop in egg production in layers, weight loss in broilers while mortality and lameness in chicks. Proper storage with more ventilation is required.

5.9 Feeding Practices

5.9.1 Broiler Feeding Management

Broilers are selected for rapid weight gain and efficient feed utilization. These chicks have a great capacity to convert feed into tender meat by their genetic background. It is difficult to establish a single set of nutrient requirement that is appropriate to all types of broiler production. In broiler production, it is necessary to take advantage of the early rapid growth. It requires careful attention to their feeding management.

5.9.1.1 Nutrient Requirement of Broilers

Due to rapid growth in broilers, their nutrition requirements are higher than of chickens being raised for egg production. Rapid growth of broilers results in higher nutritive requirements. There are two main feeding programs, one involves two rations and other involves three rations as given in Table 5.9. and Table 5.10.

Table 5.9. Requirements for two rations feeding programme.

Ration	ME (Kcal/kg)	CP (%)
Broiler starter ration # 4 or 14 (0-4 weeks)	3190	23-24
Broiler finisher ration # 5 or 15 (5^{th} week,-market)	3300	20-21

Table 5.10. Requirement for three ration feeding programme.

Ration	ME (Kcal/kg)	CP (%)
Broiler starter (1-14 days)	3080	24
Broiler grower (15-39 days)	3190	21
Broiler finisher (day 40 to market)	3300	18.5

Last five days before marketing is the drug (antibiotic) with drawl period.

5.9.1.2 Water and Feeder Space for Broilers

Ample water space that is 0.75 inches per bird should be provided and ensure the 24 hours supply of fresh water. Feed space about 2 inches (through space) up to 5 weeks of age and 3 inches until marketing should be provided per bird to ensure the maximum feed intake. Broilers are reared under 24 h light programme so that they can have unlimited access to feed level in the feeders fill (1/3 full) to prevent feed wastage.

5.9.2 Layer Feeding Management

Growing and developing a good pullet is one of the most important items in operation of a layer/breeder farm. Undoubtedly quality of bird at time of her production cycle begins, will greatly determine how profitable she will be during her period of lay. Therefore, special emphasis must be placed on feeding growing bird so that she may develop into a healthy productive individual and one that can fulfill her genetic potential. Mistakes made during growing phase cannot be corrected during laying cycle.

5.9.2.1 Nutrient Requirements of Egg Type Pullets

Each group of egg type pullets must reach sexual maturity at the correct weight.

For the sake of these reasons, the nutrients requirements of these egg type birds are lower than the meat type birds. Nutritional standards are given in Table 5.11. In market three types of rations are available for egg type birds.

a. Chick starter ration No. 1 or 11 (fed from 0-8 weeks)
ME = 2900 Kcal/kg CP 19%
b. Grower mash ration No. 2 or 12 (fed from 9-20 weeks)
ME = 2700 Kcal/kg CP= 15%
c. Layer mash ration No. 3 or 13 (fed from 21 wks.-end of production)
ME = 2800 Kcal/kg CP=17%

Table 5.11. **N**utritional standards for layers.

Nutrients	Amounts Required					
	Cool Climate			Warm Climate		
	6-12 week	12-20 week	21-72 week	6-12 week	12-20 week	21-72 week
Metabolizable energy Kcal/kg	2970	2750	2640	2750	2695	2750-2860
Protein %	17	15	19	19	16	17
Lysine %	0.85	0.75	0.75	0.95	0.95	0.72
Methionine %	0.42	0.38	0.38	0.47	0.42	035
Calcium %	1.00	1-3	4.00	1.00	1-3	4.00
Available Phosphorus %	0.50	0.50	0.50	0.50	0.50	0.50
Vitamin A IU/kg	11000	11000	11000	11000	11000	11000
Vitamin K mg/kg	4.4	4.4	2.2	4.4	4.4	2.2
Choline chloride mg/kg	1320	499	500	1320	499	500
Vitamin B_{12} mg/kg	0.013	0.013	0.026	0.013	0.013	0.026

At an age that is optimum to produce eggs economically during her laying year.

5.9.2.2 Feeding during First 6 Weeks

During first 6 weeks of life of chick, a well-balanced diet should be fed. In some instances, starter is fed for more than 6 weeks, if body weights are below standard.

5.9.2.3 Feeding from 6-20 Weeks

This is a critical period in development of an egg type pullet for how well she is grown will have an important bearing on her productivity during her laying period.

Feeding standards from 6 to 20 weeks are given in Table 5.12. A pullet must develop at a rate appropriate for her strain and reach sexual maturity at an opportune and economical age. Nutritional requirement during growing phase are vastly different from starting phase, especially amount of protein in growing ration. Protein must be materially reduced as her body weight increase. Because daily protein requirement of growing bird is relatively constant (7-8 g/day). Normally, total protein in ration should be reduced by about 1% per week after 6th week until it is 15%. Increasing protein in diet, increases body weight at maturity and decreases days to sexual maturity. Pullet should weight 1.35 kg at 20 weeks of age for maximum production potential.

i. Feed Control and Optimal Mature Weight

Feed control during growing period varies from full feeding to some degree of feed restriction to attain a given body weight and age at sexual maturity. For this program to be effective, it is necessary to maintain body weights on a weekly schedule beginning at 7 or 8 weeks of age. There are two methods of feed restriction.

a. Qualitative Restriction

Birds are fed low energy or low protein diets or diets low in both, however, birds are fed ad libitum.

b. Quantitative Restriction

The bird's feed is quantitatively (10-20% of recommended) reduced to provide the optimum amount of protein and energy.

5.9.2.4 Grit Feeding

Beginning from 8th week, feed 0.5 kg/100 birds/week hen size grit (0 number) on litter floor. Feed the allowance on one day/week.

5.9.2.5 Feed Changes at Sexual Maturity

Just prior to egg laying begins, several management practices and feed changes must be carried out such as increase in total light duration, feed allocation and growing ration must be replaced with a laying ration.

1. Calcium consumption must be increased.

Amount of feed consumed by the individual pullet just prior to and after production of her first eggs has an almost unbelievable pattern. Rapid daily increase in feed intake during first four days of egg production takes place. Pullet's calcium requirement is relatively low during growing period, but when first egg is produced the need is increased at least four times, for production of strong egg shells. Do not increase calcium until ten days before flock is expected to produce first egg. Two thirds of calcium supplemented should be large size flake oyster shell of coarse lime so that it can stay in gizzard. Grit should be provided @ 11.3 kg/1000 birds/month.

Table 5.12. Feeder and water space requirement.

	0-8 weeks	9-20 weeks	Onward
Feeder trough space	1-2"/bird	3"/bird	4-5"/bird
Waterers	2/100 birds/gal	2/100 birds/2 gal	100 birds/2 gal

5.9.2.6 Some Recommendations

a. Full feed starter until chickens are 5 weeks of age.
b. Full feed grower during 6th and 8th week.
c. Begin controlled feeding at 9th week of age.
d. At 20th week of age feed 13.6 kg of flaked oyster shell per 100 birds/week.
e. At 22nd week of age, if controlled feeding in growing, change to full feed.

5.9.3 Breeder Feeding Management

Breeding chickens may be divided into two groups; egg type and meat type. Because meat type breeders tend to become obese, their feed and feeding programs are much different than those used for egg type breeders, including the starting, growing and laying phases. Breeder parents have different nutritional requirements from commercial layers; careful attention is required for feeding management.

Nutrient Requirement of Breeders for Different Phases

a. Ration during Brooding
ME 2750-2850 Kcal/kg CP 17-18% and Ca 0.90%
b. Ration during Growing
Layer breeders
ME 2950 Kcal/kg CP 15% (6-20 weeks) and Ca 0.90-0.95 %
Broiler breeders
ME 2860 Kcal/kg CP 18% (5-9 weeks) and Ca 0.90-0.95%
15% (10-15 weeks)
12% (16-22 weeks)
c. Ration during Laying
Layer breeders
ME 2970 Kcal/kg CP 17% and Ca 3.5-4%
Broiler breeders
ME 2860 Kcal/kg CP 16% and Ca 3-3.5%

5.9.3.1 Feeding Breeders during Starter Period

From day old to 5 weeks, the starter rations should be approximately same for egg type male and female breeders as for commercial egg type pullets. However, if chicks are raised on a litter floor or slats a coocidiostat should be added. If average weights of birds are below standard, continue feeding starter until target weights are attained. Easy access to feed can be provided by use of chick feeder trays or clean chick box lids at the rate of one per 100 chicks during first week. Feeding and watering space for breeders are given in Table 5.13.

5.9.3.2 Feeding Breeders during Growing Period

Breeder pullets should become sexually mature (produce egg) at a specific age and specific body weight. Pullet stimulated into production before are not in optimum physical condition, will fail to peak, have poor egg size, producer a high percentage of double yolk and suffer an increased risk of prolapse.

a. Layer breeder target weight at 24 weeks

Male	1.9 kg	Female	1.5 kg

b. Broiler breeder target weight at 26 weeks

Male	3.0 kg	Female	2.5 kg

Meat type breeder females producing broiler off springs possess the inherent ability to grow rapidly. When full fed during the growing period they gain excessive weight and deposit too much fat. Restrict the caloric intake to produce pullets that are smaller at time of laying. Process of weight control must be under taken in entire growing period of broiler breeders. Always adjust the amount of feed to meet body weight target. Commence controlling amount of feed from 6-8 weeks of age.

i. Method of Controlled Feeding

In quantitative restriction birds are offered a measured amount of normal feed to meet body weight target while in qualitative restriction birds are fed low energy, low protein or low energy and protein diet. Birds are full fed in this programme.

ii. Uniformity

Body weight at different ages must be according to company recommendations. To maintain the uniformity first weigh a sample of each group of birds within house and established an average weight for flock. Acceptable weight band is established by multi playing average weight by 110% to obtain upper limit and by 90% to establish lower limit. Weigh birds in flock and remove all light weight birds to a separate pen. Overweight birds should also be separated at this time. Underweight birds should be gradually brought up to target weight for age by a small increase in their daily feed compared to average, but do not attempt to make up weight difference too quickly. Over weight birds should not have their feed reduced, but increases in feed should be low than those given to birds within target weight band. 90% of birds should always be in weight band of ± 10% of average of flock.

iii. Feeding Grit during Growing

On a feed day, feed 0.5 kg of large size grit (zero number) per week per 100 birds. Program of changing egg type breeders from the growing to the breeding ration is identical to program for changing egg type commercial pullets from a growing to a laying ration. Necessarily a breeder ration capable of producing high hatchability of the egg laid is to be used rather than a laying ration. Substitute breeder ration when flock is about 20 weeks of age to build yolk reserves for vitamins and other components. Although feed formula must be changed during period of egg production to compensate for production of eggs that can hatch into quality chicks.

5.9.3.3 Nutritional Requirement of Breeder during Laying

Energy requirement of breeder diet for egg type strains is slightly higher than diets for egg production alone. Meat type strain tends to get too heavily if full fed during laying as well as during growing. Meat type breeders produce fever eggs. For this reason, the energy content of the meat type breeder ration is usually lower than that of egg type breeder. It depends upon environmental temperature, caloric content of diet and rate of egg production.

i. Dual Feeding System

Feeding two separate rations to male and female during breeding season is known as dual feeding. Pullets are fed their regular rations but cockerels are fed a ration low in protein, energy and calcium. For this purpose, two independent feeding systems must be used. Male exclusion grills over female feeder have an opening 41 mm wide: provide 6 inches of trough space per pullet. Male feeding system is raised 18-20 inches (46-51 cm) above floor level to exclude females. Fill feeders in the evening and serve feed in next day morning to birds once a day.

Table 5.13. Feeding and watering space for breeders.

Type of Birds	Feeder space (inches/bird)		Watering Space (inches per bird)
	Growing	Laying	
Leghorn breeder pullets	2.50	3.75	0.75
Leghorn breeder cockerel	2.50-3.00	3.75	0.75
Meat type breeder pullets	5.00	6.00	1.00
Meat type breeder cockerel	6.00	6.00-8.00	1.25

5.10 Induced Moulting and Poultry Welfare

Forced moulting is replacement of old feathers with new ones. Moulting is believed to be a period of restoration and rejuvenation of reproductive system, enabling hen to produce eggs in subsequent production cycle. Induced moulting is desirable when cost of replacement flock is high, feed cost is more and egg prices are less. Start of moulting depends upon economic condition of individual farm. A new bird is generally more productive as compared to moulted bird.

Advantages of induced moulting are reduced layer replacement cost, improved production, eggshell quality, feed efficiency and fewer small eggs. Disadvantages of forced moulting are lower rate of production than in pullet year, more rapid decline in egg quality, greater percentage of off-grades and defective eggs, handling problem with high-speed equipment, more disease build-up, mortality may be higher and houses may be empty if flock becomes unprofitable earlier than anticipated.

During molting thyroid gland under goes a series of changes, feather replacement is under the control of thyroid hormone namely tri-iodothyronine (T_3) having synergistic effect with progesterone and antagonised by oestrogen activity. Standard metabolic rate increases (45%) during moulting which results in a higher

body temperature than normal. Normal sequence of feather replacement is given in Figure 5.1.

Then new feathers grow under control of normal thyroxin level. Feathers growth is retarded by a high level of circulating oestrogen as occur during egg laying. Progesterone administration prevents ovulation and induces moult by stimulating follicles replacement. All the mechanism i.e. reduction in oestrogen and increase of T_3 and Progesterone are controlled by the hypothalamus, interior pituitary under the influence of nerve impulses (Figure 5.2.)

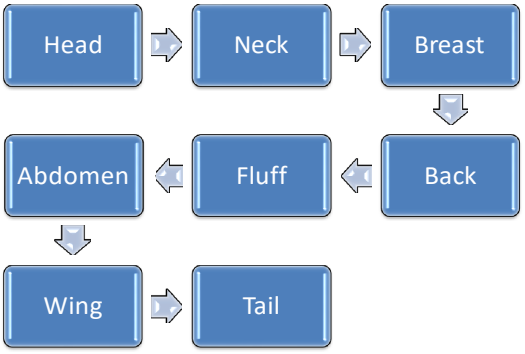

Fig. 5.1. Feather shedding pattern during moulting.

Fig. 5.2. Hormonal changes during moulting.

All these hormonal changes results in plumage change and change in body fat, ovary, oviduct, gastro-intestinal tract. By these changes there is 25-30% loss in body weight. Main idea of moulting is to reduce body weight by 25-30%.

5.10.1 When to Moult Flock

Poultry flocks are molted when spring like conditions prevails or house temperature is 75 °F, birds are healthy not underweight and not under stress.

5.10.2 Moulting Procedure

Before starting induced moulting followings practices are necessary (one week prior to start); deworming, use of antibiotics, vitamins, vaccination (I.B+ND) for optimum titer level, ad libitum feed and water.

5.10.3 Methods of Moulting

Moulting is done generally by:

a. Administrating hormones like thyroxin, progesterone, prolactin, metals like zinc or aluminum or exerting stress to change its hormonal profile.

	Days	Feed	Water	Light
8-10 day		No feed	No water	6 hours light
11-14 days		No feed *	*Ad-libitum*	6 hours light
15-49 days		45 g ground maize/bird + $CaCo_3$ or ration No. 2	*Ad-libitum* water	6 hours light
After 50 days		Ration No.3*ad-libitum*	*Ad-libitum* water	12-15 hour light

**Feed can be withdrawn for 1-14 days depending on season and body weight loss.*

Other Methods are

a. Feed withdrawal (without feed), *ad-libitum* water for 14 days.
b. Zinc Oxide =3.0-5.0 g/kg feed depending on concentration for 14 days.
c. Aluminium Oxide = 4.0 g/Kg feed for 14 days.
d. Progesterone = (Hydroxy Progesterone) 0.1 ml/bird I/M on alternative days for 14 days.
e. $CuSO_4$ = 4.0 g/Kg feed for 14 days.

After 14 days, use ground maize or ration number @ 45 g/day for 4-6 weeks. Then increase feed slowly i.e. 15-20 g/week so that it may be 110 g at peak production.

5.11 Use of Computers in Record Keeping

Computer is being used in every sphere of life. Its uses are increasing day by day. It seems that after a few years, life would be useless without the computer. There is not even a single field that is beyond grip of computer. It is because of this invention that world has reduced to a global village. Wars are won and lost from computer's keyboard. It is also used in manufacturing, welding and painting cars and buses. This revolutionary development decreased mental and physical burden of mankind.

Computers are everywhere in our lives, today including poultry industry. From accounting to waste management and everything in-between, there are many programs which helps in collection and store right information, make calculations, summarize results, predict future needs, and schedule most efficient ways to get things done, all done to produce a better more efficient product with minimum cost or maximum profit. When the size of a business increase, data on every aspect of that industry increase and requires a system that can efficiently utilize that data and

produce easy to understand and summarized results so that decision making is easier at this point. Computer is doing its job in every business. Regardless of industry, some problems are universal; for example, resource allocation, scheduling and routing, competition, inventory, searching for requirements, replacement and maintenance. A manager in any field has a modern "toolbox" of decision assisting programs at hand, including, for example, inventory control software, statistical analysis, simulation models, forecasting and business analysis.

Interactive models greatly enhance poultry industry efficiency. They utilize a strategic module for long-term questions and to answer "what if" situations. A tactical module contains all kinds of statistical soft wares such as that for projecting egg production, assisting site planning, linear programming, econometric models, and so on. Thirdly, an operational module provides day-to-day advice about hot day, flock planning, processing plant planning and shift planning. Decision making software that can project current production for the future and assess profit or loss and in case of loss steps to be taken to avoid that loss are the need of the world of business. One thing for sure that only properly interpreted data is of any benefit in these situations otherwise "Garbage in Garbage out" would be true.

Due to technology advancements competition among poultry industry is increasing day by day this time, future will be of that company that will be reducing losses from different sources and producing poultry meat and eggs at minimum cost. It will be possible when there will be well managed data management system for different enterprises of poultry business, well manners data makes a very efficient decision making system that can analyze even minute change in inputs of industry. Future should include alternatives to linear programming for feed formulation, better nutrient prediction, assisted disease diagnosis, more accurate price forecasting, supply chain optimization etc. Topics such as simulation, artificial intelligence and dealing with complexity will receive greater attention as technology advances.

5.12 Feasibility Reports

5.12.1 Feasibility Report for 30,000 Broilers in Environment Controlled House

Feasibility report can be recalculated according to market rates as there are always fluctuations in the rates of inputs and outputs. Land is available

5.12.1.1 Capital cost

i. Building Construction Cost (Rs.):

Construction of Shed	400×45	=	18000 feet^2 @ 325 / feet^2	= Rs. 5850000
Construction of office	10×10	=	100 feet^2 @ 425 / feet^2	= Rs. 42500
Feed Store	10×15	=	150 feet^2 @ 325 / feet^2	= Rs. 48750
Equipment Store	10×15	=	150 feet^2 @ 325 / feet^2	= Rs. 48750
Labor Colony	20×15	=	300 feet^2 @ 325 / feet^2	= Rs. 97500
Water Tank	7×7	=	49 feet^2 @ 400 / feet^2	= Rs. 19600

Wash Room	2 (5 × 6) = 60 feet^2 @ 400 / feet^2		= Rs. 24000
Total (Rs)			= Rs. 6131100
5% Depreciation (Rs) for one year	= 6131100 × 5%		= Rs. 306555
5% Depreciation (Rs) for 6 weeks			= Rs. 35371

ii. Equipment Cost (Rs)

Feeding Equipment			= Rs. 1250000
Drinking Equipment			= Rs. 550000
Fans	11 fans	@ 28500	= Rs. 313500
Inlets	56 inlets	@ 3250	= Rs. 182000
Lighting + Controller			= Rs. 150000
Pads	66 Pads	@ 3200	= Rs. 211200
Controllers of Feeding, Drinking and Ventilation System			= Rs. 150000
Heater			= Rs. 180000
Generator	2 generator	@ 500000	= Rs. 1000000
Transformer		@ 300000	= Rs. 300000
Refrigerator		@ 32000	= Rs. 32000
Automatic Syringe		@ 5000	= Rs. 5000
Weighing Balance		@ 1200	= Rs. 1200
Water Pump	2 pump	@ 9000	= Rs. 18000
Spray Machine		@ 5000	= Rs. 5000
Chick Guard for Brooding			= Rs. 10000
Total (Rs)			= Rs. 4357900
20% Depreciation (Rs) for one year= 4357900 × 20%= Rs.871580			
20% Depreciation (Rs) for 6 week			= Rs. 100566

5.12.1.2 Running Cost (Rs)

Broiler Chicks (0.6 feet^2 / chick)	= 30000 chick	@ 40	= Rs. 1200000
Feed Bags (3.25 kg / bird)	= 1950	@ 2264	= Rs. 4414800
Vaccination + Medication	= 15/bird		= Rs. 450000
Electricity + Gas charges	= 10/bird		= Rs. 300000
Labor charges	= 5/bird		= Rs.150000
Litter cost	= 3.33/bird		= Rs.100000
Miscellaneous			= Rs.100000
Total (Rs)			= Rs. 6714800

i. Total Flock Cost Items (Rs)

Depreciation of Building (Rs)	= Rs. 35371
Depreciation of Equipments (Rs)	= Rs. 100566
Running Cost (Rs)	= Rs. 6714800
Total (Rs)	= Rs. 6850737

5.12.1.3 Income

Total Birds		= 30000
Mortality	@ 4%	= 1200
Total Live Birds		= 28800
Total Live Weight	@ 2.00 kg / bird	= 57600 kg
Price	@ Rs 130/ kg	= Rs.7488000

Sale of Empty Bags	1950 bags	@ Rs 8.0	= Rs. 15600
Sale of litter			= Rs. 100000
Total income (Rs)			= Rs. 7603600

5.12.1.4 Profit

Income – Expenditure = Profit
Profit = Rs. 7603600 – Rs. 6850737 = Rs.752863.

5.12.2 Feasibility Report for 24000 Layers in Environment Controlled House

Land is available

5.12.2.1 Capital Cost

i. Building Construction Cost

Construction of Shed	400 × 45 = 18000 feet^2	@ 325 / feet^2	= Rs. 5850000
Construction of office	10 × 10 = 100 feet^2	@ 425 / feet^2	= Rs. 42500
Feed Store	10 × 15= 150 feet^2	@ 325 / feet^2	= Rs. 48750
Equipment Store	10 × 15 = 150 feet^2	@ 325 / feet^2	= Rs. 48750
Labor Colony	20 × 15= 300 feet^2	@ 325 / feet^2	= Rs. 97500
Water Tank	7 × 7 = 49 feet^2	@ 400 / feet^2	= Rs. 19600
Wash Room	2 (5 × 6) = 60 feet^2	@ 400 / feet^2	= Rs. 24000
Total			= Rs. 6131100
5% Depreciation for one year	= 6131100 × 5%		= Rs. 306555

ii. Equipment Cost

Cage system (Rs 200/bird)	= 200 × 24000		= Rs. 4800000
Fans	11 fans	@ 28500	= Rs. 313500
Inlets	56 inlets	@ 3250	= Rs. 182000
Lighting + Controller			= Rs. 150000
Pads	66 Pads	@ 3200	= Rs. 211200
Controllers of feeding, drinking and ventilation system			= Rs. 150000
Heater			= Rs. 180000
Generator	2 generator	@ 500000	= Rs. 1000000
Transformer		@ 300000	= Rs. 300000
Refrigerator		@ 32000	= Rs. 32000
Automatic Syringe		@ 5000	= Rs. 5000
Weighing Balance		@ 1200	= Rs. 1200
Water Pump	2 pump	@ 9000	= Rs. 18000
Spray Machine		@ 5000	= Rs. 5000
Chick Guard for Brooding			= Rs. 10000
Egg Tray	80% production (7 days)	@ 25	= Rs. 112000
Total (total trays 7780 @ Rs. 25/tray)			= Rs. 7469900
20% Depreciation for one year	= 7469900 × 20%		= Rs. 1493980

5.12.2.2 Running Cost

Spent layer is purchased

Layers (0.75 feet^2/layer)	= 24000 layer	@ 230	= Rs. 5520000
Feed Bags (38 kg/bird)	= 18240 bags	@ 2120	=Rs. 38668800
Vaccination + Medication*	= 120/bird		= Rs. 2880000
Electricity**	= 108/bird		= Rs. 2592000
Labor charges	= 10/bird		= Rs.240000
Miscellaneous			= Rs.50000
Total			= Rs. 49950800

*Till maturity Rs.50+Rs.10 per month (10×12) =120
** Electricity + diesel (90+72)= Rs. 162/bird for 18 months for 1 year = Rs. 108

i. Total Flock Cost Items

Depreciation of Building	= Rs. 306555
Depreciation of Equipments	= Rs. 1493980
Running Cost	= Rs. 49950800
Total	= Rs. 51751335

5.12.2.3 Income

Total Birds			= 24000
Mortality		@ 5%	= 1200
Total Live Birds			= 22800
Egg / layer			= 280 eggs
Total eggs	280 × 22800	= 532000 dozen eggs	
Sale of egg		@ Rs. 120/dozen	= Rs. 63840000
Sale of Empty Bags	18240 bags	@ Rs. 10	= Rs. 182400
Birds	22800 birds	@ Rs. 150	= Rs. 3420000
Total income			= Rs. 67442400

5.12.2.4 Profit

Income – Expenditure = Profit
Profit = 67442400 – 51751335 = Rs. 5691065

5.12.3 Feasibility Report for 7362 Female and 818 Male Broiler Breeders in Environment Controlled House

Land is available

5.12.3.1 Capital Cost

i. Building Construction Cost

Construction of Shed	400 × 45 = 18000 feet^2	@ 325 / feet^2	= Rs. 5850000
Construction of office	10 × 10 = 100 feet^2	@ 425 / feet^2	= Rs. 42500
Feed Store	10 × 15 = 150 feet^2	@ 325 / feet^2	= Rs. 48750
Equipment Store	10 × 15 = 150 feet^2	@ 325 / feet^2	= Rs. 48750
Labor Colony	20 × 15 = 300 feet^2	@ 325 / feet^2	= Rs. 97500
Water Tank	7 × 7 = 49 feet^2	@ 400 / feet^2	= Rs. 19600
Wash Room	2 (5 × 6) = 60 feet^2	@ 400 / feet^2	= Rs. 24000
Total			= Rs. 6131100
5% Depreciation for one year		= 6131100 × 5%	= Rs. 306555

5% Depreciation for 18 months			= Rs. 459832

ii. Equipment Cost

Feeding Equipment			= Rs. 1250000
Drinking Equipment			= Rs. 550000
Fans	11 fans	@ 28500	= Rs. 313500
Inlets	56 inlets	@ 3250	= Rs. 182000
Lighting with Controller			= Rs. 150000
Pads	66 Pads	@ 3200	= Rs. 211200
Controllers of feeding, drinking and ventilation system			= Rs. 150000
Heater			= Rs. 180000
Generator	2 generator	@ 500000	= Rs. 1000000
Transformer		@ 300000	= Rs. 300000
Refrigerator		@ 32000	= Rs. 32000
Automatic Syringe		@ 5000	= Rs. 5000
Weighing Balance		@ 1200	= Rs. 1200
Water Pump	2 pump	@ 9000	= Rs. 18000
Spray Machine		@ 5000	= Rs. 5000
Chick Guard for Brooding			= Rs. 10000
Total			= Rs. 4357900
20% Depreciation for one year	= 4357900 × 20%		= Rs. 871580
20% Depreciation for 18 months			= Rs. 1307370

5.12.3.2 Running Cost

Broiler Breeder Chicks (2.2 feet^2 / chick)= 7362 chicks @ 200				=Rs.1472400
(Out of these 7362 female and 818 male)				
Feed	(55 kg / bird)	= 8998 bags	@ 2200	= Rs.19795600
Vaccination + Medication		= 20 / bird		= Rs.163600
Electricity + Gas charges + Diesel		= 20 / bird		= Rs.163600
Labor charges		= 40 / bird		= Rs.327200
Litter cost				= Rs.60000
Hatching Cost	1132875 eggs		@ 2	= Rs. 2265750
Miscellaneous				= Rs.50000
Total				= Rs.24298150

i. Total Flock Cost Items

Depreciation of Building	= Rs.459832
Depreciation of Equipments	= Rs.1307370
Running Cost	= Rs. 24298150
Total	= Rs. 26065352

5.12.3.3 Income

Total Birds		= 8180
Mortality + culling	@ 10%	= 818
Total Live Birds		= 7362
Egg produced 180 × 6625		= 1192500 egg
Broken/market eggs	@ 2.5%	= 29813 eggs

Hatchable eggs			= 1162687
If hatchability is 82%			
Chick hatched			= 953403 chicks
Saleable Chicks			= 934335
Sale of chicks		@ Rs 40/chick	= Rs.37373398
Sale of Empty Bags	8998 bags	@ Rs 8.0	= Rs.71984
Sale of litter			= Rs.100000
Total income			= Rs.37545384

512.3.4 Profit

Income – Expenditure=Profit
Profit = Rs. 37545384 – Rs. 26065352=Rs. 11480032

Conclusion

Good brooding of chicks is recommended to have good results from the flock. Poultry birds be handled properly during hot and cold weather. Proper light is required during production period. Layer birds can be kept more than one year by practicing induced molting. Cage layer production is increasing rapidly in Pakistan. Computerized records are a good source of data which can be processed at a rapid rate for knowing performance of present flocks and for future planning.

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Chapter 6

Poultry Feeding

Muhammad Yousaf and Shakeel Ahmad[†]

Abstract

Poultry feed is one of the most important component in raising poultry. Main cost is incurred on feed of birds. To produce quality feed, proper feed ingredients quality and storage play a major role. Feeding methods needs due consideration for specific rearing of broilers, layers and breeders. Feed forms have their own impact on performance of the poultry birds. Automatic feeding is gaining more popularity as compared to manual feeding in modern day poultry farming. Specific measures are taken care of to avoid feed wastage. Effective feeding strategies are practiced during summer and winter season to achieve production goals. To achieve better feed efficiency, feed additives, toxin binders, enzymes etc. are used in poultry feed. Proper attention is required while feeding the feed to the birds. Equal feed distribution, proper number of feeders, proper placement of the feeders, height of feeders and drinkers, feeding time, duration of the feed intake, environmental conditions needs to be addressed to get appropriate production from poultry birds. Behaviour and conditions of flock be judged during feeding of birds. Poultry feed and feeding are most important in poultry operations requiring due consideration for better production of the birds.

Keywords: Feed ingredients, feeding methods, seasonal feeding, feed efficiency

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6.1 Introduction

Poultry feed constitutes one of the major expenses during raising poultry birds. Feed comprises of 55-70 % of expenses incurred on raising various poultry species. Poultry feed has its prime importance in poultry business. Good feed quality and proper feeding inappropriate environmental conditions ensure successful farming. To produce quality feed, proper feed ingredients quality and storage play a major role. Feeding methods are of great importance for rearing poultry. Feed forms have their own impact on production performance of poultry birds. In modern day poultry industry, automatic feeding is gaining more popularity as compared to manual feeding. Careful consideration is given to avoid feed wastage. To achieve better production goals effective feeding strategies are practiced during summer and winter season. Feed additives, toxin binders, enzymes etc. are used in poultry feed to achieve better feed efficiency. Equal feed distribution, proper number of feeders, proper placement of feeders, and height of feeders and drinkers, feeding time, duration of feed intake, environmental conditions are very important to get excellent production. Behaviour and conditions of flock be judged during feeding of birds.

6.2 Principles of Poultry Feeding

Poultry feed should have all essential nutrients like crude protein, metabolizable energy, vitamins and minerals according to requirements of poultry species keeping in view their age. Balanced poultry diets will fulfill nutrient requirements of poultry birds resulting in better egg and meat production. Feed should be free from mycotoxins or microbial contaminants to save birds from diseases which can cause lower production, immunity and mortality. Appropriate feed storage facilities and fresh feed will contribute in exploiting the potential of poultry. Feed birds at proper time, ensure even feed distribution and avoid over filling feeders. For optimum production, change nutrient level keeping in view season. Presence of farm manager at feeding time is recommended to observe flock closely and making decisions on actual grounds which will ensure improved flock (Jadhave 2003; Singh 2004). Modern feeding systems, quality feed and better feed efficiency in modern poultry housing systems will result in more egg and meat production resulting in more profit to poultry farmers.

6.3 Poultry Feed Ingredients and Their Storage

Finished poultry mash is a complex mixture of various feed ingredients grinded and homogenously mixed together, containing required nutrient levels depending on species, type and category of birds. Feed ingredients level in poultry diets are given in Table 6.1. Similarly, nutrient levels of ingredients are highlighted in Table 6.2.

Table 6.1. Common feedstuffs and their inclusion levels in poultry rations.

Feedstuff	Inclusion (%)	Feedstuff	Inclusion (%)
Alfalfa meal	0-3	Meat com bone meal	0-3.5
Bajra	5-15	Molasses	0-8
Barley	0-10	Oats	0.15
Barseem	0-5	Rice-kani	15-30
Blood-meal	1.0-2.0	Rice polish	10-30
Bone meal	1.5-2.5	Rice bran	10-20
Corn (maize yellow)	0-55	Rice bran (deoiled)	5-10
Cotton seed cake	0-7	Salseed cake	4-6
Dried poultry manure	0-8	Soybean meal	5-25
Fish meal	0-8	Sunflower	0-15
Fat (animal or vegetable)	0-7	Sesame cake	0-25
Ground-nut-cake	0-25	Silk worm purpose meal	0-5
Hatchery waste	0-3	Tapioca flour	5-15
Jowar (light variety)	15-30	Triticale	0-30
Lime stone	1.5-3.5	Wheat	0-25
Maize gluten meal	0-12	Wheat bran	0-13
Manganese sulphate	0.02-0.045	Oyster shell (shell grit)	0-7
Meat meal	0-8	Steamed bone meal	0-3

6.3.1 Energy Feedstuffs

Cereal grains unfit for human consumption, damaged grain and agro-industrial by-products can be conveniently used for preparing cheaper poultry rations. About 45 to 65 percent inclusion of energy feedstuffs are required to manufacture feed of desired energy level.

6.3.1.1 Maize (corn):

It is major source of energy and commonly used in higher quantity in poultry feeds in India. Maize is highly palatable and rich in energy but protein and mineral content is lower. Good quality corn is shown in Figure 6.1. Out of two varieties i.e. red and yellow, yellow maize is preferred for poultry feed due to its higher content of carotene (vitamin A precursor) and xanthophyll, a substance responsible for yolk yellow color in eggs. Various fed ingredients are shown in Figure 6.2.

Figure 6.1. Good quality corn

6.3.1.2 Jowar (Sorghum)

Nutrient value of it is as good as that of maize, but its energy content is slightly lower and palatability is also less due to presence of tannin. Hybrid jowar is commonly used in poultry rations and light yellow colored variety is preferred, as the dark variety contains some bitter substances.

6.3.1.3 Millets

Rough grains like bajra (pearl millet) is sometimes included in poultry diets at low levels, because bajra also contains tannin.

6.3.1.4 Barley and Oats

They can be safely used in low energy diets for growers and broiler replacement breeders. Slightly higher fiber content in barley and oats prevent cannibalism, similarly good manganese content of oats can reduce leg deformities and disorders like slipped tendon.

6.3.1.5 Wheat and Wheat Bran

Wheat bears more nutritive value and wheat bran' is commonly used as filler in diets. Common feedstuffs are given in Table 6.2.

6.3.1.6 Rice-Kani

It is a good source for poultry feed (Figure 6.2). It has high digestibility and palatability with fair amount of energy and protein.

6.3.1.7 Rice Polish and Rice Bran

Rice polish is a powder obtained while polishing rice after removing its hulls and bran, while rice bran is bran layer or pericarp of rice. Rice polish is a very good source of energy and B-complex vitamins. Because of its high fat content rice polish can develop rancidity during long-time and faulty storage. Deoiled rice bran is available after solvent extraction, used as filler for poultry feeds.

6.3.1.8 Salseed Meal

Nutrients levels of salseed meal are as good as that of cereal grains and because of its fair energy content it can be used to replace grains in poultry feed. But tannin content is again a limiting factor for its inclusion in poultry feed.

6.3.1.9 Tapioca Meal

Tapioca meal is obtained from its tubers and is fair source of energy. Even though some varieties of tapioca contain cyanogenic principles they can be removed by heating or sun drying of it and can be safely used to prepare poultry feeds.

6.3.1.10 Damaged Food Grains

Grain spoiled and infested with insects during storage in warehouses mostly by food corporations, are called as damaged grains. Even grains can also be damaged due to untimely rains and pest infections before harvesting. Such grains which are

unfit for human consumption can be used to manufacture poultry diets provided they are not heavily damaged and can supply energy.

6.3.1.11 Dried Poultry Manure

Droppings from caged layers are collected without contamination, processed after drying and sterilization can be safely used in poultry rations up to 10 percent. It contains high amount of calcium and phosphorus with fair amount of protein.

6.3.1.12 Molasses

A by-product of sugar industry contains fair amount of energy. Besides increasing palatability of feed it also reduces dustiness of feed. It can be safely used up to 4 to 8%. Various good quality poultry feed ingredients are shown in Figure 6.2.

Fig. 6.2. Various poultry feed ingredients

Table 6.2. Composition and grouping of common feedstuffs for poultry.

S. No	Feedstuff	ME Kcal/kg	Crude protein %	Crude fiber %	Ether extract %	Calcium %	Phosphorus %	Manganese mg/kg	Zinc mg/kg	Lysine %	Methionine %	Tryptophan %	Vit. B_{12} mg/kg	Acid insoluble ash %
Energy feed stuffs														
1.	Bajra	2640	12.5	2.1	4.8	0.12	0.7	-	-	0.41	0.2	0.21	-	1.45
2.	Barley	2620	11.8	6.3	2.6	0.3	0.62	18.2	17.1	0.58	0.2	0.2	1.9	-
3.	Corn	3330	9.0	2.2	3.8	0.23	0.38	4.9	12.2	0.17	0.15	0.1	1.4	-
4.	Jowar	2650	9.8	3.5	4.4	0.16	0.3	16.1	15.2	0.35	0.17	0.11	-	-
5.	Molasses	2410	2.7	-	-	1.5	0.65	56.1	-	-	-	-	3.2	0.45
6.	Oats	2845	14.5	13.3	4.5	0.1	0.4	42.7	-	0.4	0.3	0.2	1	-
7.	Rice polish	2930	12.2	11	13.8	0.25	13.5	-	-	0.45	0.25	0.1	1.6	6.7
8.	Rice kani	2340	7.7	1.5	1.6	0.1	0.46	-	-	0.07	-	-	0.8	0.65
9.	Rice bran	2220	14	13.5	1.6	0.35	1.75	-	-	0.45	0.36	10	-	8.3
10.	Salseed cake	3090	10.2	3.3	3.0	0.25	0.15	-	-	0.61	0.38	0.4	-	214
11.	Triticale grain	3840	15	5	2.2	-	-	-	-	-	0.3	-	-	-
12.	Tapicaflour (cassava)	2290	2.8	10.7	0.6	0.56	0.11	-	-	0.06	0.06	0.05	-	-
13.	Wheat	3040	10.2	2	2.5	0.16	0.41	55	15.5	0.46	0.2	0.2	1	-
14.	Wheat bran	1080	14.5	11	3.6	0.18	1.1	125	0.06	0.52	0.1	0.26	-	-
15.	Fat (veg or anim)	7690	-	-	90	-	-	-	-	-	-	-	-	-
Protein feed stuffs														
16	Blood meal	1420	74	0.6	1.4	0.31	0.3	5.7	-	6.35	0.82	1.01	4	3.2
17.	Fish meal	2450	44	3.5	4.4	7.18	1.7	39	-	4.17	1.41	0.35	-	8
18.	Dried poultry manure	800	26	15	2.3	3.9	1.45	-	-	-	-	-	-	5
19.	Hatchery waste	1930	38	3.5	1.8	7.2	2.1	-	1.15	0.85	0.21	-	-	-
20.	Meat meal	2320	56	2.1	12	2.7	2.05	10.1	-	4	0.85	0.94	-	9

21.	Meat cum bone meal	2110	53.5	2.2	-	11.2	5.40	13	104	3.73	7.75	0.212	-	-
22.	Bone meal	1040	14.5	2.6	3	26.8	12.1	32	446	(fluorine: 0.05%)	-	-	-	-
23.	Maize gluten meal	2700	50	2	4.1	0.2	0.33	8.1	-	1	1.26	0.26	1.5	-
24.	Soybean meal	2690	50	2	4.1	0.2	0.33	8.1	-	1	1.26	0.26	1.5	-
25.	Sunflower cake	2235	37	11.4	10.8	0.42	0.15	24.4	-	1.95	1.55	0.6	6.3	0.6
26.	Sesame meal	1880	38.9	4.5	9.1	2.45	1.4	51.5	107.3	1.15	1.22	0.7	3.1	1.48
27.	Yeast	-	32.1	1.8	1.2	6.05	0.4	-	-	-	-	-	-	-
Mineral supplements														
28.	Lime stone	-	-	-	-	37.5	0.025	-	-	-	-	-	-	-
29.	Oyster shell	-	-	-	-	37.4	-	-	-	-	-	-	-	-
30.	Dicalcium phosphate	-	-	-	-	23	18.1	fluorine 0.01 – 0.05%	-	-	-	-	-	-
31.	Rock phosphate	-	-	-	-	33.5	18.1	fluorine 0.01 – 0.30%	-	-	-	-	-	-
32	Manganese sulphate	-	-	Mn	-	22	-	-	-	-	-	-	-	-

6.3.2 Proteins Feedstuffs

Protein feed stuffs are included in poultry diets mainly to supply protein abut along with it they also contribute around 30-35 percent energy. They are mainly classified into vegetable and animal proteins depending on source of origin.

6.3.2.1 Vegetable Proteins Feedstuffs

Vegetable protein feed stuffs are usually deficient in lysine and methionine which are limiting amino acids and most of them contain some or other anti-nutritional factors or toxic principles. For some processing methods are available to detoxify or to destroy the anti-nutritional factors but for some of them technology has not been developed to eliminate them. Commonly available vegetable protein feedstuffs which can be used in poultry feeds are groundnut cake, soybean meal, sunflower cake, sesame cake, cottonseed cake, coconut meal, maize gluten meal, mustard cake, linseed cake, yeast, penicillium mycelium.

a. Groundnut Cake (CNC-Solvent Extracted)

It is an excellent source of protein and was commonly used as major ingredient for supply of protein in poultry rations. But nowadays due to its afflation content, its use is limited. Extraction variety is used for poultry feeding which contains more protein but low in energy than expeller type.

b. Soybean Meal (toasted)

Nowadays soybean meal is widely available and very good source of protein. It is good source of lysine but deficient in methionine. It is abundantly used to replace fish-meal and GNC in poultry diets. It contains anti-nutritional factor namely trypsin inhibitor but it can be removed by toasting.

c. Sunflower Cake

Protein quality sunflower cake is better but protein content is lower than soybean meal and fiber content is also higher. It is good source of arginine and methionine when compared with soybean but lower lysine and cystine content. It is very good in water soluble vitamins like niacin and pantothenic acid.

d. Sesame Cake (Til Cake)

It is fair supplement for protein. Its methionine, tryptophan and arginine content are better but poor in lysine and cystine. Sesame cake when combined with GNC forms a better protein supplement.

e. Cotton Seed Cake

Even though it contains higher percentage of protein it is poor in lysine. Besides it contains gossypol and cyclopropenoid fatty acid which are limiting factors for its use in poultry rations. Toxic gossypol leads to discoloration of yolk and slower growth.

f. Coconut Meal

Even though it is non-toxic its digestibility is poor. Hence it is not commonly used in poultry rations. Its protein content is 20 percent and can be included in poultry diets up to 10-15 percent.

g. Maize Gluten-Meal

It is by-product of starch industry. They are obtained while processing yellow maize for starch and contain higher levels of carotene and xanthophyll. Even though its total protein content is higher it is deficient in lysine, arginine and tryptophan.

h. Mustard Cake

Despite its abundant availability, its use in poultry feed is very limited due to toxic principle glucoside and strong aroma, odor and taste, besides it is deficient in lysine.

i. Linseed Cake

It is hardly used up to 3 percent in poultry ration due to its toxic principle cyanogenic glycoside and anti-pyridoxine factor. Its tryptophan content is higher and some essential fatty acids in it improve the appearance of feathers. It is mildly laxative and can be detoxified by boiling.

j. Guar-Meal

In spite a good source of protein, guar meal's use in poultry rations is limited due to guar-gum and trypsin inhibitor.

k. Yeast

A by-product of distillery and brewery industries is yeast. Despite its high cost it is included in poultry diets due to good content of B-complex vitamins.

l. Penicillium-Mycelium

Waste product obtained in manufacturing of penicillin is penicillium-mycelium. Primary its residual antibiotic is beneficial for poultry feeds besides its good protein content.

6.3.2.2 Animal Protein Feedstuffs

As far as quality is concerned animal protein feedstuffs are better than vegetable protein feedstuffs. They have the best amino acid composition with high levels of lysine and methionine, which are most important in case of poultry diets. Besides they contain fair amount of calcium and phosphorus along with excellent natural sources of vitamin B_{12}. In animal protein feedstuffs, feather and blood-meal has poor amino acid composition and they are less palatable also. Therefore, they are not included in poultry feeds more than 2.5-3.0 percent level.

a. Fish-Meal

Among all animal protein source fish-meal is the best protein source due to its rich contents of essential amino acids. Similarly, it is also richer in vitamins like choline, vitamin B_2, pantothenic acid, vitamin B_{12} and in minerals like calcium and phosphorus. Fish-meal is obtained from grinding of clean, dried and whole undecomposed fish. Grinding of whole fish may be without or with fish oil and usually does not contain more than 3 percent salt.

b. Meat Meal, Meat cum Bone Meal

Besides very good content of calcium and phosphorus, these products are good source of high quality protein. Their vitamin content of choline, vitamin B_{12}, pantothenic acid, vitamin B_2 is fair. Products quality varies depending on processing methods and amount of gelatin in it, which limits its use in poultry rations up to 5-10 percent. Composition of meat meal, meat cum bone meal is given in Table 6.2.

c. Blood Meal

Despite its high protein content, blood meal cannot be used in poultry rations more than 1.5-2.5 percent level due to its high un-palatability and poor digestibility. Even though its lysine content is high, it is poor in amino acid composition. Blood collected in processing and slaughter houses is collected in coagulated form and then dried to manufacture blood meal.

d. Liver Residue Meal

It is a by-product of pharmaceuticals and contains high levels of lysine, methionine, cysteine and tryptophan. Similarly, its vitamin B_2 content is quite high. Its oil content is higher, store it properly to avoid rancidity.

e. Silkworm Pupae Meal

A good industrial by-product, on deoiling contains protein and fats in high proportions. But its protein is poorly digested.

f. Hatchery Waste

Infertile eggs, dead embryos, egg shells, killed chicks in hatchery form hatchery waste. As a protein source, it can be used in limited quantity in poultry feed.

6.3.3 Recent Unconventional Poultry Feedstuffs

To reduce increasing poultry feed costs, search for new low cost feedstuffs is necessary to economize cost of poultry feeding. This brings in light many more potential feedstuffs, which can be used in poultry rations. Such feed stuff is usually agro-industrial by-products or unusual feed ingredients. Some of them are as under:

6.3.3.1 Mango Seed Kernel

This can be obtained from fruit canning industry. About 15-18 percent maize can be safely replaced by mango-seed kernel.

6.3.3.2 Triticale

A grain produced from cross of wheat and rye, contains around 18-22 percent protein having considerable higher yield than either the grains.

6.3.3.3 Opague-2 (Corn)

It is a cross of grains and contains high levels of lysine.

6.3.3.4 Lucerne and Berseem Meal

Over dehydrated lucerne meal contains more levels of carotene pigment than sun-dried meal. Its protein content is around 15 percent but higher fiber content in it limits its use up to 3-5 percent in poultry.

6.3.3.5 Alfalfa Meal

It is also good source of protein and provitamin A.

6.3.3.6 Tadpole and Frog Meal

Literature on this cheap poultry feed ingredient is scanty. But it can very well replace costly fish-meal.

6.3.6.7 Algae and Sea-Weed Meal

As a product of aqua-culture, it contains high amount of minerals, vitamins and crude fiber but its protein and energy content is low. Therefore, it cannot be used in poultry feed at more than 3-5 percent level.

6.3.6.8 In-Edible Fats

Slowly soap industries are witching over for using synthetic detergents to manufacture soaps, which can make available poor grade fat to use it in poultry feeds.

6.3.6.9 Mineral Supplements

Lot of minerals supplements like common salt, oyster-shell (grit), lime stone, steamed bone meal, dicalcium phosphate (DCP), defluorinated rock phosphate are available to incorporate as mineral supplements in poultry diets. Similarly, mineral mixtures are commercially available for ready to use in poultry feeds where no separate, inclusion of mineral supplement is needed.

6.3.6.10 Vitamin Supplements

Some parts of vitamin requirements are naturally met from all the ingredients used in poultry feeds as protein and energy sources and rest of need is fulfilled by using vitamin mixtures in pure form from medicine manufactures.

6.3.6.11 Agro-Industrial Byproduct in Poultry Feeds

Nowadays a lot of discussions are made about incorporation of agro-industrial by-products in poultry rations to manufacture low cost poultry feeds. In fact, except, a few, most of them have been in use to manufacture cheaper poultry feeds by adopting proper care to reduce their toxic principles, fiber content or sand and silica impurities. Information on their utility and nutrient contents has already been highlighted earlier in this chapter.

6.4 Nutrient Requirements of Poultry

Poultry feed is composed of several feed ingredients like cereal grains, their by-products and meals, animal by-product meals, fats/oils, vitamins, minerals and antibiotics. Water has its pivotal role in utilization of these components effectively. These components provide nutrients and energy for growth, production, reproduction and health status of individuals. Carbohydrates, fats and to some extent proteins provide energy for metabolism, production of eggs and meat. Poultry feed comprises of following major components;

6.4.1 Energy

Energy is measured as digestible energy and metabolizable energy. Most commonly values used in poultry are metabolizable energy poultry.

6.4.2 Carbohydrates

Carbohydrates are important energy source for poultry birds. Main source of carbohydrates are cereal grains like maize, wheat, soybean meal, rice broken, rice polishing and canola meal. Other carbohydrates are as follows polysaccharides, like hemicelluloses, pentosans, cellulose and oligosaccharides, like raffinose and stachyose. Their digestion is poor in poultry birds.

6.4.3 Proteins and Amino Acids

Amino acids are required on daily basis by poultry birds being contained in dietary protein. A reduction in amino acids availability will result in declining growth or productivity. Body contains 22 amino acids which are all essential ones.

6.4.4 Fats

Fats are added to the poultry diets to increase concentration of energy to enhance growth / production performance in poultry. Vegetable oil refining is a main source of oil used in poultry feed. Fat from intestine is absorbed and is transported to liver.

6.4.5 Minerals

Minerals are inorganic part tissues or feed. They are classified as major (macro) and minor (trace) minerals. Requirements are given as % of diet whereas for minor ones in mg/kg of diet or ppm. Minerals are required for skeletal formation, enzymes cofactors and osmotic balance maintenance. Mineral supplements used in poultry are;

i. Dicalcium phosphate
ii. TCP (Trichloro phosphate)
iii. Limestone
iv. Bone meal
v. Manganese sulphate ($MnSO_4$)
vi. Superphosphate.
vii. Bone and Meat meal
viii. Rock phosphate
ix. Oyster shell
x. Sodium chloride (NaCl)
xi. Potassium iodide (KI)

6.4.6 Vitamins

Vitamins function is to work as regulators of metabolism and coenzymes. Vitamin sources are by products of milk, fish soluble and yeast. Vitamin are supplemented to enhance egg production in laying hens and to boost immunity in birds (Austic and Nesheim 1990; Bell and Weaver 2007).

6.5 Feed Forms, Feed Formulation and Feeding Methods

Feed forms used in chicken feeding are mash, pellet, crumble and wet mash.

6.5.1 Mash Form

Dry mash is generally cheapest method of feeding compounded rations when considered in terms of cost of feed. Mash should be made available at all times, i.e. fed ad libitum. It is also essential for mash to be freshly mixed. Stale feed may result in reduced nutritional value and reduced intake which will be reflected in rate of growth or production. Stale feeds are prone to mold formation and rancidity.

6.5.2 Pellet Form

Birds normally consume about 6-8 percent more feed when fed pelleted feeds. Pelleting is especially important with low density diet which reduces the feed intake to less than optimum due to less consumption. Compressing the feed into pellets stops ingredient segregation. Broilers fed pellets spend less time in eating and thus more net energy is available for body weight gain.

6.5.2.1 Pellet Binders

To improve hardness of pellets pellet binders are often added. Common pellet binders are sodium bentonite (anhydrous silicate), cellulose products (from wood pulp industry), lignin derivatives and grain industry by-products.

Occasionally molasses and guar gum meal is used as a pellet binder. These binders absorb water from processed pellet tend to reduce wet droppings and improves growth of young chicks. Hemicellulose wood pulp products, gain industry by-products, molasses and guar gum meals are good energy sources at levies necessary to form firm pellets except lignin.

6.5.2.2 Advantages of Pellets:

i. Pelleting results in a saving of 15-20% of feeding.
ii. It is convenient, since it can be directly fed from bags.
iii. It reduces labour, handling cost of feed and feed wastage.
iv. Feed wastage is reduced.
v. Drinking water remains clean in troughs.
vi. There is no wet feed to mold and to attract flies.
vii. It is easier for a bird to eat a crumble or pellet than to eat mash.
viii. Pelleted feed has a higher nutrient density.
ix. Pelleting reduces bulkiness of feed by 18%.
x. It reduces selective eating by birds.
xi. It destroys toxic organisms like Salmonella, E. Coli etc. during processing.
xii. Molds are not formed in pelleted feed as propionic acid added during pelleting.
xiii. Trypsin inhibitors and gossypol are destroyed during pelleting process.
xiv. Metabolizable energy of some feed stuff is improved.
xv. Availability of Vitamin E and B_{12} is increased.
xvi. Digestibility of certain nutrients is increased.

6.5.2.3 Disadvantages of Pellets:

i. Pelleting involves additional cost.
ii. Higher investment and machinery.
iii. Specific know-how is needed for pelleting.
iv. Considerable variation in the characteristics of different raw materials.
v. Pelleting destroys Vitamin A.
vi. Increased water consumption.
vii. Increased cannibalism.

6.5.3 Crumble Form

It is method of choice for feeding broilers and capons. Crumbles are usually made from 4.7 mm (3/10 inch) pellets. Crumbles are very easy to handle and convenient to use. It has been found that compressing a feed into pellets and crumbles dependents on fiber content of mash (Bell and Weaver 2007).

6.5.4 Wet Mash

Dryness of mash feed sometimes reduces feed intake below desired level, particularly if water intake is low. Constituents and some ingredients may be used specifically for this purpose. It is advisable to include a minimum of 20 percent of miller's offal's in the mixture. A ration containing 20 percent middlings and 20 percent bran can be made up into a very well textured wet mash. Feeding of wet mash may be true for one or two days but birds soon learn to adjust for the increased palatability and feed consumption reverts to its normal level. Wet mash feeding will not increase egg production, egg weight, growth and feed conversion.

6.5.5 Feeding Methods

1. All Scratch Method
2. All mash method
3. Pellet Method
4. Home mixture method
5. Feeding Greens
6. Kitchen waste
7. Scratch and mash method
8. Wet Mash method
9. Free choice method
10. Feeding oyster shell and grit
11. Cooked potatoes and garbage

Avian species are simple stomach, no teeth, affected by severe weather, have short digestive system, urinary bladder absent and cloaca is common opening for digestive, urinary and genital system.

6.5.6 Methods of Formulating Rations

Five methods of ration formulation are;

1. Square Method
2. Simultaneous Equation Method
3. Computer Method
4. Trial and Error Method
5. 2×2 Matrix Method

6.5.7 Feed Formulation Software:

1. Feed live
2. Brill
3. Mill mix
4. Ufff
5. Winfeed
6. Best mix
7. Eco mix
8. Uffda

Least Cost Feed Formulation

Least cost feed formulation is of prime importance in poultry feed milling meeting nutritional demands of poultry birds along with reasonable profit to feed manufacturers. Least cost formulas (one ton batch) are given in Table 6.3.

Table 6.3. Least cost formulas for poultry birds (one ton batch).

Feed Ingredients	Feed ingredients inclusion level per ton basis		
	Broiler Feed (No. 14)	Layer Feed (No. 13)	Layer Breeder Feed (No. 17 C)
Maize	300	470	478
Rice broken	166	100	100
Rice polish	120	64	55
Soybean meal	295	208	196
Canola meal	50	-	50
Guar meal	-	-	5.00
Poultry byproduct meal	40	34	-
Limestone	9.20	94	90
Dicalcium Phosphate	7.500	11.050	7.398
Oil	-	10.000	9.000
Lysine sulphate 70%	3.780	0.350	0.666
DL-Methionine	2.710	1.860	1.850
Threonine	0.360	-	-
Premix	2.500	2.500	2.500
Salt	2.500	2.710	3.306
Sodium Bicarbonate	1.000	1.500	1.241
Phytase	0.100	0.050	0.050
	Nutritional composition of feeds		
Crude Protein	20.00	16.00	16.25
Metabolizable Energy	2800	2750	2750

6.5.8 Poultry Feeding Problems

Poultry feeding problems are faulty feed formulation, faulty feeding practices, reduction of nutrient intake, loss of feed freshness, toxic substances, reduced resistance to disease, mycotoxins, resistance to infections, poor feed storage conditions, less feeding space, less number of feeders, less floor space, uneven feed distribution and feeder levels.

6.6 Manual vs Automatic Feeding

Poultry feeding systems have evolved with passage of time. Earlier, feed was thrown on ground which was picked by birds. Alternatively, some poultry farmers use plates or troughs to feed birds. However, once commercial poultry farming started, this method of feeding large number of birds was no longer viable.

In 1938, first ever trough chain feeding system was developed, however, poultry feeding systems have undergone a lot of changes, but many poultry farmers still favor these mechanical feeding systems. Today, manual filled plastic round feeders are favored by small scale poultry farmers.

As for as commercial poultry industry is concerned, farmers use automatic systems to save money on labor costs. In this technique, there is an overhead conveyor belt that carries feed from storage house to the hopper feeders. However, this technique of feeding underwent a change sometime in early part of 1950's with introduction of pan feeders. In pan feeding technique, pans were affixed to horizontally placed pipes. These pipes drop feed into pans. In this technique of feeding, small quantities of feed are automatically placed on pans to ensure that birds always had access to feed. Today, most poultry farmers that raise broiler favor the pan feeding method. However, this does not mean that chain feeders have been discarded completely. Earlier, chain feeders had slow speed and just active poultry used to get access to best particles from feed. Now, speed of chain feeders has improved and with addition of a grill, all birds can get access to feed without any discrepancy.

Today, due to advancement made by science, serious poultry farmers are aware that hens and roosters require different nutrition demands. Hence, farmers are trying to ensure that they meet these demands. So, it has been seen that where poultry feeding systems are concerned, males are fed using pan feeders, while females are fed by chain or pan feeders that are attached with special grills. Grill has opening for feeding purpose. Manual vs automatic feeding shown in Figure 6.3.

Fig. 6.3. Manual vs automatic feeding systems.

6.7 Feeding Broiler, Layer and Breeders

6.7.1 Broiler

Feed is major cost of poultry production operations which significantly affects production performance of birds. Therefore, feed and feeding is the most important consideration for efficient poultry farming. Improper feeding not only affects production performance but also causes several deficiency diseases. There should be all nutrients (carbohydrates, protein, fats, minerals and vitamins) in right proportion in feed. In addition, some additives to facilitate digestion and growth are often added in reputed commercial feed (Figure 6.4).

Fig. 6.4. Feeding broilers in environment controlled house.

6.7.2 Layer

Nutritional requirements during growing phase are different from those of starting period. Nutrient requirements of birds vary with climatic conditions. Energy requirements of birds increase with decrease in temperature because birds need energy for maintenance of their body temperature. Although energy should be 2.970 Kcal/kg in growing ration from 6-14 weeks but it should be reduced after 24 weeks to 2.750 Kcal/kg of ration to control or regulate body fat deposits. Exceeding fat pullets usually suffer from an increased rate of prolapse. Insufficient energy consumption will result in poor laying house performance. Protein requirement of growing birds is 15%, Ca 0.6% and phosphorus 0.4%. Feeding method; generally during rearing period feed is restricted to produce pullets with lean carcass at sexual maturity. Quantitative restrictions; in this method quantity of feed is recommended is restricted up to 15-20% from 9 weeks to sexual maturity to improve laying performance. Qualitative restrictions; this method involves use of low energy (2500 Kcal/kg) or low protein (13%) diet during rearing period. Layer feeding is shown in Figure 6.5.

Fig. 6.5. Layer production system.

6.7.3 Breeder

Broiler breeder pullets are placed under feed restriction starting at about 14 days of age. An early moderate restriction of growth rate is less stressful than a severe restriction later. This allows for better uniformity and proper fleshing, both of which contribute towards good hatching egg production. There are two methods of restricting growth rate in broiler breeders. There is a qualitative restriction, which utilizes reduced level of nutrients in feed, and there is a quantitative restriction, which utilizes reduced feed allowances. Although qualitative restriction is simpler and has been shown to maintain average body weight in accordance with breeder recommendations, uniformity using this procedure is poor. This method of restriction has not been used by breeders to any extent. Two methods of quantitative restriction can be used.

Birds can be fed either restricted amounts daily or on a skip-a-day programme. Advantage of every-day feeding versus skip-a-day feeding is a feed saving of approximately 1.4 kg per bird to 20 weeks of age. To produce the first egg, a pullet should attain a minimum body weight and age. Body protein content has been more closely linked to onset of production than body fat, and properly fleshed birds can mature and begin laying on time. Several workers have studied effect of high-protein and in many cases high-lysine, pre-breeder rations on reproductive performance of broiler breeder hens in a temperate climate. Furthermore, high-protein pre-breeder diets do not appear to have any positive effect on well-fleshed and adequately developed pullets. Increased body weight during rearing has been practiced to increase egg weight in pullets stimulated to lay at an early age. Feeding of broiler breeder is shown in Figure 6.6.

Energy requirement of the breeder hen is considered by most nutritionists as the most limiting nutrient. Breeder hen requires energy for body maintenance, activity, growth and egg production. About 50–75% of its energy needs are for maintenance and activity, while requirements for egg production vary from 0 to 35%, depending on rate of production. Best feed conversion and optimum hatchability and number of chicks can be achieved by feeding 90% of feed consumed by floor breeders (Leeson and Summers 2002).

Fig. 6.6. Broiler breeder feeding system.

6.8 Feed Additives/Premix in Poultry Rations

6.8.1 Feed Additives

Additives are added in combination or singly to poultry feed and called as "non-nutrient" feed additives.

6.8.2 Premixes

Premix is a mixture of vitamins, medicaments, feed supplements, diluents and trace minerals. Main purpose is to provide micro in the poultry feed in a homogeneous manner (Figure 6.7).

Fig. 6.7. Premix mixer for poultry feed.

6.9 Measures to Avoid Feed Wastage

There are several factors that can contribute to waste in a caged layer facility, including genetics, environmental control and feed quality. Following checklist is a logical start to implement a quality control program to reduce feed wastage.

1. Reduce physical wastage in the system. Adjust augers and chains to reduce any feed spills. Make sure that all feed troughs is adjusted as to height and that any holes or imperfect joins are repaired to avoid spillage. Check time clocks to ensure full delivery is made to all hens without over-filling of troughs. If feed accumulates on floor there is spillage.
2. Monitor flock feed intake. Ensure that there are no sudden increases in feed intake in your flock. Sudden increases could indicate a defect resulting in spillage. Keep records to compare actual intake with breed standard. Irregularities and deviations from standard must be investigated. Have hens gained weight? Is the house cold? Are spills evident?
3. How often are feed lines operated? Research has shown that running the line more than twice daily will improve access to feed by all hens and enhance feed efficiency. Care must be taken to avoid an accumulation of fines and unconsumed feed in the troughs.

4. Provide high quality feed free of mycotoxins, mold and feedstuffs that have low palatability. If hens refuse to eat normal quantities, a problem exists. Unconsumed feed is a problem that needs to be addressed quickly to avoid deterioration in quality and mold growth.
5. Monitor house insulation and ventilation systems for ideal temperature control. Insulation is much less expensive than having to heat the house through production of metabolic heat from feed. Usually insulation is maximized at time of construction or during remodelling. If house temperatures are not maintained between 70-80°F, flock will consume up to 2 lbs/100/day more feed than at a lower temperature. As the industry increases cage space allowance to meet Animal Welfare guidelines, maintaining house temperature has become more challenging.
6. Monitor body weight and gain, case weight and grade distribution. Overfeeding hens to achieve excessive body weight gain and egg size is a waste of feed if there is no incremental return for extra-large eggs. This consideration does not necessarily apply to breaker operations. Research supports maximum egg mass when hens are producing large grade eggs with optimum rates of egg production. Maintaining heavy hens to produce larger grades is not an efficient use of feed.
7. Evaluate strains of hen to select the lowest feed maintenance cost to optimize egg mass given specific housing and environmental conditions. Management of hens and selection of strain and body weight differ considerably between a breaker and a shell egg operation. After the mechanical defects and leaks are repaired, emphasis needs to be given to fine tuning record-keeping, quality control and adherence to goals for egg mass.

6.10 Proper Mycotoxin Risk Management

After the acknowledgment that mycotoxins are a major hindrance to a successful production, mycotoxin risk management is crucial to eliminate the effects of mycotoxins and their toxicity. Livestock feeds should contain substances called mycotoxin binders. These binders eliminate mycotoxins present in feeds. Mycotoxins and their determination are shown in Figure 6.8.

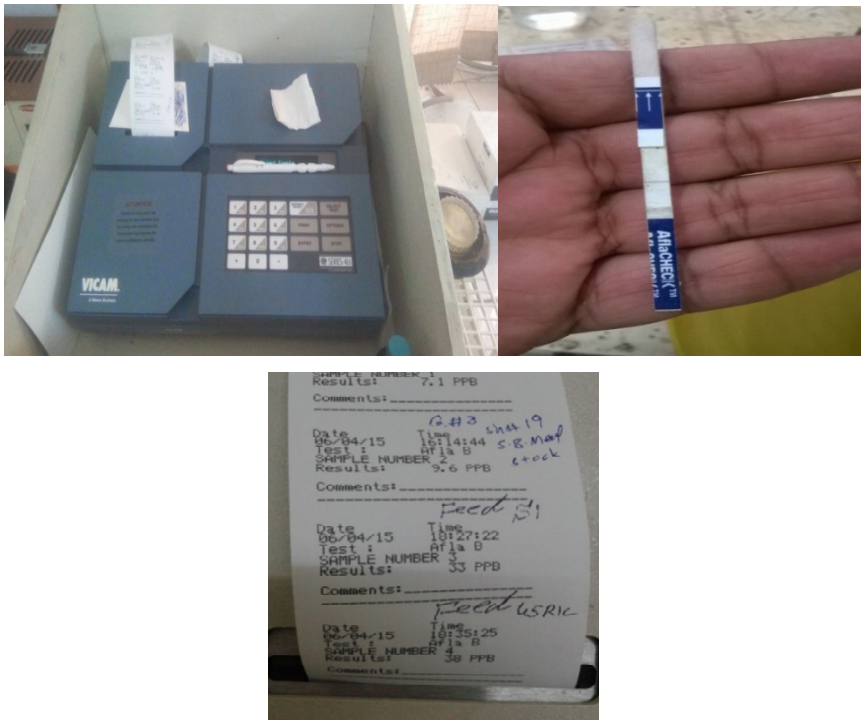

Fig. 6.8. Mycotoxins determination in poultry feed

Conclusion

Feed ingredients of good quality are prerequisite for quality feed manufacturing. Proper storage of ingredients has its due importance. Mostly farmers are providing crumble form of feed. Automatic feeding is gaining more popularity among poultry farmers. Good quality premixes are used. Proper care is taken to avoid mycotoxins in poultry feed.

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Chapter 7

Poultry Hygiene and Disease Prevention

Ahsan-ul-Haq and Tanveer Ahmad[†]

Abstract

Poultry hygiene and disease prevention is of utmost importance because healthy poultry birds ensure more production and profit margins. However, vaccination and medication is done as and when needed to save birds from lethal diseases. In this way poultry birds are saved from viral, bacterial, protozoal diseases. Feed of good quality is used to avoid mycotoxins which hinder bird's performance.

Keywords: Vaccination, Preventive measures against Viral, Bacterial, Parasitic Diseases, Feed Poisoning

7.1 Vaccine and Vaccination

A vaccine is A suspension of live attenuated or killed organisms (bacteria, viruses, parasites), which stimulate immune responses to prevent infections. Vaccines used in poultry are of two types. Live vaccine usually contains one antigen and may be administered by spray (aerosol), drinking water, eye drop (Ocular) or in some case by injection. Antigen may be either disease organism, which has been attenuated (made less virulent by some suitable means e.g. IB H120) or a naturally occurring mild strain of the organism (e.g. IB Strain of ND). Killed vaccine consists of concentrated antigens combined with an oil emulsion or aluminum hydroxide $\{Al(OH)_2\}$. They give high and prolonged level of immunity, especially when use

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after live vaccine. In bivalent or trivalent vaccine two or three antigens can be included in one vaccine. Oil or adjuvant in killed vaccine causes local inflammation increasing blood circulation which helps transportation of vaccine and releases vaccine slowly to produce antibodies for longer period.

In devising a vaccination program, both immunological and commercial factors must be considered including general health of flock, local pattern of disease, genetic type, cost benefit against potential loss, short or long term protection required and vaccination of flocks exposed to diseases in previous generation which would influence maternal antibodies. Consider type of vaccine required, route, method and frequency administration, type of poultry geographical location. Better management, housing, hygienic conditions and preventive measures are effective disease control measures (Haq et al. 2009).

Vaccination is like an insurance against dreadful diseases. Vaccination also reduces secondary bacterial complication. Following are instructions for vaccination. Purchase vaccine from reputed manufacturers and their authorized or get your vaccine directly and store them in refrigerator at 4-8°C. Check expire date. Preferably do vaccination in cool hours of morning or evening. Preferably keep vaccine container in ice bath and don't expose to sunlight. For vaccination in drinking water, keep birds thirsty for a few hours before giving water-containing vaccine. Ample number of waterers is recommended for proper vaccination. Use cold water, free from chlorine, obnoxious smell or any drug, when vaccine is to be dissolved in it. Use vaccine within prescribed limit after it is dissolved. Generally, use within 1hour is very safe. Use plastic made drinkers (but not made iron made drinkers) for vaccination in drinking water. If possible, serum of vaccinated birds may be tested to ascertain proper vaccination and immunity against that disease, two weeks or more after vaccination, particularly Newcastle Disease. Restrict traffic near vaccinated birds. Supplement vitamins before and after vaccination. Mostly use automatic injectors. Make sure that nasal of injection and dropper works efficiently. Keep frozen vaccine frozen, mix that thoroughly, and do not vaccinate more birds form a vial than the recommended. Don't rush the vaccination job. Presence of technical person is necessary to avoid skipping of birds.

Below are listed the methods of vaccine administration:

1. Injections I/M and subcutaneous.
2. Ocular: Most effective in case of live vaccine.
3. Nasal
4. Oral
5. Water
6. Dust
7. Cloacal: into the tissues in the upper portion of cloaca.
8. Wing web: by puncturing wing web and applying vaccine.
9. Feather follicles: By removing several feathers and swabbing or spraying vaccine over the area.
10. Spraying: Sprayed in air, on bird, in the mouth very fine mist of size 5 μ m is effective.
11. Beak-dipping (oculo-nasal route).

12. Transfixion and scarification.

Take a bowl containing ice in it, mix vaccine (1000 doses) with diluents of 30 ml in a sterile dropper bottle. Each millilitre should deliver about 35 drops from this dropper bottle, take two other sterile, empty diluents dropper bottles and distribute this reconstituted vaccine (as mentioned in 2) including these two empty sterile bottles evenly. Now mix vaccine in three dropper bottle in almost even quantities i.e. about 10 ml in each dropper bottle and place three dropper bottles in a bowl of ice with heir nozzles facing upwards. Two workers should work at a time with three dropper bottles. Third bottle should be placed in bowl contain ice in it. Both workers should keep exchanging their dropper bottle with one in the ice bowl alternatively after about every 5 minutes therefore, they would always have an access of cool vaccine and the quality of the vaccine would be maintained more efficiently during vaccination period. Eyeball of chicken must be held horizontally to prevent droplets of vaccine from rolling off. In case of nasal-drop vaccination, one nostril is covered so that vaccine is inhaled adequately by birds. Keep adding new and good dropper bottles to your stock and keep kicking out old dropper bottles which fall into category of "leaking bottles" or bottles with inadequate nozzles. One may develop multiple replicates of this procedure at one premises at a time if if the sufficient labour and other resources are available.

The main causes which render vaccines useless are listed below:

Immunosuppresson: There are various factors which cause immune-suppression. They are disease like Gumboro, Marek's and Coccidiosis, Mycotoxins in feed, certain bacterial, viral infections and nutritional deficiency.

Handling of Vaccines: If the vaccine is not handled properly, vaccination failure may occur.

Storage of Vaccines: If vaccines are not stored at required temperature (4-8°C), they may lose potency and vaccination failure may occur.

Transport of Vaccines: Vaccines should be transported in a closed chamber packed with ice. Negligence may result in vaccination failure.

Expired Vaccines: If vaccine used is expired one, vaccination failure occur.

Presence of Maternal Antibodies: After hatching chicks have some antibodies that are transmitted from parents. These antibodies protect them in early life. Sometimes, antibodies produced because of vaccination interfere with the maternal antibodies and hence desired immunity does not develop.

Interval between Two Different Vaccines: Sometime birds are vaccinated against two different diseases within a very small gap. This can also result in vaccination failure may be due to interference of direction of different vaccines, existing antibodies may get neutralized due to encountering antibodies produced by other vaccine, birds are exposed to additional stress.

Health Status of the Flock: Weak sick or diseased birds should never be vaccinated. If carried on vaccination failure occurs.

Stress: Never vaccinate before or after deworming or before or after debeaking.

Worms: if present interfere with defense mechanism of the bird. Due to weakness, proper immunity is not produced. Therefore, deworming should be done prior to vaccination.

Weather/Climate: Always avoid administration of vaccine during warm hours of the days.

Different Age Groups: Vaccination failure may also occur if different age birds are reared at the same time and vaccinated separately. If diluent is not pre-chilled it may contribute to breakdown in immunity. Diluent should be sterile.

Reconstitution of Vaccines: If vaccines are not reconstituted properly, exact is not supplied to birds so it results in vaccination failure.

Storage of Reconstituted Vaccine: Reconstituted vaccine should be stored under refrigerated conditions in an ice packed container, otherwise it results in failure.

Time between Reconstitution and Administration: Reconstituted vaccine should be administered within an hour or maximum within two hours otherwise. Potency of vaccine diminishes greatly.

Antibiotic in Feed/Water: No antibiotic should be given in feed or water three days before and after the vaccination.

Poor Sanitation: If hygienic conditions are not maintained at farm, failure of vaccination occurs frequently.

Pesticides Consumption: Pesticides in feed if consumed by bird depresses defense mechanism and hence immunity is not developed.

Disposal of Vaccine: vaccine vials should be properly disposed off. They may cause problems. Vaccination Period (Age): There is an age of administration of each vaccine. If age factor is neglected vaccine may fail to produce immunity in birds. Vaccination route: If vaccine administration route is changed vaccine fails. Under Dosing: If vaccine dose is less failure may occur.

7.1.1.5 Defects in the Method of Administration Water Vaccination

When water vaccination is done, chances of failure may be due to more number of birds, more quantity of water added, some sanitizer is used, high water temperature, exposure to direct sunlight, sick birds unable to drink water, water contains high metallic level and pH. When birds are not of uniform age/size, smaller birds not able to drink well.

In Spray vaccines, improper spraying, dilution, equipment not working well and all birds cannot come under the range of spray. Intra-Ocular vaccine could not be dropped in eye due to blockage in dropper. Wing Web vaccine not administered properly or stabber not properly dipped in vaccine vial. Injectable vaccine not injected at proper site, non-sterile syringe or needles or having residues of disinfectants and birds let unvaccinated.

7.1.1.6 Vaccination Schedules

Vaccination schedule for broiler, layer and breeder flock is given in Tables 7.1, 7.2 and 7.3, respectively.

Table 7.1. Broiler vaccination schedule.

Age (days)	Vaccine
4	ND+IB Live and ND Killed
8	IBD Intermediate
14	ND Lasoota
16	IBD Hot Strain/Intermediate Plus

Table 7.2. Layer vaccination schedule.

Age in Days	Name of Vaccine	Company
1	ND + IB	Intervet
8	ND + IB + IBD Killed IBD Live	Merial
18	IBD Live	Intervet
26	H9 Killed	Merial
33	IB 4/91 Live	Intervet
45	FOWL POX	Merial
53	ND + IB Live/ND+H9 Killed	Intervet/Merial
62	IB 4/91 Live	Intervet
83	ND + IB Live/H9 Killed	Intervet/Merial
92	ND + IB +E.D.S	Merial/Ceva
After every two month	ND (Lasoota)	Intervet/Merial

Table 7.3. Broiler breeder vaccination schedule.

Age (Days)	Name of Vaccine	Company	Route
1	Ma5+IB4/91 Live	Intervet	Hatchery spray
4	Cocci Live	ICI/Pfizer	Drinking Water
7	ND Lasoota+ H9 Killed	Intervet/Merial	Eye drop +Injection
10	IBD D-78Live+ND/IB/IBD Killed	Intervet /CEVA	Eyed op+ Injection
18	Hydro Killed (Anga Vac)	Merial	Injection
22	IBD(D78) +H5Killed	Intervet +Merial	Eye drop +Injection
28	ND Live +(ND+H9) Killed	Intervet + Merial	Eye drop +Injection
36	IB 120 + H7 Killed	Ceva + Merial	Eye drop +Injection
44	Fowl Pox	Ceva+ Merial	Injection
48	IB 4/91	Intervet	Eye drop
52	ND+ IB Killed	Merial	Injection
60	SHS Live	Merial	Eye Drop
70	AE Live+ H9 Killed	Merial	Eye Drop+ Injection
77	CAV Live	Intervet	Injection
80	EDS Killed	Intervet	Injection
86	FowlCholera +Reo	Merial + Intervet	Injection +Eye drop
92	ND+IB Live+H7	Intervet + Merial	Eye drop
105	AE Live + H5 Killed	Merial	Eye Drop+ Injection

Age (Days)	Name of Vaccine	Company	Route
112	ILT Live	Intervet	Eye drop
119	SHS+ Fowl Cholera	Merial	Eye Drop + Injection
130	ND+H9 Killed+ Reo	Merial+ Intervet	Injection + Eye drop
140	ND+IB+EDS+SHS	Merial	Injection
144	IB Variant Killed	Merial/Intervet	Injection
147	IBD Killed	Merial	Injection
150	H7 Killed	Merial	Injection
158	H5 Killed	Merial	Injection
168	NDI+IB Live+ ND Killed	Intervet + Merial	Eye drop+ Injection

7.2 Parasitic Diseases and their Control

7.2.1 Coccidiosis

Light to severe acute, chronic disease exhibiting high mortality, anorexia, enteritis, drooping wings, mild to severe pin point hemorrhages on external surface of intestine and caecal lesions, fluffy birds and death may occur. This disease can be classified into two types: intestinal and caecal Coccidiosis.

7.2.1.1 Etiology

Coccidiosis is caused by *E. acervulina, E. nagani, E. maxima, E. mitis, E. mivati, E. necatrix. E. praecox, E. brunetti* and *E. tenella.*

7.2.1.2 Factors Influencing Susceptibility

High humidity overcrowding and moist litter causes severe disease outbreak. Broilers are more susceptible than layers and disease can occur at any age but mostly during 3rd week of age.

7.2.1.3 Symptoms

a. External Signs

Birds seem fluffy, having blood in droppings.

b. Postmortem Symptoms

There are pin point hemorrhages on small intestine which can be seen from outer surface and intestine when cut refold immediately. Blood in small intestine and caeca can be observed in severe coccidiosis outbreak, which is full of bloody feces.

7.2.1.4 Prevention and Control

a. Hygiene

Proper disinfection and sanitation is required at poultry farm.

b. Management

Keep young stock away from adults, regular stirring of litter. Prevent dampness in shed. To keep litter dry add super phosphate at the rate of 15-20 kg/1000 feet^2.

c. Treatment

Any one of the followings may be given for treatment of coccidiosis

- SB Amprol-50 1g/litter
- ESB3 @1 g/litter water
- Diasulfina @1 cc/litter water
- Amprolium @1 g/litter water
- Darvisul AK plus @1 teaspoon/gallon water
- Embazine @ 4 ml/litter water
- Narcox @ 1 teaspoon/gallon water
- Coxeva powder @ 1 teaspoon/gallon water
-

Administer medicine for 3 days then 2 days rest and then 2 days. Always use vitamins A and K with medicine, never use vitamins of B group during treatment. Move the bird in case of severe disease outbreak so that they can drink medicated water. In broilers for preventive measures use any one of the following continuously

- Nopidol 125 g/ton of feed
- Coccidine ½ kg/ton of feed or 25 g/kg feed
- Clopidol-25 ½ kg/ton of feed or 25 g/kg feed
-

In layers for coccidiosis treatment Stenrol 1-2 kg/ton of feed is given for 7 days as it does not affect egg production.

7.3 Prophylactic Measures against Bacterial Diseases

7.3.1 Omphalitis

This disease affects chicks when they are hatching. It results in an infection of umbilical opening. Disease is also known as yolk sac infection, naval infection and mushy chick disease. There is an inflammation of navel when chicks are hatching or during first week of life. It is commonest cause of early chick mortality. Infection of yolk sac and navel are responsible for majority of deaths in chicks after three days of hatching and up to 14 days of their life.

7.3.1.1 Etiology

It is a disease of single or mixed bacterial infection. Mainly it is a salmonella infection, however, *Salmonella gallinarum*, *Salmonella typhimurium,* Coli form (*E. coli*), *Staphylococcus aureus*, *Clostridia* spp. (*C. Welchii*, *C. Sporogenes*), *Enterococci* and *Pseudomonas* are causative agents for coccidiosis disease.

Bacteria invade umbilical tissues because of improper conditions in hatcher. Navel opening does not close, and infection passes to the internal organs. Mostly neonatal chicks are affected. This cause stress to newly hatched chicks which is mainly due to improper hatchery hygiene, low humidity in hatchery and imperfect healing of naval

7.3.1.2 Pathogenesis

Seat of infection is incubator due to high humidity, fluctuating temperature, poor hygiene and penetration through shell into yolk. Bacteria There is deterioration and decomposition of yolk causing nutrient deprivation. Umbilical penetration during last days of incubation or immediately after hatching due to high humidity which prevents closure of umbilical opening, infection passes to internal organs and septicemia leading to death.

7.3.1.3 Signs and Symptoms

There are weak chicks that huddle near heat source. Vent pasting (may be due to high temp.). Pungent odor from yolk is unique symptom of this disease. Infected skin around navel with inflammation, abdomen soft, mushy, flabby and distended due to enlarged yolk sac.

7.3.1.4 Postmortem Symptoms

Abdomen filled with yolk, inflamed and discoloured yolk (yellow, blue or green). Large watery yolk with foul smell. Sometimes bean shaped yolk at duodenum and jejunum junction. Lungs congested, liver and kidney are dark and swollen.

7.3.1.5 Prevention and Control

For Salmonella free breeder, set clean eggs (check storage and fumigation process at hatchery), avoid chilling or overheating, improve hatchery cleanliness, management and provide best brooding conditions.

7.3.1.6 Treatment

In case of outbreak do flushing to open closed vent (2.5 kg molasses solution/1000 chicks or 250 g sugar per gal water), high quality feed (give mold free ground maize), green fodder (to increase motility of intestine). Use antibiotics any one of these; Nitrofurans (Furazolidone @ 20 g/bag of feed, Furasole 1 teaspoon/gal water, Furazole 80 g/bag of feed, Erythro-FZ 4-5 teaspoon/gal water) or Tribrissen @ 1 cc/gal 5-7 days.

7.3.2 Pullorum

Acute, infectious and highly fatal disease of young chicks and mature poultry birds, caused by Salmonella pullorum having vertical and horizontal transmission. Predisposing factors are overcrowding, poor ventilation and high brooding temperature

7.3.2.1 Symptoms (Chicks)

Small grayish nodules on heart, gizzard muscles, leg paralysis and swollen joints.

7.3.2.2 Diagnosis and Control

Whole blood test, remove carrier birds from the parent flock and use proper medicine for parent flock and proper sanitation and disinfection of hatchery and poultry house.

7.3.2.3 Treatment Anyone for 5-7 Days

Furazolidone (Furazolidone @ 20 g/bag of feed, Furasole 1 teaspoon/gal water, Furazole 80 g/bag of feed)

Sulpha drugs (Tribrissen @ 1 cc/gal, Trimodin 1 teaspoon/gal water)

Erythro FZ. (4-5 teaspoon/gal water or 150 g/bag of feed)

7.3.3 Fowl Typhoid

This disease is associated with unhygienic condition and poor management. Most commonly found in egg producing units. Fowl Typhoid i also known as Infectious leukemia and Klien's disease. It is characterized by profuse, bright, sulfur yellow diarrhea, sleepiness and anemia of the comb and wattles.

7.3.3.1 Etiology and Transmission

Cause of this disease is *Baccillus gallinarum* also known as *Salmonella gallinarum*. It is killed in a few minutes by direct sunlight. Ingestion of contaminated feed, water, droppings, contaminated hands of workers and careless disposing of dead bird carcass. In carcass, it survives 7 months and in droppings 1-2 months.

7.3.3.2 Signs and Symptoms

Birds become weak. Comb and wattles become black and congested. Yellowish colour faeces sometimes green or gray or sulphur yellow colour. High body temperature 110-113°F is noticed in this disease. Liver become dark red, when exposed to air its colour change into bronze. Swollen and congested spleen. Lungs show yellowish, brown colour, congested and edematous. On opening intestine, there may be yellow colour faeces and mucus.

7.3.3.3 Prevention and Control

Visibly affected birds should be destroyed and carcasses of dead birds should be disposed off. Proper hygienic conditions must be maintained at farm. Droppings of infected birds should be properly dumped. Furazolidone is added in feed @ 0.04% for 10 days. Carrier birds must be detected and culled from flock. Do proper disinfection of hatchery and chick transporting vehicles. Vaccination of birds if available.

7.3.3.4 Treatment

In case of outbreak, first reduce body temperature of birds by calpol syrup or soda salicylate 1 teaspoon/gallon or 5 tablets of paracitamol/gallon. Furazolidone is drug of choice. Use any one of the followings for 5-7 days.

Furavex 1 TSP/gal.
CF suspension ½ TSP/gal.
Chlorophenical capsules 5-6 /gal.
Furazolidone 20 g/bag
Furasole 1 TSP/gal.
Furazole 80 g/bag

7.3.4 Fowl Cholera

It is infectious bacterial disease which may be in acute septicaemic or chronic form. In septicaemic form there is high mortality, while in chronic form production losses occur. Causative organism *Pasteurella multocida*, which is transmitted by contamination from carrier birds, rodents, nasal exudates, cannibalism of dead carcass and mechanical carriers.

7.3.4.1 Symptoms

Acute infection: Visibly sick birds, ruffled feathers, mucous discharge from beak, diarrhoea, cyanosis of combs and wattles and respiratory distress prior to death.

Chronic infection: Swollen wattles, swollen sinuses, arthritis, respiratory distress, drop in egg production and low mortality.

Postmortem findings: Small haemorrhages on heart, lungs, abdominal fat and intestines. There is congested liver having yellowish follicles. Facial oedema and blood stained mucous in mouth, cheesy plugs in conjunctivae sac and in wattles.

7.3.4.2 Diagnosis

Inject 0.2 ml suspension of infect tissues in the sparrows s/c route if death occur within 24 hrs then fowl cholera is confirmed. In A.I. large blood splashes are found on sternum, proventriculus and other abdominal organs. In case of cholera small haemorrhages may be found on abdominal organs.

7.3.4.3 Prevention and Treatment

All in all out system is method of choice with proper disposal of dead birds. Carrier birds should be removed. Proper sanitation and hygiene should be adopted.

Use any of the following medicines.

- TM 200 65 g/bag for 7 days.
- Tribrissen 1 cc/gal water for 7 days.
- Polymycin 1 TSP/gal water for 7 days.

7.3.5 *E. coli* Infection

E. coli is normal inhabitant of intestinal tract of birds, animals and man. This is also found in dust, water, on skin, hair, feathers and in all places contaminated with feces. There are many specific conditions showing involvement of *E. coli*, usually it appears as thin white creamy layer over liver and abdominal organs. Enteritis, pericarditis, salpingitis, synovitis, omphalitis, coligranuloma, septicemia, air sacculitis and peri hepatitis are specific conditions of *E. coli*. *E. coli* is usually a secondary cause.

7.3.5.1 Transmission, Prevention and Control

Transmission to egg is either by faeces or salpingitis. Other sources are feed, hatchery and water. Cross ventilation help reduce *E. coli* load. Pelleted feed has less chances of contamination. Keep chicks warm and well fed. Proper egg storage and hatchery sanitation. Rodent droppings are source of pathogenic *E. coli.*

7.3.5.2 Treatment

Disinfection: With $KMnO_4$ and then keep equipment in sunlight and spray formalin 1:24 inside the shed and 1:12 outside. Use any of the following medicines for 5-7 days.

- Tribrissen 1 cc/gal water
- Gallamycine 2 TSP/gal water
- Tylan premix 80-100 g/bag feed
- Lincospectin 1 g/2 liter water
- TSC-80 1 g/2 liter water

7.3.6 Infectious Coryza Infection

Acute or sub acute rapidly spreading respiratory disease, characterized by swelling of face, nasal discharge and sneezing. Causative Organism is *Hemophilus gallinarum*. Mostly outbreaks occur at high altitude and in cold damp weather. It is transmitted though carrier birds, air, feed and water.

7.3.6.1 Symptoms

There is foul smelling, nasal, eye discharge and sticking of feed on beak. Swelling of face, eyes, comb, wattles, decreased egg production (10-40%), Haemorrhages and mucous in respiratory tract is also observed in this disease.

7.3.6.2 Prevention and Control

Provide good hygienic and sanitary conditions to birds. Proper sanitation and disinfection is recommended of poultry house. Isolate sick birds. In case of outbreak: Wash equipment with $KMnO_4$ and spray formalin (1:24 inside and 1:12 outside shed).

7.3.6.3 Treatment

1. TSE 380 @ ½ Tsp/gal. for 5-7 days
2. Tribrissen @ 1.0 ml/gal. for 5-7 days or Inj. 0.1 ml/kg
3. Gallamycine @ 2 Tsp/gal. for5-7 days
4. Terravet @ 3-6 g/gal. for 3-5 days
5. Oxy-N50 @ 2.5 g/liter for 5-7 days
6. Tylodox @ 1.0 g/gal. for 5 days
7. Fumicin @ 0.5 ml/liter for 5 days
8. Streptomycin Inj. @ 1.0 g/5 birds
9. Procaine Penicillin @ 40 Lac. One inj./250 birds.
10. Erythrocine powder @ 150-200 g/bag feed.

7.3.7 Chronic Respiratory Disease (Mycoplasma)

Chronic respiratory disease affects upper and lower respiratory tract of chickens, turkeys and other birds. Characterized by gasping, rales, coughing, nasal discharge

and rhinitis. *Mycoplasma gallisepticum* smallest bacterium with no rigid cell wall. Infected eggs, contact with infected birds and equipment.

7.3.7.1 Signs and Symptoms

Chickens: Nasal discharge, rattling in wind pipe, coughing, gasping, sneezing and shaking of head. Males have more prominent signs.
Broilers: Poor carcass quality, high condemnation rate. Thin and weak birds with razor blade breasts are seen. Most outbreaks occur between 4-8 weeks of age. Poor feed conversion, sharp decline in weight gain. Morbidity rate is fairly high.

7.3.7.2 Postmortem Findings

Early stage: Excess mucous in trachea, consolidated and solid spots on lungs, cheesy material in lungs, air sacculitis, beaded or lymph follicular appearance and caseous exudates in air sacs. "Foamy or Soapy" air sacs are observed in the disease.

Advanced stage: Perihepatitis and pericarditis. Formation of creamy color layer over heart and liver. Abdominal organs are covered, thickness of layer will indicate advancement of CRD and plugs of pus are seen in trachea and pale muscles.

7.3.7.3 Prevention

Prevention is through establishment of Mycoplasma free breeders, purchase CRD free chicks from hatchery, keep good biosecurity conditions, dispose dead birds properly. Avoid wild birds, prohibition of visitors and strict sanitary measures should be adopted.

7.3.7.4 Treatment

Disinfect equipment with $KMnO_4$. Spray formalin solution or TH_4 @ 4 cc/liter. Use any one of the following medicines.

- Imequyl 20% @ 2-2.5 ml/gal for 7 days
- Avitryl @ 2-2.5 ml/gal for 7 days
- Norfloxillin 200 @ 1.0 cc/gal for 7 days
- Tribrissen @ 1.0 ml/gal for 7 days
- Terramycin L.A. Inj. @ 1.0 cc/kg body wt.
- Gallamycin @ 2 Tsp/gal for 7 days
- Linco-Spectin @ 0.5 Tsp/gal for 7 days

Use any of Tylan preparation.

- Tylan premix @ 80 g/bag for 7 days
- Pulmotil @ 15-20 mg/kg body weight 3-5 days
- Tyleco Solubal @ 1.0 g/2 liter water 3-5 days
- Tylodox injection.
- Tylodox powder 1.0 g/gal for 7 days
- Tylotad injection
- Tylan D.H.S. Injection.

Tylomycin F @ 2.5 g/liter for 7 days.
Cenamicina Sol. @ 2.5 g/liter for 7 days.
Quimicoli @ 1.0 cc/2 liter for 7 days.
Eriprim @ 2.0 g/liter for 7 days.

Floxatxil @ 1 cc/2.0 liter for 7 days.
Sintsol @ 1 cc/2.0 liter for 7 days.
Atiquinine @ 1.0 g/5 liter for 7 days.
Doxycycline powder @ 1.0 Tsp + Oxy-N50 @ 1.0 Tsp /gal for 7 days
Improve ventilation for having good results of medicine.

7.4 Preventive Measures for Viral Diseases

7.4.1 Newcastle Disease

It is an infectious, highly contagious and fatal disease chiefly affecting chickens and characterized by respiratory, digestive and nervous symptoms and high mortality in susceptible birds. Caused by a paramyxovirus type-1.

7.4.1.1 Transmission

Transmission of this disease is through infected, carrier birds, poultry products, offals from infected birds, mechanical vectors, wild birds, incomplete vaccination, contaminated feed and water.

7.4.1.2 Signs and Symptoms

Incubation period is 2-15 days. ND affects 3 major systems; respiratory, digestive and nervous system. There is voice production during disease period. Greenish white diarrhoea and nervous signs i.e. convulsions, muscular tremors, stargazing, walking in circles.

7.4.1.3 Internal Signs

In this deisease haemorrhages are Present on glandular portion of proventriculus. There is reddening of trachea, cloudy air sacs, lung congestion and haemorrhages in mucosa and submucosa of intestine. Dark red and purple red hemorrhagic lesions are seen on intestinal wall. Spleen may be enlarged in early stages and shrunken in late stages.

7.4.1.4 Differential Diagnosis

Vice production: voice production is also found in IB, ILT, Coryza, CRD and Fowl pox (in case of fowl pox, pox lesions are present in mucosa of buckle cavity).

Haemorrhages on proventriculus: This present in case of Gumboro but these are found on the junction of proventriculus and gizzard.

Backward movement of bird: This is also found in case of Vitamin E deficiency. Respiratory symptoms along with greenish white diarrhoea and haemorrhages on glandular portion of proventriculus confirm N.D. disease.

7.4.1.5 Prevention and Control

Avoid entry of carrier birds. Feed and water should not be contaminated. Prevent contact of virus with susceptible birds. Hatchery should be away from broiler dressing and other poultry operations. Adopt strict biosecurity measures. Vaccinate broilers at 7-10 days and 25-28 days while layers at 7-10 days, 25-28 days and 4

month then repeat every 3 months. Repeat after every three months, Lasoota in drinking water. Due to any stress or disease antibody level may reduce then do not wait for three month interval but vaccinate birds as early as they recover for disease. In case of outbreak, adopt all sanitary measures and vaccinate all healthy birds as early as possible. There is proper treatment but to avoid secondary infection some antibiotics should be used.

7.4.2 Infectious Bursal Disease

Synonyms are Gumboro, Infectious Bursitis and Avian Nephrosis Syndrome. It is characterized by destruction of lymphocytes, β cells which are responsible for antibody production. Destruction of these cells immune response to vaccines is reduced and birds become susceptible to other infections like CRD, Coryza and enteritis etc. Causative organism is a virus of Birna viridae family.

7.4.2.1 Transmission and Symptoms

No vertical transmission. Virus is secreted in droppings even after 2 week of infection. Disease is transmitted through contaminated feed, water, worms, mites and blood sucking insects. Whitish watery mucoid diarrhoea, soiled vent feather with white diarrhoea, ruffled feather and trembling of birds. There is high body temperature 110-112°F when bird is suffering from this disease.

7.4.2.2 Postmortem Lesions

Bursa becomes congested oedematous and swollen, 2-3 times than normal size. There are haemorrhages inside the bursal folds. Mucosal haemorrhages seen at proventriculus and gizzard junction. In this disease kidneys become pale and swollen with deposition of urates. Haemorrhages are seen on breast and thigh muscles, sometimes with pus formation.

7.4.2.3 Prevention and Control

Proper hygiene and sanitation (with formaldehyde and phenolic compounds) conditions are required for prevention and control of this disease. Vaccination is done on day 7^{th}, 14^{th} and 28^{th}. Disease attack is maximum up to 12-16 weeks of age. Phenyl is disinfectant of choice after Gumboro attack at farm, it can kill virus. Vaccines are Bur706, Gumboral CT, Gumbopest, Bigopest, Gumboro vaccine Nobillis D78 and Bursine II.

7.4.2.4 Treatment

In case of outbreak if symptoms appear after 1-2 days of vaccine, then it is vaccine reaction and if after 15 days then it is Gumboro attack then repeat vaccination to healthy birds. Reduce temperature by APC, paracetamol tablets or Calpol syrup 5 tsp or 5 tablets/gal. or soda salisilate 1 tsp/gal. or 5 Brufen tablet/gallon water. Use any antibiotic to reduce secondary infection chances. Use vitamins and dilute feed i.e. corn 50 parts, wheat and rice 25 parts each with ½ kg dry milk for 100 kg ration.

7.4.3 Hydro Pericardium Syndrome

Hydro pericardium means water in pericardium (membrane surrounding heart filled with water). This disease is also called as Angara, Hydro pericardium pulmonary edema, hepato nephrosis complex or inclusion body hepatitis. Hydropericardium disease was first observed in Pakistan in 1987-88 and is caused by Adenovirus strain K31/89. Broilers, layers as well as breeder birds are susceptible birds. Birds shed virus in feces which is source of infection.

7.4.3.1 Predisposing Factors

Highly pathogenic to day old chicks causes 80% mortality. Most susceptible age is 3 to 5 weeks. No sex predisposition. Predisposing factors are overcrowding, unhygienic and poor sanitary conditions. Presence of hepatotoxins and mycotoxins in feed is one of the predisposing factors for this disease. Any type of stress in farm can cause this disease.

7.4.3.2 External Symptoms

Externally it is very much difficult to diagnose it. There is chalky gray to bright light yellow mucoid droppings. Jaundice signs in some birds. Sudden mortality in 3rd week peaks in 4/5 week subsides in 5/6 week. Sometimes birds show signs of difficult breathing.

7.4.3.3 Postmortem Symptoms

Febrile carcass like Gumboro and Fowl Typhoid are found in case of this disease. Most important organ to be observed is heart. Pericardium sac is distended with fluid. Mostly amount of fluid is 5-8 ml. Colour of fluid is clear to light yellow. There is non-clotted fluid but gelatinizes on exposure to air. Misshapen and flabby heart i.e. soft and cracks on touching. Sub cutaneous and body fat of pale yellow color. Enlarged, congested, pale and necrotic liver are seen during postmortem. Pale bone marrow, death of bird occurs due to heart and liver failure.

7.4.3.4 Vaccination and Treatment

½ cc inj. preferably intramuscular on 15-17 or 21 day of age. No treatment but supportive therapy can be done. Protein and fat content of diet is reduced. Provide glucose in water. Feed grains only. Provide liver tonic medicines like Hepamerz or Jetepar @ 2 teaspoon/gal water.

7.4.3.5 Prevention and Control

Purchase Adenovirus free chicks. Proper cleanliness and disinfection of shed is required for prevention and control of this disease. Isolate sick birds. Keep all birds of same age. It is recommended to provide mycotoxin free feed and stress free environment to birds.

7.4.3.6 Outbreak Management

No treatment, vaccinate birds, repeat vaccine only if previous vaccine was done 15-20 days before. Surviving birds are susceptible to E. coli, respiratory infections, coccidiosis, IBD and ND so precautionary measures should be taken. To avoid

secondary infections especially respiratory infections, use broad spectrum antibiotics after vaccination.

7.4.4 Infectious Bronchitis

It is an acute or sub-acute highly contagious disease of chicken, characterized by respiratory symptoms and high mortality in young chicks and decreased egg production and deterioration of egg quality in laying birds. Corona virus is the cause of this disease. Chicken is susceptible host. Mostly it attacks at 10-12 weeks of age. ND, Coryza and CRD are influencing factors.

7.4.4.1 Clinical Signs

In young chicks: coughing, sneezing and nasal discharge, huddle under heat source, mortality up to 30%, it damages oviduct; birds grow like normal birds but produce less eggs. In growing birds: mild respiratory signs and may remain unnoticed. Disease may lead to permanent oviduct injury resulting in 20% non-layers with 1-2% mortality. Adult birds: less severe or absent respiratory signs, egg production comes to normal in 30 days, misshapen eggs, moulting before time, watery albumin. Sometimes with haemorrhages on albumin or yolk

7.4.4.2 Postmortem Lesions and Control

Same symptoms as of ILT but accumulates watery mucous in trachea, acute tracheitis. Ovary looks normal but oviduct is affected (abnormal), kidneys of chicks are damaged (swollen). Follow vaccination program. In case of disease outbreak antibiotics are used to avoid secondary infection. To reduce misshapen eggs, use DCP @ 1 kg/bag and Ferrous sulphate @ 10 g/bag for 5-7 days.

7.4.5 Avian Influenza

There are three types of influenza viruses namely influenza A, B and C. Type C influenza virus shows very mild symptoms and does not cause epidemic. Type A and B influenza viruses are epidemic causing viruses. Type B influenza virus is not having any subtypes but it can be divided into strains viz. B Yamagata and B Victoria viruses. Influenza A virus has numerous subtypes base on surface antigens haemagglutinin (H) and neuraminidase (N) having 18 and 11 subtypes, respectively (Anonymous 1980; Anonymous 2014). Influenza A type virus infection can be classified into low pathogenic and high pathogenic infections. High pathogenic influenza virus strains include H1N1, H3N2 and H5N1. This infection can cause a wide variety of symptoms ranging from conjunctivitis to dyspnea, acute respiratory distress which may lead to respiratory failure etc. Sometimes it can show even neurologic symptoms like fits along with abdominal pain, nausea and diarrhea. Diagnosis of highly pathogenic influenza A from B or C type virus is not possible as this virus shows overlapping symptoms and requires laboratory testing.

Its symptoms range from mild upper respiratory disease to reproductive failure or highly fatal generalized disease caused by Orthomixovirus A type. There are two types of attack; less virulent influenza virus and highly pathogenic virus.

7.4.5.1 Low Pathogenic Avian Influenza

Anorexia, huddling, ruffled feathers. Mild respiratory sings, sinusitis, sneezing. There is severe drop in egg production, decreased fertility. There may be low mortality or high (60-70%) in case of secondary infection.

7.4.5.2 Highly Pathogenic Avian Influenza

Sudden onset of disease may cause high mortality. High and body temperature (113°F). Swelling (subcutaneous oedema) of head, face especially wattles, severe respiratory signs, rales, coughing, oedema of glottis excessive fluid from sinusitis and cessation of egg laying is noticed in this disease.

7.4.5.3 Postmortem Lesions and Diagnosis

Blood splashes on sternum, proventriculus, heart, trachea and intestine. Haemorrhagic tracheitis and dark red muscles are observed in this disease. Disease occurs in late summer, fall or early winter. Decreased egg production or increased condemnation for secondary collibacillosis. Severe drop (90%) in egg production, blood splashes on sternum, proventriculus, heart and intestine will confirm the disease.

7.4.5.4 Differential Diagnosis

In case of ND haemorrhages on glandular portion of proventriculus while in case of influenza there are blood splashes on whole proventriculus. In case of fowl cholera apparently, bird shows similar conditions (wattles swollen and dark blue) but signs are less pronounced.

7.4.5.5 Treatment, Prevention and Control

Disease spread through infected birds or wild birds, infected feed/water utensils. Vaccinate birds, isolate sick birds and destroy them. No specific treatment.

7.4.6 Fowl Pox

Fowl Pox is characterized by formation of lesions and scab on soft parts of body (comb, wattles, mouth, under wings). Disease is caused by a virus of genus avipox and family pox viridiae. Mechanical transmission to injure and laceratred skin. Mosquitoes can also transmit it. Incubation period is 4-10 days.

7.4.6.1 Symptoms

This occurs in following three forms i.e. cutaneous, diphtheritic and oculo-nasal form.

Cutaneous (dry) Form: Most common, small lesions on comb and wattle remain moist for short time then dry, turn yellow, brown and then dark brown. Lesions at the angle of beak, mouth, around eyes, ventral surface of wings on legs and vent. Removal of lesion leaves dry or moist hemorrhages. Negligible mortality but high morbidity is noticed in this disease.

Diphtheritic (wet) Form: This is also known as avian diphtheria. There is voice production, lesions on moist mucus membranes, white opaque nodules develop and

increase rapidly, gasping, suffocation occur due to lesions in larynx, mortality prevails due to suffocation.

Oculo-nasal Form: Swelling of eyes (conjunctivitis), infra orbital sinuses and in breeders lesions are in oviduct, cloaca and skin of vent.

7.4.6.2 Effects of Disease

Reduced growth and abnormal feathering, lowered production even remains out of production for several weeks, lowered fertility and infection prevails even from 8-9 weeks of age.

7.4.6.3 Postmortem Lesions

Lesions are seen on mucus membrane of mouth, respiratory tract and oesophagus.

7.4.6.4 Prevention and Control

Dead birds must be buried or incinerated, proper disinfection, control of cannibalism, beak trimming not recommended during disease outbreak and vaccinate at 6-8 weeks along with vitamin A, K to overcome stress.

7.4.6.5 Treatment

No treatment, avoid secondary infections. Apply tincture iodine on lesions. Application of vaseline around lesions and in mouth will facilitate feeding and prevent secondary infection. Use any one of the followings for 7 days.

- TM200 @ 65 g/bag feed
- Oxytetracycline (11%) @ 125 g/bag
- Tribrissen @ 1.0 ml/gallon
- Tylomycin @ 2.5 g/liter etc.

7.4.7 Avian Leukosis Complex

Viruses of leukosis group induce a spectrum of neoplasm including following,

7.4.7.1 Leukosis

Leukosis is a condition of malignancy of haemopoietic (blood producing) cells. There are mainly 5 types of leukosis as given in Table 7.4.

1. **Lymphoid Leukosis** (Big liver disease): Caused by malignancy of lymphoblasts, the precursor of the lymphocytes. Under field conditions this is most prevalent form.
2. **Erythroid Leukosis** (Erythroblastosis): Caused by malignancy of the erythroblasts, the precursors of red blood cells.
3. **Myeloid Leukosis** (Myeloblastosis): Caused by malignancy of the myeloblasts, the precursor cells of the granulocytic series.
4. **Myelocytomatosis** (Myelocytosis): Characterized by myelocytic tumors of the skull, ribs and long bones.
5. **Osteopetrosis**: Affect long bones.

7.4.7.2 History

Disease was initially described in first decade of 20th century by Ellerman and Bang. Disease has worldwide distribution. This disease is one of the most important causes of loss to poultry industry throughout the world.

7.4.7.3 Etiology

Leukosis group of viruses belong to genus "Oncoronavirus C', RNA containing virus of family "Retrotnridae'. There are at least 5 subgroups, A to E. Each subgroup consists of several distinct antigenic types. Virus survives at 37°C from 3-15 Hours at pH 5-9.

7.4.7.4 Susceptible Hosts

Chicken, pheasants, Guinea fowl, ducks, quails and turkeys are affected by this disease. Disease is mostly seen in chicken.

7.4.7.5 Transmission

Vertical Transmission: From parent to offspring through infected ova or sperm. Horizontal transmission: Virus die quickly outside host body thus horizontal transmission is slow and inefficient. Use live vaccines when eggs do not originate from LL-free flock.

7.4.7.6 Factors Influencing Susceptibility

Genetic constitution of chicken, virus strain, route of exposure (I/M Sarcoma, I/V Erythroblastosis and haemorrhages) and age of bird (resistance increases with age).

7.4.7.7 Tumors

Tumors growth is seen on some part of body. Tumors are of three types.

a) Nodules: Soft smooth and glistening (0.5mm-5cm)
b) Miliary: (less than 2 mm)
c) Diffuse: (patches)

7.4.7.8 Internal and External Signs

Table 7.4. Diseases, clinical signs and postmortem lesions.

Disease	Clinical Signs	Postmortem Lesions
1. Lymphoid Leukosis	1) Comb pale and shrunken. 2) Slight drop in feed consumption or egg production.	1. Grayish white tumors in liver, spleen and kidneys. 2. Uniform enlargement of affected organs.
2. Erythroid Leukosis	A. Acute form: Sudden death B. Chronic form: Anemia, Emaciation, Diarrhea	1. Diffuse bright cherry red discoloration. 2. Enlargement of liver & spleen.
3. Myeloid Leukosis	Occurs sporadically in mature birds	1. Liver has a granular appearance. 2. Discolored grayish yellow liver. 3. Hyperplastic and pale bone marrow.

4. Myelocytomatosis	Occurs sporadically in immature birds.	1. Soft yellowish-white tumors on cranium (skull), long bones and pleural surface of the thoracic cage.
5. Osteopetrosis	1. Occurs sporadically in birds of all ages. 2. More often in males than in females.	1. Affect long bones. 2. Abnormally shaped. 3. Thickened. 4. Hard to break.

7.4.7.9 Diagnosis

In this disease tumors are observed in liver, spleen or kidneys without nerve or ovarian involvement, abnormal thickened bones and thin keel bone results in case of this disease. Microscopic examination of tumors or blood confirms disease.

7.4.7.10 Prevention and Control.

There is no effective treatment, practice high hygiene standards in the flock. Detect and eliminate birds that shed viruses in their eggs. Many virus infected birds do not shed their virus in their eggs. Establish leukosis free breeding stock. Avoid contact with carrier birds particularly in early age. Do not mix separate broods of chickens until after 20 weeks of age. Selection of genetically resistant birds for breeder flock (Resistance of infection is controlled by recessive genes present in varying frequencies). Use live vaccines (of other diseases) of pathogen free source (egg or flocks). Drug administration: "Miboleronc" in feed for first 49 days reduced incidence of tumour but it did not prevent proliferation of virus. Thoroughly clean and disinfect houses, equipment and building premises. Use fresh litter for each new batch of chicks. Spray with an efficient insecticide to eliminate external parasites and other insects, between and during broods. Disease can be carried by rats, mice, wild birds, insects, mosquitoes and pets (Finberg and Wilson 2010). Comparison of Marek's and Leukosis diseases is given in Table 7.5.

Table 7.5. Comparison of Marek's and Leukosis diseases.

Particulars	Marek's Disease	Lymphoid Leukosis
1. Age of group affected	Usually 6-16 weeks	16 weeks or older
2. Etiology	DNA virus	RNA virus
3. Common tumor sites	Nerves, eyes, skin, liver, spleen, kidney, lung, heart, proventriculus, bursa	Bursa(common), liver, spleen and kidney
4. Transmission	Horizontal, through dander from feather follicles	Vertical
5. Paralysis	Usually present	Absent
6. Enlargement of nerves	Usually present	Absent
7. Bursa of fabricious	Diffuse enlargement or atrophy.	Nodular tumors
8. Skin and muscle tumors	May be present	Usually absent
9. Prevention	Vaccine at 1st day with HVT is effective	Raise birds with high genetic resistance to LL.
10. Treatment	No successful treatment	No effective treatment

7.4.7.12 Tests

Tests available to detect the presence of virus in breeder flock are as follow;

1. Resistance inducing factors (RIF) test.
2. Complement Fixation of Avian Leukosis virus (COFAL) test.
3. Phenotypic Mixing test (PM) test (currently preferred)
4. Enzyme Linked Immunosorbent Assay (EUSA) test.

7.4.7.13 In Case of Outbreak

Collect feathers and burn them. Give antibiotic and vitamins to birds.

7.4.8 Marek's Disease

Marek's disease is also known as gray eye, polyneuritis, range paralysis, neural leucosis and skin leukosis. Viral disease destroy nervous system especially peripheral nerves. Disease is characterized by legs and wings paralysis with a critical sign of one leg in front and one leg behind. In Marek's disease tumor forms on skin, muscles, digestive and respiratory tract. Marek's disease virus lives in feather follicle epithelium.

7.4.8.1 Etiology and Transmission

Caused by Group B cell associated Herpes Virus (DNA virus) there are 3 serotypes; Type 1: Pathogenic Marek's disease virus, Type 2: Naturally a pathogenic virus and Type 3: Herpes virus of Turkey. No vertical transmission, direct or indirect contact, air borne through feathers. No vector birds or biting insects. Mechanical: clothing, feed bags, equipment and persons.

7.4.8.2 Signs and Symptoms

Classical Form: Symptoms are related to peripheral nerves. Brachial nerve (wing paralysis), schiatic nerve (leg paralysis, cervical nerve (torticollis), vagus and intercostal nerves (respiratory symptoms) are mainly affected by this disease.

Acute Form: Paralysis with greenish white diarrhoea, affected nerve is 2-3 times more thick, enlargement of liver, ovaries, spleen, kidney, proventriculus, bursa and sometimes tumours on skin, muscles, digestive and respiratory tract.

7.4.8.3 Control and Treatment

No effective treatments, vaccinate birds at day old age, collect infected feathers daily from the shed and burn them. Use vitamins.

7.5 Feed Poisoning

7.5.1 Poisons in Feed Ingredients of Vegetable Origin

It includes gossypol in cotton seed meal, glucosides in rape seed meal, antipyridoxine in linseed meal and gums in guar meal.

7.5.2 Poisons in Feed Ingredients of Animal Origin

It includes anti-thiamine factor in fish meal, contaminants in meat and blood meal and rancid fat in poultry by-product meal.

Conclusion

Live and killed vaccines are administered to the poultry birds keeping in view their health status. Different medicines are also used to treat the birds in various bacterial, viral and protozoal diseases. Good biosecurity measures are recommended.

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Chapter 8

Poultry Processing

Muhammad Yousaf and Sarzamin Khan[†]

Abstract

Poultry eggs and meat have prime importance in human's balanced diet. Egg structure and composition are mannered in such a way that its keeping quality provision of nutrient at a cheap rate is excellent. Egg protein is easily digestible and metabolized. There are well established egg grades for ease of consumers which are equally accepted in international eggs trade. Eggs are mostly produced in cage system. Eggs are properly stored at specified temperature and relative humidity. Eggs are sold on intact basis in market or processed in highly sophisticated/mechanized machines. Proper washing, disinfection, candling, weighing and dirt detection is done in egg processing plants to produce table eggs. Eggs are broken in processing plants and sold as liquid or dry basis. Dried yolk, dried albumen or as dried egg contents are processed in international market. Egg and egg products are used in human food and in so many allied industries. Poultry meat is favorite food item of the human beings. Poultry meat is preferred due to more protein contents and least fat contents. Poultry birds are properly graded, inspected and transported to produce quality meat and meat products. Certified poultry processing plants are maintaining proper sanitary conditions, quality control, pathogens control and HACCP as per international featured standards guidelines to assure food safety and public health. Value added meat products are prepared, packed, stored, transported and effectively marketed.

Keywords: Egg and meat composition, storage, processing, value addition, marketing.

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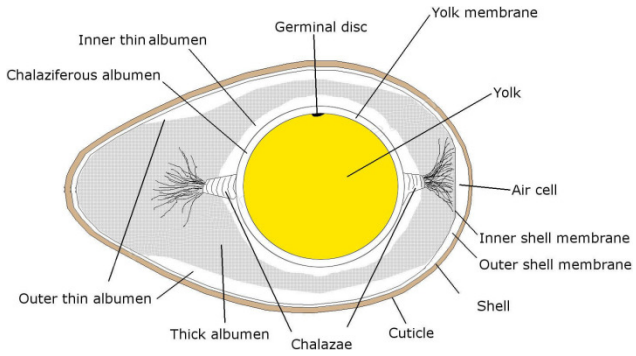
8.1 Introduction

Poultry egg and meat processing have prime importance in Pakistan poultry industry. Processed and value added products are fulfilling needs of countrymen and being exported to various countries to earn foreign exchange. However, attention is required by poultry egg and meat processors to meet International Featured Standards to enhance exports.

8.2 Egg Structure and Composition



Source: Haq and Akhtar (2004)

Egg mainly consists of three parts egg shell, shell membrane, yolk and albumin.

Components	Percentage
Egg shell	11 %
Yolk	31 %
Albumin	58 %

8.2.1 Egg shell

Eggshell is outer most covering of an egg. It is 11 % of whole egg weight. Composition of eggshell mainly contains calcium carbonate along with calcium phosphate, magnesium carbonate and organic matter. Egg shell thickness normally varies from 0.33 mm to 0.35 mm.

Eggshell contents	Percentage
Calcium Carbonate	94.1%
Calcium Phosphate	0.9%
Magnesium Carbonate	1.1%
Organic Matter	3.9%

Eggshell is calcareous coat attached with shell membrane. Shell structure mainly consists of mammillary layer, cuticles, spongy layer and pores. Quality of an egg can be examined by its cleanliness, smoothness, soundness and shape. Air cell is

present at blunt end of egg. Air cell in fresh egg is 1.5 cm. Its size depends upon few conditions like storage temperature, pores, humidity and shell thickness.

8.2.2 Shell Membrane

There are two shell membrane; both are fibrous and have its vital role. Outer membrane is flexible having 0.01-0.02 mm thickness and inner membrane consists of two thick layers. Shell membrane is thicker at blunt end and thinner at narrow end and thickness depends on species of birds.

8.2.3. Albumin/Egg white

Egg white is major elements of an egg. It is composed of thin and thick layers. It is 58% of total egg weight. It has gel like structure due to presence of several types of proteins like albumin, mucoprotien and globulins. It disintegrates with passage of time. Its thickness may reduce due to enzymatic reaction. It can be preserved through canning and refrigeration's.

Nutritional Contents	Percentage
Water	88.5%
Protein	10.5%

Chalaziferous layer is cord like strand, contain mucin, surround yolk and keep yolk in center position of egg. It is 2.7% of total albumin. Inner thin layer surrounds Chalaziferous layer and is 16.8 % of total albumin. Middle dense layer is stable and profuse layer of albumin. It contains mucin like fiber perform major role to hold inner thin white and yolk.

8.2.4 Yolk

Yolk is confined within a clear film which remains integral when released from ovary and it play important role in preventing yolk material from escaping into rest of egg contents. It encloses food that will feed embryo as it grows.

Nutritional Contents	Percentage
Proteins	16.5%
Water	50.0%
Fat	33.0%

It is a major source of vitamins, minerals, lecithin (emulsifier), somewhat protein, cholesterol and fat. It comprises less water and more protein as compared to egg white. Its dark or light orange color depends upon ingredients (especially maize) used in feed and breed.

Egg is biological structure because its formation is hormonal, consists of three important components i.e. albumin, yolk and shell which are used for human. It contains well-balanced nutrients which are necessary for chick embryo development. Hen possess ovary (left is functional while right is dormant) and oviduct which play vital role in all processes involved in egg formation. Ovary is a cluster of ova which is separated from each other present in a sac known as follicle.

Its size increases as bird ages. There are 3600-4000 follicles in a mature hen. Hen on attaining sexually mature lays eggs having follicle which contains unfertilized ovum and egg yolk. A single cell secreted in ovary surrounded by membrane called as vitelline membrane which has a network of blood capillaries. Follicle stimulating hormone secreted by anterior pituitary gland play vital role in ovulation. Yolk fluid added when yolk becomes mature and it moves away from ovary. As already mentioned yolk is enclosed in yolk sac which is surrounded with blood vessel. Blood vessels may not distribute specific part on yolk sac termed as stigma which burst and yolk moves away from ovary under stimulus of leutinizing hormone. Process of ovulation may take place after every thirty minutes of laying. Oviduct that is a tube like in structure ranges about 70 cm long which has five distinct parts i.e., infundibulum, magnum, isthmus, shell gland (uterus) and vagina. Oviduct has attachment with backbone, roughly committed between ovary and tail. First part of hen reproductive part is infundibulum which gives look, like a funnel. It prevents yolk to release in body cavity. It acts as sperm reservoir and fertilization takes place (Bell and Weaver 2007).

Magnum is a largest part of oviduct; size ranges about 33 cm long. It secret white portion termed as albumin. Ovum may stay here for 2.5-3.0 hours. Isthmus secretes water, minerals, salt and shell membrane. In laying birds, its length ranges about 10 cm long. Ovum remains here for 1.14-1.30 minutes. Uterus size ranges 10-12 cm long in laying birds. Main role of it is to secrete shell membrane which is outer covering of inside egg shell. Ovum stays here for about 18-20 hours. Vagina size ranges about 12 cm long. Egg passes through vagina toward cloaca. Its major purpose is to hold egg until laying. Cloaca is exit pathway for urates, feces and eggs (Austic and Nesheim 1990).

8.3 Standards and Grades of Shell Eggs

Egg quality standard are developed to classify eggs on individual basis. Only those eggs are accepted those fulfill egg standard requirements. Poultry products especially eggs are graded, tagged and packed based on size or weight.

Egg Size	Mass per egg (g)
Very large	73
Large	63-73
Medium	53-63
Small	53 or less

Grading is done based on egg shell quality and its components. Grading of egg is practiced by observing shell shape, texture, cleanliness and soundness. Different egg grades are shown in Figure 8.1. Egg is normally oval in shape with two ends (blunt and narrow end). In AA quality egg, there will be no leakage and free from thin spots of blood. B quality eggs have thin egg white, wider yolks. Egg shell may be unbroken but slightly stained. Abnormal eggs are unusual and misshapen. These types of eggs fall in B quality eggs. Soundness of eggshell is judged by leaker and cracked shells. Clean eggs are free from foreign material and stains, cage marks and dirty shell with dirt, stains prominent and shells soiled.

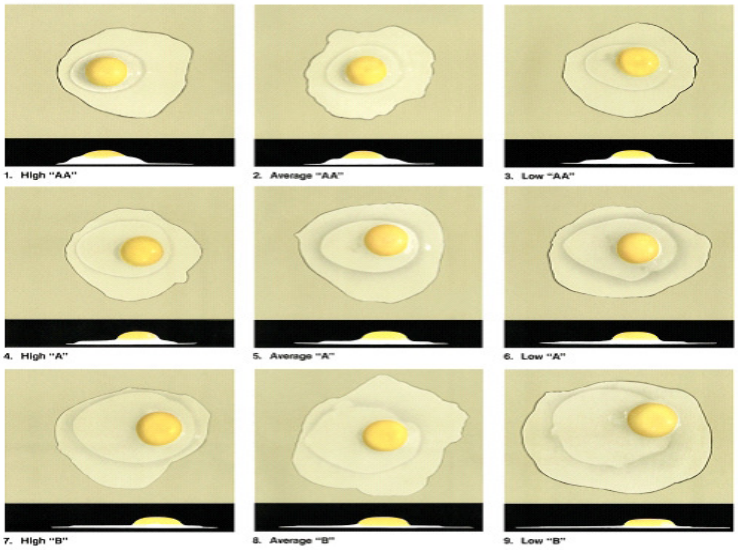


Fig. 8.1. Different grades of eggs.

8.4 Care, Storage and Preservation of Eggs

Care should be taken to maintain egg quality and standards. Egg quality deteriorates after being laid by hen. Many techniques are used to overcome loss of eggshell and egg components. From marketing stand point, consumer relies on shell soundness and shell cleanliness. All hens may not be habitual to lay eggs in nests, some hen lay eggs on floor, so all eggs are not clean. Therefore, appropriate number of nests, placement before start of egg production, placement strategy and frequent egg collection will result in production of clean eggs.

8.4.1 Collection

Clean eggs are obtained when nest is clean and eggs are frequently collected. Eggs can be collected four times in a day i.e., at 8.0 A.M, 11.0 A.M., 1.0 P.M. and 4.0 P.M. It is helpful to keep eggs clean and reduce number of leakers, dirties and checks. If eggs are collected once or twice in a day, eggs internal quality may be influenced by ammonia and external eggs quality is also influenced. Temperature and relative humidity are two main factors that have great influence on egg quality. To overcome these issues in poultry house, there should be proper ventilation arrangement. Egg quality problems are usually seen during summer season.

8.4.2 Handling

After collection of eggs, egg handling is important because it helps to reduce low quality eggs percentage. Numbers of equipment's are used for handling of eggs at poultry farms which includes plastic litter flats, metal baskets and wood paper trays. Best is wood paper tray but it has a single demerit it will be used for a once.

8.4.3 Storage of Eggs

Shell egg storage can be done by accomplished by storing clean dirt free eggs and clean, new and odourless packaging material. Water loss due to evaporation should be reduced as possible and there must be no spoiling products and materials. Egg storage room should be cleaned regularly with detergent. Temperature, relative humidity and ventilation must be checked frequently (Panda 1996; Brown 2010).

8.4.4 Cold Storage of Eggs

In tropics, eggs can deteriorate after laying quickly, so they must be stored at low temperatures. Egg must be stored at ideal temperature 13°C or lower at farm. Nowadays cold storage of eggs is also in practice to store eggs for several months. Eggs are purchased and stored when price is low and sold at high price during winter season

8.4.4.1 Factors Affecting Storage

Clean equipment's are used for egg storage. Proper temperature (1.5°C), relative humidity (80-85%) and air circulation is required proper storage of eggs.

8.4.4.2 Transport of Eggs

For transportation of shell eggs, good quality egg boxes are required to avoid damage to the eggs. Proper handling and packing of eggs by trained workers. There must be a proper loading/unloading platform. If possible, make use of lifter. Egg boxes be properly stacked and avoid jerks. Vehicle must be properly covered to overcome sun light amd rain.

8.4.5 Preservation of Egg

Objectives of preserving intact eggs are to prevent microbial growth, maintain egg water content and carbon dioxide tension of interior egg components for as long as possible. There are several methods used for egg preservation which include Chinese method, immersion in liquid, dry packing, lime water, cold storage, shell sealing treatment and coating with oil.

Chinese Methods:

There are various Chinese egg preservation methods as given below:

Huilden

Mixture of salt and wet clay use as coating material to store eggs for a month.

Dsaudan

Cooked rice and salt is used in this egg preservation technique for six months. Shell softens, egg content coagulates, membrane thickened and winey taste is developed.

Pidan

Lime, salt, tea and wood ashes are used to preserve eggs for five months duration. There is effect on egg components, yolk become greenish gray and albumin color change into coffee brown jelly containing tyrosine like crystal.

Immersion in Liquid

This method is used to prevent bacterial decomposition and prevent evaporation of moisture from egg by action of physical mean.

Dry Packing

This method is also used for the preservation of eggs. Borax and salt solution, brine, chlorinated lime stone water, phenol, boric acid, bran, chaff, oats, peat dust, salt, sand, burned gypsum, sawdust, sulfur, soda lime, straw and wood ashes are used as packing material. To prevent evaporation or decomposition, material which is used fort packing must not be loose and if the material compact, it may only retard but not prevent micro-organism growth.

Lime Water

Mixture of slaked quicklime and water is used as preservatives. Alkalinity of lime water depresses growth of microorganism. A thin film of calcium carbonate is deposited which help in sealing of pores.

Cold Storage

Egg are held at as low temperature (-1.5°C and -2.0°C) and relative humidity of 85%. Temperature must be kept above freezing point to avoid bursting of shells. Eggs must be defrosted when removed from cold storage to avoid bacterial growth and moisture condensation on shell. It delays mold growth on shell egg.

Shell Sealing Treatment

Alum, varnish, wax, boric acid, cotton seed oil, magnesium chloride and mineral oil are used to prevent removal of CO_2, water vapours and microorganisms entrance into eggs.

Coating with Oil

In this method, eggs are immersed in oil for short time. For coating, dip the eggs in a tasteless, odorless and colorless edible oil sealing solution to reduce atmosphere pressure. As normal pressure is restored, here tendency of air to enter in pores of shell causes solution to drawn in.

Thermo Stabilization

In thermostablization eggs are rotated in a container having oil for a 10 minutes duration at a temperature of 60°C.

Flash Heat Treatment

Eggs are immersed in boiling water for five seconds which helps in coagulation of a thin film of albumin just under egg membrane for sealing (Panda 1996).

8.5 Egg Processing

Egg processing is practiced to prevent eggs from contamination. Several steps are involved in egg processing. Pasteurization (heating of egg for preserving purpose) of egg products take place at accurate temperature and time. Main objective of shell egg pasteurization is to retain quality. Pasteurization has bacteriostatic property, killing salmonella and has no effect on product color, nutritional value and flavor. After shell eggs pasteurization, food grade wax is used to prevent contamination and to maintain freshness. Egg pasteurization play important role against avian influenza virus. Eggs can be easily frozen for one year, when anyone wants to use it, just thaws them under running tape water. Eggs are fully dehydrated by spray drying just like manufacturing powdered milk (Stadelman and Cotteril 2002). Advantage of processed eggs is that they are free from bacterial contamination, increased egg shelf life and customers can use cholesterol free eggs.

8.6 Poultry Meat Composition, Inspection and Grading

8.6.1 Chemical Composition of Meat

Chemical composition of different meat categories as narrated by Panda (1996) is given below;

Cut	Water %	Protein %	Fat %
Chicken	72.2	25.9	0.6
Mutton	71.5	18.5	13.3
Chevon	74.2	21.4	3.6
Pork	77.4	18.7	4.4

Meat contains proteins which include actin, myosin, myoglobin, elastin, reticulum, collagen (2.54% of meat, 25% of total proteins) nucleoprotein and blood protein (hemoglobin, albumin, fibrinogen and globulin).

8.6.2 Meat Inspection

Meat inspection is done to keep away diseased birds from human due to some health risk factors. Basic purpose for meat inspection is to confirm that whole poultry meat and meat products are fit for human consumption. Inspection of transportation system, live animal, carcass, plant facilities, internal organs and equipments is done for slaughtering poultry. This is all under government control to make sure that products delivered in market are stamped without any pressure. There is a licensed inspector, who may be veterinarian or any other special officer hired who ensures proper product handling, marketing and packing according to the Act of country. Poultry inspection is usually done by doing ante-mortem and postmortem inspections. Birds passed by inspector receive a stamp that birds are fit for human use (Mountney and Parkhurst 2001).

8.6.2.1 Objectives

Meat inspection objectives are to inspect product, protect consumer, provide official assurance of wholesome meat, minimize presence of pathogen, detect and prevent false labeling.

8.6.3 Principles of Hazard Analysis Critical Control Point (HACCP)

Principles of HACCP include making list of all levels where hazard may occur and determining preventive measure, maintaining control for monitoring activities, establish corrective actions, make record of all results/information and establish procedure for verification.

8.6.4 Carcass Disposition

At first step, inspector takes decision about wholesomeness of individual bird carcass being inspected. If carcass is wholesome, it can move for further processing and if small portion/area of meat is affected by disease, it will be removed. Unhealthy carcass is rejected. Avian tuberculosis, leukosis, septicemia, tumors, synovitis, bruises, air sacculitis, over scald and discolouration requires due consideration regarding quality meat production.

8.6.5 Meat Grading

Grading is done based on standard which is set to meet market demands. Meat grading is a procedure through which carcasses are separated based on tenderness, flavor and juiciness. The criteria for grading poultry meat are given below;

Conformation: Part of bird body being processed is free from any type of abnormalities (curved breast bone, curved back) that diminish proper distribution of flesh.

Fleshing: Carcass has proper covering of flesh. Breast has long and deep look with rounded appearance. Legs are looking wide and with adequately thick fully well fleshed knees and hip joint area, and have a fleshy appearance of drumstick and wings are well fleshed.

Fat covering: Well-developed and proper distributed fatty layer in skin.

Defeathering: Looking clean, especially legs and breast

Discoloration: Some part of carcass may have slightly discolored look, it does not mean that this look has reduce the grade

Disjointed: Tips of joints are sometime removed in case of geese and ducks. Sometime cartilage bone may separate from breast bone; it may not include in disjointed.

8.7. Poultry Meat Processing

Poultry meat processing includes following operations;

Unloading: Live birds are transported to processing plant. At processing plant, live birds are unloaded by automatic unloading machine. It is a simple process in which one operator is involved which reduces risk of damage to live birds, ensures longer shelf life, reduced labor and operation time.

Killing: After stunning, birds head are directed to a circular cutter by a bar. In this process, blood vessel in bird neck is severed without damaging windpipe.

Scalding: This process refers to loosening skin feathers of carcass in super scalder. It consists of pre-scalding and main scalding which results in high defeathring. Temperature of water is maintained by temperature control system. Inner water is agitated by a steam injected mixer nozzle.

Rehanging: After plucking, shanks are removed and birds are transferred on evisceration line automatically. By removal of legs, level of hygiene is enhanced.

Vent Cutting: It involves cutting of vent before opening bird.

Opening of Vent: After vent-cut process, machine opens vent to draw out intestinal tract.

Evisceration: In this process, viscera is removed by using automatic eviscerator. Ribs, breast, cartilage, or femur are not damaged by using automatic eviscerator.

Harvesting of Viscera: Automatic viscera harvester separates contents of intestinal tract. It separates gizzard from intestinal tract. This machine consists of up-screw and down-screw rollers which separates intestines and gizzard.

Cropping: Trachea and crop are removed by using automatic cropping machine. In this machine, a specially designed screw draws up trachea and crop from interior of the carcass after penetrating abdominal cavity. Brush and nozzles are also present which ensures the removal of impurities from inside and outside of carcass.

Further Cleaning: It is done by using vacuum machine, which removes any blood or pieces of lung in abdominal cavity. Carcass is also rotated along to remove any waste matter left in the interior.

Washing of bird: High pressure water is applied to remove any impurities from carcass. Probes open neck of carcass and spray nozzle washes inside of the carcass for removal of further impurities (Richardson and Mead 2005; Sam 2005).

Conclusion

Chicken eggs and broiler meat are processed in processing plants in good sanitary and hygienic conditions. Further processing is also done because of customer demand. These processed products are gaining more popularity in international market. Proper marketing strategies will ensure more demand and higher returns to poultry producers.

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Chapter 9

IT Applications in Poultry Production

Shahid-ur-Rehman and Awais Ihsan[†]

Abstract

This chapter aims to introduce and use of information technology applications in various poultry enterprises. Various inventory control systems, data management systems and summarization systems. There are various software solutions for poultry farming, hatchery, milling and delivery systems for poultry and poultry products. Poultry performance prediction and evaluation systems and their types are discussed. Expert systems and decision support systems solutions for poultry enterprises and work done in Pakistan is discussed.

Keywords: Computer software in poultry operations, Inventory control, data management, expert systems, decision support systems.

9.1 Introduction

Computer is being used in even sphere of life. Its uses are increasing day by day. It seems that after a few years life style will be more dependent on use of computers. There is not even a single field that is beyond computer grip. It is because of this invention that world has become a global village. Wars are won and lost from computer's keyboard. It is also used in manufacturing, welding and painting cars and buses. This revolutionary development has decreased mental and physical

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burden of mankind. Computers are everywhere in our lives nowadays including poultry industry. From accounting to waste management and everything in-between, there are many programs which helps in collection and store right information, make calculations, summarize results, predict future needs and schedule most efficient ways to get things done, all done to produce a better more efficient product with minimum cost or maximum profit.

When size of a business increases, data on every aspect increases and requires a system that can efficiently utilize that data and produce easy to understand and summarized results for easy decision making. Computer is doing its job in every business. Regardless of industry, some problems are universal; for example, resource allocation, scheduling and routing, competition, inventory, searching for requirements, replacement and maintenance. A manager in any field has a modern "toolbox" of decision assisting programs at hand, including, for example, inventory control software, statistical analysis, simulation models, forecasting, "genetic" algorithms, and business analysis. Interactive models greatly enhance poultry industry efficiency. They utilize a strategic module for long-term questions and to answer "what if" situations. A tactical module contains all kinds of statistical soft wares such as that for projecting egg production, assisting site planning, linear programming, econometric models, and so on. An operational module provides day-to-day advisement about hot day. It provides flock, processing plant and shift planning for efficient business operations. Decision making software that can project current production for future and assess profit or loss and in case of loss steps to avoid that loss are the need of world of business. One thing for sure that only properly interpreted data is of any benefit in these situations otherwise "Garbage in Garbage out" would be true.

With technology advancements competition among poultry industry is increasing at this time, future will be of that company that will be reducing losses from different sources and producing poultry meat and eggs at minimum cost. It will be possible when there will be well managed data management system for different enterprises of poultry business, well manners data makes a very efficient decision making system that can analyze even minute change in inputs of industry. Future planning should include alternatives to linear programming for feed formulation, better nutrient prediction, assisted disease diagnosis, more accurate price forecasting and supply chain optimization. Topics such as simulation, artificial intelligence and dealing with complexity will receive greater attention as technology advances.

9.2 Computerized Record Keeping of Various Enterprises of Poultry

9.2.1 Data Collection and Management

Data collection and management systems are major infrastructure requirements for any modern business, poultry producing enterprises also require data storage and manipulation capabilities especially on computers. General accounting software can be used for poultry business data however specialized computer software developed for various poultry enterprises are available. Computer software used by

most of poultry enterprises are normally ready made inventory control software. Feed mills and breeder farms mostly use specialized software developed for their specific data storage.

9.2.2 Poultry Farm Data Collection

Environment control house data collection can be linked with computer software systems to maintain and monitor environment impact in layer and broiler houses. Sensors can directly send data regarding temperature, ventilation, ammonia or carbon dioxide levels and relative humidity in poultry farms. These controllers/soft wares may also monitor function of environment systems i.e. air flow, water flow, and electric flow leakages. Data regarding biological performance can also be monitored in house parameters like egg count, live weight of birds and feed intake. Such software can be operated and monitored through internet.

9.2.3 Feed Mills and Feed Delivery Software

Computer software are more extensively used in feed mills and feed delivery. Mainly feed formulation software is used for feed formulation moreover feed delivery is mainly handled by inventory control software. However, specialized feed mill management software which can handle both feed formulation, batch management, batch mixing and inventory control of input ingredients, storage bin and mixer management and output management of various forms of feed (mash, crumbs and pellets) along with tracking of various types of rations to different consumers. In large integrations, these feed mill software can be linked to farms and other operations.

9.2.4 Poultry Software

Various types of poultry software are used worldwide which can be categorized as flock performance, single and multiple flock projections, economic analyses of performance, replacement pullet costs, egg size distribution and egg value.

9.3 Enterprise Optimization

Computers have capabilities much more than just clerical work of data collection and summarization various performance models are available and can be developed for broiler growth and layer production for prediction, comparisons and use of this software is growing in poultry operations. Various types of programming models being used in poultry performance software are as under

1. Linear Programming Models
2. Stochastic Programming Models
3. Expert Systems
4. Decision Support Systems

9.4 Poultry Management System

Numerous poultry management systems have been used in poultry operations which range from just inventory control system to highly specialized expert systems. Juliana (2009) defined expert system as a software computers that have the knowledge base to solve problems and uses inference reasoning resembles an expert or experts in a particular field to solve a problem. Developed application was made aiming to assist patients in diagnosing disease earlier and to facilitate serving our chicken breeders without leaving house which can help early treatment. Schmisseur and Pankratz (1989) developed an expert system (Xlayer) to help layer farmers in trouble shooting and assistance of managemental problems on economic grounds. Analysis of commercial layer data provides decisions on 80 managemental problems based on size and scale of layer operations. Raju and Rao (2006) developed poultry expert system which is less complex, provides greater utility and moderate compatibility. It provides technical feasibility of various parameters and is user friendly. Kalentzi1 (2003) used linear programming for broiler farmers in development of a decision-making system. Rose (2003) developed a decision-support system for assessment of the risk regarding contamination of broiler flocks by Salmonella. Data for development of this system was obtained from 85 broiler flocks in western France. Sensitivity was 97.8% and specificity 64.3%.

9.5 Work done in Pakistan

First information management system for handling of poultry performance data was introduced for M.Sc.(Hons.) Poultry Husbandry degree requirement at Poultry Research Centre (PRC), Department of Poultry Science, University of Agriculture, Faisalabad (Rehman, 2002). Three modules were developed under umbrella of one main system modeling various types of data generated at PRC. First module deals with government poultry farm model dealing with a fixed budget for inputs and outputs were submitted in government account. Second module deals with commercial project account which has revolving account i.e. inputs are purchased from an account owned by the chairman, of the department and outputs' generated revenue is deposited in same account for reuse. Third module deals with student research in which performance data generated by M.Sc.(Hons.) students can be recorded (Rehman, 2002).

9.5.1 Poultry Management System

Poultry management system was developed under Pakistan Science Foundation Project No. PSF/NSLP/P-AU(167) entitled "Development of Information Management System for commercial broiler and layer farm data". A computer based management system is developed first time in Pakistan history in Government Sector for broiler, layer and breeder farmers using information communication technology. Poultry management system offers following flock records;

1. Financial record management (including purchases, sales and bank account management)
2. Employee record management (salary, farm entry, exit and visitor records)
3. Farm building record management (poultry sheds, stores, offices and labour colonies)
4. Farm stock record management (consumable, non-consumable and repair/maintenance)
5. Flock performance record management (growth, feed, medicine, vaccination and other expenses).

Poultry management system is also capable of providing daily tips, comparison of flock performance with strain standards and future resource forecasting for purchases and performance predictions based on Artificial Intelligence based algorithms. Poultry management systems is available in following modules keeping in view farmer types

1. Broiler flock control system
2. Layer flock control system
3. Breeder flock control system
4. Broiler and layer flock control system
5. Broiler and breeder flock control system
6. Layer and breeder flock control system
7. Broiler, layer and breeder flock control system

Conclusion

Poultry operations in modern day poultry units are mostly controlled by computers. Software's and related applications are helping hands nowadays requiring less labour input and are more efficient and economical in long term production. These systems play a vital role in successfully operating mechanized poultry units.

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Glossary

ABA - American Bantam Association

Abdomen - area between keel and pubic bones

Abdominal capacity - distance between two pubic bones (width) and between pubic bones and tip of the keel (depth)

Acquired immunity – immunity to a disease from maternal side by transmission of immunity through egg yolk

Active immunity – immunity to a disease developed by exposure to disease or by receiving a vaccine for the disease

Acute disease– disease that is sharp or severe in onset and effect on the animal

AET - online record keeping system for agricultural experiences

Air cell - air space between the two shell membranes, usually at large end of egg

Air chilling - less efficient alternative chilling method preferred in Europe and Canada

Air sacs – structures that replace diaphragm increase buoyancy in avian respiratory system

Albumen – protein source for developing embryo

Allantois – embryonic membrane that plays a role in albumen metabolism and calcium absorption of developing chick. Also, location of excretory product storage during incubation

Alternating current - Alternating current (AC) is current in which position of positive and negative current is changed on the wires. This change of current happened about 50 or 60 times in a second. This is also called frequency (Hz) of alternating current like 50 Hz or 60 Hz. Frequency of electric motors must match with the frequency of current for their appropriate functioning.

Ambient temperature– temperature of surrounding environment

Amino acid – building block of proteins composed of an amine portion (NH2) a carboxylic acid portion (COOH) and a functional side chain. There are 20 naturally occurring amino acids which can be broken into two groups - non-essential and essential amino acids

Ammonia – nitrogen gas produced by the bacterial breakdown of protein in fecal matter.

Amnion - a sac surrounding embryo filled with amniotic fluid which protects developing embryo from shock and provides a medium for the developing embryo to exercise their muscles

Ampere: Ampere (I) is the rate at which current is caused to flow through a resistance of one ohm by a pressure of one volt.

Anatomy - structure systems of an animal (skeletal, muscular, digestive, etc.)

Anthelmintic - medication given to treat a bird with internal parasites

Antibiotic - a chemical produced by a microorganism or fungi and used to destroy or inhibit the growth of bacteria and other microorganisms

Antibodies – chemical substances, in circulating fluids, colostrums, and milk, that contributes to immunity against disease or infection

Antibody - a natural substance in the blood that recognizes and destroys foreign invaders and that causes an immune response to vaccination or infection

Antigen - a foreign protein in blood that differs from natural body proteins which stimulates the natural production of antibodies

APA - American Poultry Association

Artificial incubator –used to hatch large numbers of offspring at the same time maximizing hatchability through precise control of hatching environment to encourage embryonic growth.

As hatched - description of a group of chicks that have not been sorted

Ascites - accumulation of fluid in the abdominal cavity

Aves - a class of animals composed of birds

Avian - pertaining to birds

Aviary - a large enclosure for holding birds in confinement

Aviculture - the science of birds

Axial feather - short wing feather located between primary and secondary flight feathers

Back-up Pac Man - pulls gizzards missed by automated machine on production line

Back-up Killer - checks for chickens missed by the auto-killer and manually kills them

Bacteria – a class of single-celled ubiquitous organism which can be pathogenic

Bagger - places product into plastic bags

Banding - putting a tag or band with identification on it to the wing or leg of a bird

Bantam - a chicken breed that is one third to one half the size of a standard breed.

Banti - a non-technical term sometimes used to mean 'bantam'

Barbicels - tiny hooks that hold a feather's web together

Barring - alternate markings of two distinct colors on a feather

Bay - light golden brown in color

Beak - hard protruding mouth part of a bird consisting of an upper and a lower part

Beak conditioning- trimming of the beak

Beard - feathers bunched together under the beak of some breeds of chickens; coarse hairs protruding from the breast of turkeys

Bedding - material scattered on the floor of a poultry house to absorb moisture and manure (also called litter)

Biddy - a non-technical term for a laying hen that is over one year of age

Bill - the 'beak' of waterfowl

Billing out - act of chickens using their beaks to scoop feed out of a feeder and onto floor

Biosecurity – Procedures Designed to minimize disease transmission from outside and inside a production unit

Blade - lower, smooth part of a single comb

Bleaching - disappearance of color from vent, face and shanks of yellow-skinned chickens

Blood spot - blood in an egg

Bloom - the moist protective coating on a freshly laid eggs that partially seals the pores of the egg shell to prevent penetration by bacteria (called cuticle)

Blowout - when there is vent damage, typically caused by laying a very large egg (also referred to as a prolapse)

Blue - slate gray feather color

Bone Popper - disjoints thigh bones

Booted - having feathers on the shanks (legs) and toes

Box Labeler - produces labels for boxes containing finished product and places on box

Box Maker - constructs self-locking boxes for holding finished product

Branded product – a product identified with the company name

Breast blister - enlarged, discolored area on breast or keel bone seen in heavy birds

Breast Bin - places breasts into bin for deboning; takes product out of bin for placement back on production line

Breast Cutter - debones breast portions

Breast Machine Operator - loads front-halves into automatic machine for cutting

Breast Puller/Inspector - pulls and inspects breast filets for bone, cartilage

Breed - a group of chickens having a distinctive body shape and the same general features; also a term used when group male and female birds for mating

Broiler - a chicken of either sex produced and used for meat purposes

Brood - to care for a batch of chicks

Brooder - a devise used to provide warmth to young chicks

Broodiness - tendency of a hen ‘sit tight in a nest; to behave as if she were in an attempt to naturally incubating an eggs

Brooding- raising young poultry under environmentally controlled conditions for first few weeks of life

Broody - a hen that is sitting on eggs with the intent of hatching them

Buff - orange-yellow color in feathers that is not shiny or brassy

Candle - to examine contents of an intact egg with the use of a light

Candler - light used to examine contents of an egg without breaking it open

Candling - using a candler to check contents of an egg

Cannibalism - when poultry eat the flesh of fellow flock mates

Cape - narrow feathers between a chicken's neck and back

Capon - a castrated male chicken (requires surgery, reproductive organs are internal

Capon - castrated male bird Cartilage Remover - checks deboned product for cartilage and removes same

Caeca – two pouches where small and large intestine join, some fermentation of feed occurs here

Cecum - a blind pouch at junction of small and large intestines that hosts community of microorganisms that can ferment (digest) fiber

Carcass grading – using USDA standards to assign a degree of quality

Career Development Event - an activity in which FFA members demonstrate skills in competition

Carrier - an apparently healthy bird that can transmit a disease to others; also refers to a container to transport birds

Caruncle - brightly colored growths on throat region of turkeys and the face of Muscovy ducks

Checker (shipping) - checks finished product against manifest/order

Chalazae - two white cords of tightly spun albumen (egg white) found on either side of yolk and important in keeping yolk properly positioned within egg

Chick - young (baby) chicken

Chick tooth - a tiny, hard projection on beak of a newly hatched chick that was used by the chick to break shell to hatch (also called an egg tooth)

Chicken tractor - a portable pen for chickens on pasture

Chiller Belt Operator - operates the movement of the production line for chickens rehung after exiting the chiller

Chiller Hanger - rehangs chickens onto production line after exiting the chiller

Chook - an Australian term for chicken that has been used in the US for chickens in a small flock

Chorion - a membrane the surrounds the yolk sac and amnion

Chronic disease–a disease continuing over a long period of time or having gradual effect

Class - a group of chicken breeds that were originally developed in a particular region of the world (e.g. American, Asiatic, Mediterranean)

Clean legged - having no feathers on the shanks or toes

Clean Up - sanitizes production line, production areas, and equipment

Cleaning Rack - sanitizes small equipment

Clipper - places metal clip on poly-bagged finished product to seal bags

Clinical disease– disease in which symptoms of the disease are expressed

Cloaca - portion of avian anatomy where intestinal, reproductive and urinary tracts end

Clubbed down - a condition where down feathers do not erupt from their feather sheath resulting in a coil-like appearance

Cluck - sound a hen makes after laying an egg

Clutch –number of eggs a hen lays in a row

Clutch length-complete set of eggs produced or incubated at one time by a single hen in consecutive days

Coat Service - launders coats used by plant personnel

Cone Loader - places product onto cones for deboning

Cooler - maintains refrigerated equipment used to store product at specific temperatures

Coccidia - protozoan intestinal parasite

Coccidiosis - a parasitic infection (coccidia) in intestinal tract of poultry

Coccidiostat - a drug used to keep poultry from getting coccidiosis

Cock - mature male chicken, over a year of age

Cockerel - young male chicken, usually under a year old

Coliform - any bacteria resembling *Escherichia coli*

Comb - the fleshy red outgrowth on the top of a chicken's head

Comb dubbing-removing comb or parts of comb, (and wattles in game chickens)

Condition - typically refers to a chicken's state of health and cleanliness

Conduction – transfer of heat through a medium, warmth is passed to cooler particles by direct contact

Conformation - refers to body structure of poultry

Conjunctiva - mucus membrane covering eyeball

Conjunctivitis - infection of conjunctiva

Contagious - disease that is easily passed from one bird to another

Contract grower -a farmer that grows chickens under contract with broiler company

Convection – flow of heat through air or water

Cool house brooding- raising poultry under controlled cool house conditions with warm areas provided for chicks to find as needed

Coop - house or cage in which poultry are housed

Coverts - feathers that cover primary and secondary wing feathers

Crest - ball of feathers on the heads of some breeds of chickens and geese

Crop - enlarged part of digestive tract, serves as a temporary storage space of food

Cropper - removes the crop by hand when missed by automated machinery

Cross ventilation (natural ventilation) – Using natural or mechanically induced air flow across the width of a house to exchange air in a poultry house

Crossbred - the offspring of parents from different varieties or breeds

Crumbles - a poultry feed that has been pelleted and then the pellets broken up

Cuckoo - a course and irregular barring pattern in feathers

Cull - to remove a bird from flock because of productivity, age or health

Culling- to remove from a flock due to undesirable traits

Culture - incubating a sample from a diseased bird to look for presence of bacteria

Current - Current is the flow of electricity in a circuit it is measured in amperes.

Cushion - mass of feathers that gives a round effect seen in female cochins

Cut Up - fabricates whole chicken into bone-in parts

Cuticle - moist protective coating on a freshly laid eggs that partially seals pores of egg shell to prevent penetration by bacteria (also called the bloom)

Cygnet - young (baby) swan

De-caking – removing wet litter material from a house

Defect - any characteristic that makes a chicken less than perfect

Deboner - removes bones from product

Depopulate - to destroy an entire flock

Dewlap - the flap of skin below the beak of turkeys and some geese

Digestibility – ability to breakdown nutrients chemically and physically in gastrointestinal tract preparatory to absorption

Direct cause of disease– exposure to, or contact with, pathogens or other substances that cause a decrease in animal health

Direct current - Direct current (DC) is current in which position of positive and negative current did not changed on the wires. One wire is always positive; the other, negative.

Disease – state of being other than complete health

Disinfect - kill bacteria through chemical means

Disqualification-a defect/deformity serious enough to bar a bird from poultry show

Down - a layer of feathers found under the tough exterior feathers

Drake - an adult male duck

Drake - male duck

Drawhand - pulls viscera by hand when missed by automated machinery, before inspection

Dressed - cleaned in preparation for eating (feathers and guts removed)

Droppings - another term for chicken manure

Dry bulb temperature– actual temperature of air measured by ordinary thermometer

Dry-bulb thermometer - used to determine the temperature in a room or incubator

Drumstick Cutter - separates the leg and thigh portions

Dual-purpose chicken – Chicken used for both meat and egg production. Currently, commonly used in backyard flocks

Dual-purpose chicken – used for both meat and eggs

Dub - to surgically remove a bird's comb and wattles close to the head

Duck – female duck

Duck foot - a disqualification of chickens where hind toe is carried too far forward and touches third toe or is carried too far back and touches ground

Duckling - a young (baby) duck

Dump Operator - transfers birds from cages onto conveyor belt for movement to livehang

Dumps Meat - places product from totes and other bulk temporary storage onto specific production lines

Duodenal loop - upper part of small intestine (also referred to as the duodenum)

Dust bath - the habit of chickens to splash around in soft soil to clean their feathers and discourage external parasites

Ear lobes - flesh patch of bare skin located below ears of birds

Ectoparasite - an external parasite

Egg Person - removes eggs from spent hens undergoing processing

Eggshell – complex calcium carbonate structure that covers egg, protective function.

Egg tooth - a tiny, hard projection on the beak of a newly hatched chick that was used by chick to break shell to hatch (also called a chick tooth)

Electrical stunning – using electric current to make an animal unconscious or insensible

Electrolytes - a mineral solution used to treat dehydration

Embryo – developing chick, from soon after fertilization to hatch

Embryo - developing chick in an egg

Embryology - the study of the formation and development of embryos

Encephalitis - inflammation of the brain

Endoparasite - an internal parasite

Enteric - affecting the intestines

Enteritis - inflammation of the intestines

Entrepreneurship - the process of getting into and operating one's own business

Esophagus – muscular membranous tube for the passage of food from the pharynx to the stomach.

Esophagus - portion of digestive tract that moves from the mouth to the stomach

Essential amino acids– these amino acids not produced by body, but are necessary for cell function, therefore it is essential that they are included in appropriate quantities in feedstuffs

Estrogen –female hormone that promotes development of female reproductive tract.

Etiology - causes of a disease

Evaporation - changing a liquid into vapor

Exsanguination – death occurs because of loss of blood

Exudate - fluid associated with an inflammation or swelling

Exudative diathesis - accumulation of fluid (exudate) under skin or around heart

Faking - the dishonest practice of concealing a defect or disqualification from a potential buyer or a show judge

Fat Cutter - removes fat pads from trimmed product

Fat Puller - removes fat from product by hand

Fat Remover - removes fat from product by hand

Fat soluble vitamin – essential, fat-based vitamins absorbed and stored in the body that occur in nature in association with lipids

Fat Scraper - removes fat from product by hand

Feather-legged - a description of those breeds of chickens with feathers growing down their shanks

Fecal - pertaining to the feces

Feces - droppings/manure

Feed conversion ratio-amount of feed needed to produce 1 pound of meat gain or dozen eggs produced

Feed efficiency-measurement of feed intake per pound of weight gained.

Feeding Jumbo Pack - places tray packed product on line to be wrapped with protective plastic rap

Feeding Spiral - places product onto line to be frozen in spiral freezer

Feeding Weldotron - places product onto line to be put into tray packs

Feet Insp/Grade - inspects, then grades feet portions

Feet Packer - places inspected/graded feet into boxes

Feral - wild, untamed

Fertile - an egg that is fertilized and thus capable of having a chick develop (under the right environmental conditions)

Fertility - percentage of eggs that are fertile

FFA - a national organization for students enrolled in agriculture education that promotes leadership, growth and career success

Film Changer - reloads stretch wrap plastic for Weldotron

Finger Cutter - cuts breast/filet portion into strips for "chicken fingers"

Flank Cutter - removes fat from the flank of breast portion

Floor Sweeper - keeps plant floor clean

Finish - the amount of fat under the skin of a meat bird

Flight feathers - large primary and secondary feathers of the wings

Flock - a group of birds

Flock - a group of birds living together

Fluff - downy feathers

Follicle stimulating hormone (FSH) – hormone produced by the pituitary gland that promotes growth of ovarian follicles in the female and sperm in the male

Fomite - inanimate objects such as shipping crates, feed sacks, clothing, shoes and tiers that may harbor disease-causing organisms and thus able to transmit disease

Foot candle - a measurement of light intensity

Forage - to scratch the ground in search of food; also refers to the crops in a pasture

Fork Lift Operator - operates fork lift machinery

Forced air ventilation–using fans to mechanically force air into and out of house

Forced-air incubator - an incubator that has a fan to circulate warm air

Fowl - domesticated birds raised for food or other similar purpose; also refers to a hen at the end of its productive life (a stewing hen)

Free-range - a term that does not have a legal definition but is typically used to refer to providing a flock with outdoor access

Fresh product – has never been below 26 ^{o}F

Frizzle - a feather that curls rather than laying flat

Frozen product – has been held below 0^{o}F.

Fryer - a young meat-type chicken

FSIS – (Federal Safety and Inspection Service)

Fungi – group of plants without chlorophyll that reproduce by spores, includes molds which can cause animal health problems

Further processed product –food item produced by forming meat and adding a covering Gaggle - group of geese

Gander - male goose

Gas CAS stunning – using gas to use of CO_2 or other inert gasses to replace oxygen to make an animal in sensible unconscious

Germinal disc - the site of fertilization, if it occurs, in an egg

Germinal disc (spot) – Site of fertilization on the ovum

Germs - disease causing organisms

Giblets - the parts of a chicken carcass that consist of the heart, gizzard and liver

Gizzard - a portion of avian digestive tract with thick muscular walls that crushes and grinds food

Gizzard Inspect - inspects gizzards

Gizzard Peeler - manually peels gizzards missed by automated machine on production line

Gizzard Puller - pulls gizzards missed by automated machine on production line

Gobbler - an adult male turkey (also referred to as a 'tom')

Goose - a type of waterfowl; the female of the species is also referred to as a goose (male is a gander)

Goose – female goose

Gosling - a young (baby) goose

Gosling – young goose

Grade - to sort according to quality

Grading - inspects product for defects and sorts accordingly

Grit - small pebbles eaten by birds and used by the gizzard to grind up feed

Guinea cock - an adult male guinea fowl

Guinea cockerel - a young male guinea fowl under one year of age

Guinea hen - an adult female guinea fowl

Guinea pullet - a female guinea fowl under one year of age

Hang back Rack - hangs product for USDA inspection

Hanger - hangs product onto shackle line

HACCP – (Hazard Analysis and Critical Control Points), plan for monitoring food safety by setting potential points of cross contamination

Hackles - feathers over the back of a chicken which are pointed in males and rounded in females

Heart/Liver Trimmer - separates and trims the heart and liver from eviscerated package

House Inspector - inspects product on evisceration line for defects prior to placement on chiller line

Hard chilled product – has been held from 0 ^{o}F to 26 ^{o}F

Hard scald – a higher water temperature removes the waxy cuticle of epidermis

Hatch - the process by which the chick comes out of the egg

Hatch of Fertile – measure of hatchery efficiency. The percentage of chicks hatched from the total number of fertile eggs set

Hatchability - the percentage of fertile eggs that hatch when incubated

Hatchability – measure of breeder and hatchery efficiency. Percentage of total eggs set or fertile eggs set that hatch

Hatchery - a place where eggs are incubated and chicks hatched

Health – state of being where physiological homeostasis is maintained, absence of disease

Heat increment – Energy used up in the consumption, digestion, and metabolism of a feed

Helminthes - a category of parasitic worms

Hen - adult female poultry including chicken, turkey, duck, pigeon, pheasant, etc.

Hen feathered- the characteristic of some breeds of chickens where the male has rounded feathers (rather than pointed) like those of a female

Heritability –ability of measurable traits to be transferred from parents to offspring.

Heritage Breed - older breeds of large fowl poultry less commonly raised in modern agriculture

Hock - the 'knee' joint of a bird

Home meal replacement products –poultry and food products Designed to be a complete meal

Homeostasis – maintenance of physiological stability even though environmental conditions may change

Homeothermic animal – animal utilize or dissipate energy to maintain body temperature

Horizontal transmission - disease passed from mother to offspring via the egg

Horsepower: One horsepower (hp) is equivalent to 746 watts.

Host - an animal that has a parasite or an infectious agent living on or in it

Hover - canopy type brooding system

Humidity - amount of water in environment (measured with wet bulb thermometer)

Hybrid - offspring of parents from different breeds (also referred to as crossbred); the artificial crossing of two different species

Hybrid vigor (heterosis) – tendency of crossbred offspring to outperform their parents

Ice Machine Operator - maintains the machinery that produces ice

Ice Room Operator - maintains the proper production of ice for the plant

Inspector USDA inspector - monitors, oversees production operation for operations regulations

Inventory Control - accounts for product pack materials needed for daily operations

Immunity – resistance to an infectious agent or antigen

Immunity - resistance to disease (active immunity develops when an individual has had the disease or been vaccinated; passive immunity is passed from mother to chick through the egg)

Impaction - blockage of a part of the digestive tract, typically the crop or cloaca

Inbred - offspring of closely related parents

Incubate - to apply the required conditions (heat and humidity) to eggs to allow embryos to develop and chicks to hatch out

Incubation period - the time it takes for an egg to hatch once incubation starts;

Incubator - a piece of equipment especially designed to incubate eggs

Infectious - capable of invading living tissue and multiplying to cause a disease

Infectious disease– caused by living organisms, which invade and multiply in or on body and result in damage to the body

Infertile - an egg that is not fertilized and therefore will not hatch

Infertility - the inability to reproduce (can be with either the male or female and can be a temporary or permanent condition)

Infundibulum –portion of oviduct that receives yolk, site of fertilization.

Ingest - to eat

Inner/Outer shell membrane – membrane immediately beneath shell which helps regulate air exchange, protective function

Insensible heat loss– heat loss that does not increase surrounding environment temperature

Inspection – examination of a product to insure safety standards are met

Integumentary - pertaining to the skin

Intensity of lay - how well a hen is laying right now

Intranasal - in the nose

Intraocular - in the eye

Intravenous - injection into a vein

Iris - colored circle that surrounds the black center in the chicken's eye

Isthmus – portion of the oviduct that produces shell membranes

Isthmus - female reproductive tract part where inner and outer shell membranes are added

Jack Operator - transports product and materials in-house using a floor jack

Jake - a young male turkey

Jejunum - a portion of the small intestine

Jenny - a young female turkey

Keet - a young (baby) guinea fowl

Keratin - key structural material of feathers (as well as wool, hooves, and human skin, hair and nails)

Knife Line - debones down-graded product by hand

Knife Sharpener - keeps all cutting instruments sharpened

Knuckle Cutter - debones joint at the end of drumstick

Keel - the breast bone of birds

Kilowatt: Kilowatt (KW) is a measure of electric power. A kilowatt equals 1000 watt

Kilovolt-ampere: Kilovolt-ampere (KVA) is product of volts time's amperes, divided by 1000

Knob - protrusion from the skull

Lacing - border of contrast color around the entire web of a feather

Large intestine – portion of intestine that extends from the ileum to the anus, actually very short in birds, water absorption occurs here.

Layer – chickens used for egg production, typically a strain of the white Leghorn

Layer - hen raised for egg production

Lead Person - hourly assistant to the Department Supervisor; able to perform all jobs in the department

Leghorn – breed of chicken used to create the birds commonly used for commercial table egg production

Leg Cutter - separates the leg from the thigh portions

Lid Closer - places covers on boxes of finished product

Lifting Racks - places tray pack racks on carts to be transferred to coolers

Limiting amino acid – amino acid in a diet that is the most deficient (without supplement) in a complete ration

Line Relief - replaces production line workers temporarily

Line Service - replaces production line workers temporarily

Line Workers - performs tasks specific to the production line

Line Feeder - places product onto the production line

Litter – bedding material used in poultry houses to dilute fecal material and provide cushioning for birds feet and breast; typically pine wood shavings or rice hulls

Litter - material scattered on the floor of a poultry house to absorb moisture and manure (also called bedding)

Live Hanger - hangs live birds by their feet onto shackle line

Liver Cutter - removes liver from evisceration package

Liver Puller - automated equipment to separate liver from evisceration package

Loader Operator - operates the forklift to place live birds at the live hang area

Lopped comb - a comb that falls to one side

Lung Gunner - cleans lung from carcass cavity using a vacuum gun

Luteinizing hormone (LH) – gonadotrophic hormone produced by the pituitary gland that causes ovulation in female and testosterone secretion in male

Machine Operator - oversees the operation of specific machinery

Main Scale - checks weight, specifications, labeling on boxes of finished product coming off the production line

Master Scale - checks weight, specifications, labeling on boxes of finished product coming off the production line

Meat Puller - shreds meat from bone on cooked product

Mill Operator - operates a feed mill

Mill Operator, Assist. - assists in the operation of a feed mill

Move and Chain Truck - moves the truck holding live birds from the cooling area, to the scale, bucks the chains separating the truck from the trailer

Magnum – albumen secreting portion of the oviduct

Mandible - upper or lower bony portion of the beak

Marination – soaking in infusion of flavoring to improve taste

Mechanical transmission - disease causing agents carried on a surface (such as shoes, tiers, shovels, etc.)

Meckel's Diverticulum – is a protuberance on wall of lower part of intestine that is present at hatch, place where yolk residue was absorbed into the body

Membrane - a thin, soft, pliable layer

Metabolism - physical and chemical processes that produce and maintain a living body

Minerals – set of inorganic elements necessary for life, constituents of bones and teeth, also important for enzyme function, immunity and oxygen transport

Mite - a type of external parasite

Molt (Moult) - a part of the hen's reproductive cycle when she stops laying and loses her body feathers

Molting – systematic shedding of the feathers

Monogastric animal – animals with a single stomach

Morbidity – being affected by a disease, an animal that is showing clinical signs of disease

Mortality – animal that has died

Mossy - indistinct, irregular, or messy-looking markings that break up or destroy the intended color pattern on feathers

Mottled - plumage where a percentage of feathers are tipped with white; a discoloration of egg yolk caused by damage to the yolk membrane

Mounting - when the rooster mates with a hen

Muff - fluffy feathers on face of chickens (tufts are feathers protrudes from face)

Necrotic - pertaining to dead tissue

Nematode - a roundworm

Nest egg - artificial egg placed in a nest to encourage hens to lay there

Nest run - ungraded eggs

Net Weight Checker - checks the weight on traypacks and boxed finished product

Necropsy - a postmortem (after death) examination of an animal

Neural - pertaining to the nerves

New York Dressed – a bird processed with only feathers and blood removed; entrails intact Non-essential amino acids– amino acids are produced by the body, that do not necessarily have to be included in feedstuffs

Noninfectious disease

NPIP - National Poultry Improvement Plan

Offal - washes offal screens, moves offal trailers in a specific area

Open and Cut - vents cloaca (sic) for evisceration

Opener - vents cloaca (sic) for evisceration

Oyster Cutter - removes piece of meat between the thigh and the back of chicken

Ocular - pertaining to the eye

Oil sac - large oil gland on the back of birds at base of the tail and used by bird to preen or condition feathers (also called the uropygial or preen gland)

Ohm: The ohm is the amount of resistance that will permit current to flow at the rate of one ampere under a pressure of one volt.

Organic - a legalized regulated term related to production of food products according to pre-set standards

Osteomyelitis - inflammation of the bone marrow

Osteoporosis - thinning and weakening of bones

Ova - female germ cells that become eggs

Ovarian follicle – Growth on surface of ovary that contains developing ovum or yolk (germinal disc in birds)

Ovary - a part of female avian reproductive tract which holds the female genetic material and collects the yolk material normally associated with eggs

Oviduct - a part of female avian reproductive tract where egg white (albumen), shell membranes, shell and cuticle are added to form a complete egg

Oviduct – avian female reproductive tract

Oviposition - the laying of an egg

Ovulation – rupture of ovarian follicles

Ovulation - release of a yolk from the ovary

Ovum - the female germ cells in the ovary (plural = ova)

Packer - places finished product into bags/boxes

Parasite – an organism that lives at the expense of a host organism. Generally must live on or in the host

Passive immunity – immunity conferred to an animal through preformed antibodies received from an outside source. Commonly passed from mother to offspring

Pasting - loose droppings sticking to the vent area

Pathogen - disease-producing organism

Pathogen – microbial organism that causes disease

Pathogen Reduction Act - sets limits for the number of harmful organisms on food products

Pathogenic - able to cause disease

Pathogenicity –capability of an organism to produce disease

Pathogenicity - degree to which an organism is able to cause a disease

Pathology - study of damage caused by disease

Paw Operator - removes feet (only) from shank

Peachick - a young (baby) peafowl

Peacock - an adult make peafowl

Peahen - an adult female peafowl

Pecking order - the social rank of individuals within a flock

Peep - a term for chick sometimes used by small flock owners

Pellets - a form of feed where the contents are compressed into bite-sized morsels

Pendulous crop - a crop that is impacted and enlarged and hangs down in an abnormal manner

Penicled - crosswise lines or bars on feathers that form a pattern

Perch - a place where chickens can get off the floor (also called a roost)

Perch - area above the ground where birds will sit, primarily for sleeping at night (also called roosts)

Perosis - malformation of the hock joint

Persistency of lay - ability of a hen to lay eggs steadily over a long period of time

pH - a number that indicates acidity or alkalinity (7 is neutral, above 7 is alkaline and below 7 is acid)

Photorefractory- terminating reproduction prior to inclement conditions in autumn and winter

Photostimulation- providing the proper light stimulus to cue puberty

Picking Room Operator - maintains machinery used to scald birds and pick feathers

Pickup Chickens - picks up live birds that escaped during cage dumping operation in the live and area

Pick out - vent damage caused by other chickens' pecking

Picker – machine with rubber projections used to remove feathers

Pigeon milk - a cottage-cheese looking crop substance produced by both male and female pigeon to feed young from hatch till about 10 days of age

Pigmentation - color of a chicken's beak, shanks and vent

Pin bones - pubic bones

Pin feathers - a developing feather on a bird

Pinning - removes feathers missed by the picking machine

Pip - when a chick breaks through the shell

Pipping - breaking through the shell prior to hatch

Placement - working for someone else

Plumage - total set of feathers covering a bird

Polybagger - places clips to close bags of finished product

Portioning –packaging in individual serving sizes

Post - to conduct a postmortem (after death) examination

Poult - young (baby) turkey or pheasant

Poultry - a term for domestic fowl raised for meat, eggs, feathers, work or entertainment

Predisposing cause of disease– any condition or state of health that confers a tendency and/or susceptibility to disease

Preen gland - an oil sack on the back and near the base of the tail of birds providing oil used in preening (also called the oil or uropygial gland)

Preening - to straighten and clean feathers, typically with oil

Presenter - readies eviscerated package for USDA inspection

Presenter Trainee - readies eviscerated package for USDA inspection

Product Sorter - separates product according to grade and type

Production - processing plant worker

Prolapse - when there is vent damage, typically caused by laying an very large egg (also referred to as a blowout)

Protozoa – single-celled organisms that reproduce by fission, may be pathogenic

Proventriculus - true stomach of birds where pepsin and acid are produced

Pterylae – skin tracts in the skin from which feathers originate

Pubic bones - two bones that end in front of the vent of birds

Pullet - immature female bird (used with several species of birds, but most commonly with chickens)

Pullet - young hen usually less than a year old

Purebred - offspring from a hen and rooster of the same breed

QC/QA - responsible for overseeing quality control and quality assurance of product

Radiation – exchange of heat between two objects that are not touching

Rack Off - transfers tray pack product from freezer to weigh/price/label area

Rales - any abnormal sounds coming from the airways of birds

Ration - a combination of feed ingredients formulated to meet a bird's nutritional requirements

Ratite - a type of domestic bird that does not have a keel bone and includes ostriches, emus and rheas

Recorder - monitors information about plant production

Refrigeration - maintains machinery used for cooling product

Rehanger - transfers product from the picking line to the evisceration line

Relative humidity– amount of moisture in the air compared to what the air can "hold" at that temperature

Renal - pertaining to the kidneys

Render - process by which slaughter by-product are treated to convert them into protein products for use in animal feeds

Reprecessor - fixes product on production line before continuing on production line

Restrict feeding-managed controlling of feeding

Rigor mortis - stiffness following death

Roach back - deformed, hunched back (a disqualification when showing poultry)

Roaster - a meat-type chicken raised to a size that makes them suitable for roasting

Rolling Barrels - transports condemnation barrels

Roost - a place where chickens can get off the floor (also called a perch)

Rooster - adult male chicken (also referred to as a cock)

Rooster-mature male chicken

Rumpless - genetic trait in some chicken breeds where they have no tail

Saddle - a part of a bird's back just before the tail

Salvage - removes salvageable parts from defective product identified during inspection

Sanitize - to clean and disinfect in order to kill germs

Saw - operates saw to manually halve or quarter chicken

Saw KFC - operates saw to cut product into 8 pieces commonly used by Kentucky Fried chicken

Saw Wing - operates saw to cut wing into 3 pieces

Scalding – using hot water to denatures expand feather follicles proteins to allow easier picking

Scales - small, hard, overlapping plates that cover a chicken's shanks and toes

Scale and Bagger - weighs and places product into plastic bags

Scale Operator - weighs product prior to packing

Scapula Meat - remover removes meat from the back side of breast product

Scorer - marks areas on whole product for deboning

Scratch - the habit of chickens to scrape there claws against the ground to dig up food items; also a term used for any whole grains fed to chickens

Selection pressure – amount of pressure applied to each specific selection criteria

Sensible heat loss– heat loss that does increase the temperature of surrounding environment, includes conduction, convection and radiation

Sexed chicks - day-old chicks that are separated into separate groups of male and female chicks

Sex-feather - curled feather on the tail of male ducks

Sex-linked - an inherited factor linked to the sex chromosomes and used in developing specific crosses to make sexing day-old chicks easier

Sex-separate rearing - raising of either male or female chicks that have been sexed at the hatchery

Shaft - part of feather where barbs are attached

Shank - the part of a bird's leg between the foot and the hock

Shell gland - portion of female avian reproductive tract where shell is added to egg (also called the 'uterus')

Shipping - transfers finished, packages product onto trucks for delivery

Shrinkage- loss in weight

Sickles - long, curved tail feathers of some roosters

Side sprig - projection from the side of a single comb (a disqualification when showing single-comb breeds of chickens)

Singeing – using flames to remove tiny feathers

Single phase - A single phase, alternating-current system is one having a single circuit based on two wires. One is neutral and other is hot wire.

Skin Inspector - inspects skin to make sure no usable meat remains

Skin Puller - removes usable meat from skin

Small intestine – narrow, winding, upper part of the intestine where digestion is completed and nutrients are absorbed by the blood

Snood - flap of skin that hangs over the turkey's beak

Soft scald – a lower water temperature retains the outer layer of the epidermis

Spent (as in a spent hen) - a hen that is no longer laying eggs

Sperm - the male reproductive cells capable of fertilizing the ova from the female

Spike - round extension found at the end of a rose comb

Spiral Feeder - feeds product into a spiral feeder

Splayed legs - the legs are positioned such that the bird is unable to stand up (also called 'spraddle legs')

Spur - sharp horny protrusion from the back of a bird's shank (typically larger in males than in females)

Squab - a young (baby) pigeon that has not yet left the nest; also refers to pigeon meat since pigeons are usually marketed before they leave the nest

Squeaker - a young pigeon still in the nest

Squirrel tail - tail that has more than a 90 degree angle

Stacker - transfers boxes of finished product onto pallets

Starve-out - a chick that has not eaten

Stigma – area one follicle wall that is void of blood vessels where ovulation occurs.

Stocking density- number of animals per unit of floor space

Straight-run (chicks) - day-old chicks that have not been sorted by sex (also called unsexed)

Straight-run rearing - raising poultry that have not yet been sexed

Strain - a group of birds within a variety of a breed that has been bred by one person or company for generations

Strip Cutter - separates tenderloins from breast

Stuffer - places giblets into wrap pack, then wrap pack into cavity

Stub - down on the shank or toe of a clean-legged chicken

Subclinical disease– no readily available disease symptoms exist

Syndrome - a group of symptoms that occur in combination in a particular disease

Synergistic - working in cooperation

Testes - male reproductive glands (located internally in birds)

Testicles – paired male sex organs that produce sperm

Thermoneutral – an environment in which temperature is stabilized with no heat transfer

Three phase - A three phase alternating current system has three single phase circuits based on four wires; one is neutral and three hot wires.

Thermoregulatory mechanisms – Mechanisms involved with thermoregulation

Thigh Breaker - disjoints thighs for deboning

Thigh Cutter - scores and cuts the thigh bone joint

Thigh Deboner - removes the bones from thigh meat

Thigh Inspector - inspects boneless thigh meat for bone fragments, blood clots, etc..

Tow Motor Operator - pallet jack operator

Transfer - moves product from one line to another

Tray Pack - places product parts on trays to be over wrapped and weighed

Trimmer - removes defects from product with knife or scissors

Truck Driver - drives the trucks delivering product

Table egg industry – produces infertile eggs for the retail consumer

Toe clipping- removal of a bird's toes just behind the claw

Tom - an adult male turkey (also referred to as a 'gobbler')

Tom-mature male turkey

Top-dressing – adding layer of clean litter on top of used litter before a new flock

Torticollis - twisted or wry neck

Toxin - a poison produced by microorganisms

Trachea - the windpipe

Trap nest – equipment used to keep hens on nest until caretaker releases them, allows egg production to be closely monitored and accurate production records to be kept by hen.

Triglyceride – compound composed of glycerol and three fatty acids, energy source

Trio - a male with two females of the same species, breed and variety

True Fertility – measure of breeder flock or inseminating crew performance. Indicates the number of eggs that are fertile at the point of oviposition

Tunnel ventilation–fans placed at opposite end of building from air inlets; negative air pressure pulls air from outside through the building length wise in the house and exhaust it through fans

Type - size and shape of a chicken that tells you what breed it is

Unloading Vehicle - unloads product and/or materials for use in processing plant.

USDA Helper - plant employee works with USDA Inspector on eviscerating line to remove and/or trim defective product.

Unsexed - day-old chicks that have not been sorted by sex (also called straight-run)

Urates - uric acid (the avian form of pee)

Uremia - poisoning caused by accumulated wastes in body, typically due to kidney failure

Uropygial gland (preen or oil gland) - large oil gland on the back and at the base of the tail of birds providing oil for the birds to preen their feathers.

USDA – United States Department of Agriculture, government agency that regulates a Agricultural and food products

Uterus - section of female avian reproductive tract where the shell is added to egg (also known as the 'shell gland')

Vaccine – a biological microorganism administered for prevention of an infectious disease

Vagina - section of the female avian reproductive tract where bloom/cuticle is added to egg just prior to being laid

Value-added product – further processed to maximize consumer appeal

Variety - subdivision of a breed, according to plumage color, comb type, etc.

Vas deferens – passageway for sperm from testicles to cloaca, in birds also used for sperm maturation and storage

Vasoconstriction – narrowing of blood vessels, conserves body heat

Vasodilation – widening of blood vessels, used by animals to passively dissipate body heat

Vector - means by which a disease is spread

Vent - common outside opening of cloaca in birds through which digestive, excretory and reproductive tracts empty

Vent Cutter - opens the back end of bird to remove evisceration.

Viscera Puller Drawhand - eviscerates product by hand when missed by automated machinery, before inspection.

Vaccination –introduction of a vaccine into body for purpose of inducing immunity

Ventriculus – also known as the gizzard, mechanical stomach in birds, grinding mechanism for food digestion

Vertebrae - bones in the spinal column

Vertical Integration – control by a single company of most of all aspects of production

Vertical transmission - disease transmitted from parent to offspring through hatching eggs

Virulence – degree of pathogenicity

Virulence - level at which a disease-causing organism is able to cause a disease

Virus – complex protein material that is capable of causing disease which can be reproduced only inside host cell

Viscera – internal organs

Vitamin – organic compound needed by the body in very small amounts, however, critical for many physiological processes such as Ca absorption and blood clotting

Vitelline membrane - thin membrane that surrounds the yolk

Volt - Volt (V) is the amount of electric pressure that will cause current to flow at the rate of one ampere through a resistance of one ohm.

Voltage - Voltage is the electromotive force or pressure which causes electric current to flow in an electric circuit. Its unit of measurement is volt. Vulture hock - feather-legged breeds where the feathers grow off the shank and touch the ground

Warm house brooding - raising poultry under controlled warm house conditions where the entire area is warmed to the same temperature

Wash Out - uses an offline antimicrobial treatment to clean product before placing product on line.

Weighs Trucks - transfers a loaded truck to the scales for weighing; after unloading birds, weighs truck again to determine weight of birds

Water chilling – chilled in two phases moving toward cleaner water cold water submersion to reduce carcass temperature after inspection

Water soluble vitamin – essential, water-based vitamins not stored in the body and must be replaced daily

Watt - Watt is the rate at which power is expended when a pressure of one volt causes current to flow at the rate of one ampere.

Wattles - flap of skin under the chin of a chicken or turkey

Web - the network of interlocking parts that give a feather its smooth appearance; a part of the feet of waterfowl

Wet bulb temperature– lowest temperature that can be obtained by evaporating water into the air at a constant pressure

Wet-blub thermometer - a thermometer used to measure the amount of moisture or water vapor in the air (humidity)

Windrowing – a long low ridge or line of poultry litter, hay, or similar crop Designed to achieve the best conditions for drying or curing

Wing clipping - a procedure in which the primary wing feathers of one wing are cut to prevent flight

Wing Cutter - separates wing portion from whole bird or front half

Wing Disjointer - separates the wing into 3 sections

Wing Hanger - transfers wing portions to the Wing Disjointer

Wing Scorer - transfers wing portions to the Wing Disjointer

Wing Tip Clipper - separates wing tip portion from whole bird or front half

Wing Tip Cutter - separates wing tip portion from whole bird or front half

Wing Weigher - weighs and labels boxes of finished product

Yield Checker - monitors the loss of meat from deboning operations

Wry tail - tail that lays to the left or right side and is not symmetrical with the body line

Xanthophylls - yellow pigments found in leaves, grasses and green plants that are added as pigment to avian skin as well as providing yellow color of egg yolks

Yolk - round yellow mass upon which genetic material of female (and male if the egg is fertilized) is located and that provides nutrients for the developing embryo

Yolk membrane – vitelline membrane, surrounds yolk, facilitative function, contains enzymes which help break down and release nutrients from the yolk for utilization by developing embryo

Yolk sac - membrane that surrounds yolk in the incubating egg

Zoning - laws regulating or restricting the use of land for a particular purpose such as raising poultry

Zoonosis - a disease transmissible from an animal to a human (plural = zoonoses)

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