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Good practices in planning and management of integrated commercial poultry production in South Asia

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by
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Foreword

Commercial poultry production in South Asia is barely 40 years old although poultry raising dates back to pre-historic times. Hybrid layer strains were introduced into the sub-continent in 1955 and followed by broiler strains in 1961. Modern commercial poultry rearing was demonstrated in government farms and by state agricultural universities which popularised modern poultry production in villages throughout India and elsewhere. As a result, there has been a significant growth in poultry production throughout the region. For example, in India the broiler population increased from 4 to 700 million birds between 1971 and 2000, respectively. The development of a system of partnerships between private investors, known as "integrators", who provide credit and inputs to farmers who provide housing and labour has been a deciding factor in this growth of the Indian poultry industry.

In 2002, FAO commissioned the Tamil Nadu University of Veterinary and Animal Science (TANUVAS) in India to document the South Asian experience in developing its expanding poultry sector. The result is this publication which provides a comprehensive review of all aspects of poultry production in South Asia. Topics covering both egg and broiler production are discussed in detail, as are sections on feeding and nutrition, housing, general husbandry and flock health. Institutional support, issues relating to rural poultry production, as well as some of the environmental and social consequences associated with poultry keeping are also dealt with in separate chapters. While the book concerns itself mainly with chickens there is a chapter that examines quail, turkey and duck production in the region.

It is expected that this publication will serve as a practical guide providing valuable information to both experienced and novice poultry producers alike, as well as for students, researchers and those involved in development in general.

Chapter 1
Poultry Industry in South Asia

Poultry provides an immense supply of food for the world's population. All over the globe, poultry meat and eggs are preferred to other kinds of animal food products for a variety of reasons. It is estimated that 25 percent of the world's meat supply is derived from poultry, i.e. chicken, turkey, duck, geese, domesticated quail, etc. and the proportion is increasing steadily. The trend has been more noticeable in developing countries in recent years.

Even though poultry meat and eggs are consumed in both developed and developing countries and this is not discouraged by the many religious taboos, the quantity of consumption has remained much lower in developing countries in comparison to developed countries. This could be partly due to eating habits as well as to the comparatively lower purchasing power of developing countries.

South Asian countries (India, Pakistan, Bangladesh, Sri Lanka, Nepal, Bhutan and the Maldives) represent about 22 percent of the world population (Table 1.1). However, they contribute only about 5 percent of the total egg production of the world (Table 1.3) and even less in poultry meat production, with chicken slaughter in these countries amounting to only 2.7 percent (Table l.7) of the chickens slaughtered in the world.

South Asian countries are located in the tropical region of the world and the prevailing macro-climatic conditions in these countries are not the most congenial for poultry production. Yet the growing need of the ever-increasing population in the region raises the demand for poultry products. For a long time, the bulk of this demand has been met by the native breeds of chicken and commercial poultry production with high yielding hybrid strains has only been introduced in the last 40 to 50 years.

Most of the eggs and meat come from three different types of chickens taken from such stock. The first of these are indigenous chickens that have existed in these areas for centuries, most of them living as scavengers or reared in backyards in rural conditions. Their productivity level is very low but they possess genes that are well adapted to the tropical environment of their countries. Secondly, they have medium-level stocks, which consist mainly of pure breeds maintained by research stations and fancy breeders. These breeds are reasonably productive and are also comparatively more resistant to diseases than the hybrid chickens. Lastly, the third group of industrial stock, comprising hybrid strains, evolved out of three or four way crosses by breeder companies in developed countries. These grandparent stocks are imported into South Asian countries by franchise breeders. Commercial strains, which rank very high in performance through random sample testing in developed countries, do not repeat the same level of superior performance in tropical South Asian countries. The franchisers in these countries could, however, identify and locate the strains which are better suited to local conditions, from the list of different strains of layers and broilers developed in other countries. Present-day commercial strains made available by local franchisers in these countries now have matching performance levels compared to their contemporaries in developed nations with more optimal temperate climatic conditions.

India

Commercial poultry production in India is barely 40 years old, although poultry raising dates back to prehistoric times. Even today, a substantial proportion of India's poultry population comes from nondescript indigenous stock that contributes about 10-12 percent of the total poultry production in the country.

The Indian poultry industry revolves mainly around chicken. It has developed rapidly from small-scale backyard breeding to highly specialized, intensive production. Compounded poultry feed is produced on a large scale and the country has almost all the known commercial strains of broilers and layers currently available. Consequently, poultry production is one of the fastest growing food production sectors in the country. Egg production in India has gone up from 2 881 million in 1961 to 36 500 million in 2000, while poultry meat production increased from 81 000 MT to 1 050 000 MT during the same period. The value of poultry products produced in the country has climbed steeply from Rs. 8 000 million in 1980 to Rs. 100 000 million in 2000; yet the Indian poultry industry is not totally in the hands of the organized sector. Furthermore, processed poultry meat constitutes only 5 percent of the total poultry meat consumption in the country.

Pakistan

The poultry industry in Pakistan has also evolved well. Commercial poultry farming started in Karachi in 1964 and this introductory and consolidation phase continued until 1976 with a boom-period between 1976 and 1986. Since then, the industry has regulated itself. The progress from traditional small backyard units to a semi-intensive system of 100-200 bird units and to more commercial large-scale units has been smooth and decisive.

The total layer population projected for 2000 AD was 20 million and the broiler population 300 million. The layer industry is reportedly growing by 6 percent annually and the broiler industry by about 11 percent. The annual per capita consumption of poultry meat and eggs has been substantially higher than in India.

Local demand for poultry meat and eggs is increasing steadily and the possibility of a surplus for the international market is accordingly less. The infrastructure facilities available to the industry are at present inadequate to avail itself of such opportunities.

Bangladesh

Bangladesh has a comparatively higher proportion of ducks than any other South Asian country (85 million chickens and 33 million ducks). The poultry industry of Bangladesh is still in its early stages of development, and most of the egg and poultry meat production comes from indigenous stock that depends on scavenging or on very little supplemental poultry feed. Only Government farms aided by international agencies or farms promoted by non-government organizations have most of the commercial stock available in the country.

Poultry provides hard-cash income and creates employment opportunities for the rural farmers and landless women. Poultry meat contributes 37 percent of the total meat production in the country, and poultry contributes 22-27 percent of the total animal protein supply. The number of eggs produced in the country is less than the demand and there is a shortfall of 87 percent. Egg production over recent years has gone up by 3.8 percent, and poultry meat production increases by 7.2 percent annually. The most significant limiting factor has been the shortage of poultry feed and sustained promotion is needed to facilitate the growth of the poultry industry in the country.

Sri Lanka

Commercial poultry production in Sri Lanka has experienced a boom during the last decade; consequently, per capita poultry meat and egg consumption in Sri Lanka is now the highest among the South Asian countries. However, most of the eggs are still collected from scavenging birds that do not depend on compounded feed. Acceptance of processed poultry meat has increased in recent years, and has given an incentive to broiler production in the country. The poultry feed industry is also showing trends of improvement. In coming years, the growth witnessed in the tourism industry will also have a related impact on the growth of the poultry industry.

Nepal

The poultry population in Nepal was estimated at 13.6 million in 1993. Even though hybrid broiler and layer strains are available in the country, the native chickens "Sakhini" comprise about 80 percent of total chicken numbers. Per capita meat consumption was lower at 600 g and eggs at 882 g per person per year. Non-availability of major poultry feed ingredients in the local market and the need to import them makes poultry production activities cost-prohibitive. The lack of credit and insurance facilities is also cited as a reason for the poor performance of the poultry industry in this country.

Poultry production in Bhutan and the Maldives has been minimal and insignificant, and is dependent - at least in the Maldives - on the tourism industry.

Future Prospects

The diet of people of South Asian countries is often protein-poor, consisting mainly of energy-rich cereal grains, with the protein consumed being quantitatively and qualitatively less than the optimal requirement. It is impossible to achieve any significant improvement in these areas unless an increase in crop rotation, livestock, poultry and fish farming takes place.

Among the future prospects for these countries, poultry farming holds a prominent place in development plans, for a variety of reasons:

- Cattle production and small ruminant production are dependent on the availability of land, which is a limiting factor for improving such activities. Furthermore, land-area holding per person is shrinking in most of the South Asian countries because of population growth;
- Poultry farming requires a modest initial capital outlay and its returns are achieved much earlier;
- Poultry farming and production techniques are simple and need less skill which means that even the uneducated or poorly educated rural population can run a poultry farming business quite successfully if the necessary facilities are made available at a reasonable cost;
- There is a higher consumer preference for poultry products because low value units of a few eggs or a young broiler are available at low cost;
- Poultry farming provides the unemployed or poor villager with scope for diversification, increases revenue, and enhances the value of certain agro-industrial by-products (for example, cereal and bran) by transforming them into quality products like poultry meat and eggs;

- Compared with other food products, poultry products rank high in terms of protein quality. The biological value of an egg is 100 and that of poultry meat 87 which much higher than most other foodstuffs.

Considering the above economic, nutritional and practical reasons, as well as the increasing consumer demand due to population growth in the region, and the growing improvement in the quality of life because of higher literacy levels, an increase in the scale of poultry production in these countries is expected. The speed with which intensive poultry production is being introduced to this region stands testimony to the rapid progress anticipated.

TABLE 1.1 Human Population in South Asian Countries (million)

Country	Year					
	1985	1990	1997	2000	2005 (P)	GNP US$/yr 1996
India	767.9	850.8	960.2	1006.8	1082.2	380
Pakistan	101.2	119.1	143.8	156.0	177.6	480
Bangladesh	99.3	109.8	122.0	128.3	139.9	260
Sri Lanka	16.1	17.1	18.3	18.8	19.9	740
Nepal	16.5	18.8	22.6	24.4	27.4	210
Bhutan	1.5	1.7	1.9	2.0	2.3	390
Maldives	0.2	0.2	0.3	0.3	0.4	1080

Source: WATT Poultry Statistical Yearbook

TABLE 1.2 Growth in Chicken Population in South Asian Countries (million)

Country	Year				
	1991	1997	1998	1999	2002
India	294	343	375	383	413
Pakistan	78	200	145	148	155
Bangladesh	90	153	138	138	140
Sri Lanka	9	9	10	10	11
Nepal	12	16	16	18	21

Source: FAO Statistics, 2002

TABLE 1.3 World Hen Egg Production, 2002.

Rank	Country	Egg Production ('000MT')
1	China	24 191
2	USA	5 128
3	Japan	2 535
4	India	2 010
5	Mexico	1 885
6	Brazil	1 595
28	Pakistan	352
46	Bangladesh	159
70	Sri Lanka	53
94	Nepal	26
178	Bhutan	04

Source: WATT Poultry Statistical Yearbook

TABLE 1.4 Growth in Egg Production in South Asian Countries ('000 MT')

Country	Year				
	1989	**1992**	**1995**	**1998**	**2002**
India	1 105.00	1 251.00	1 500.00	1 611.00	2 010.00
Pakistan	202.10	217.00	278.50	270.00	352.00
Bangladesh	46.00	67.51	82.00	104.00	159.00
Sri Lanka	47.30	45.60	48.86	48.47	53.00
Nepal	13.70	17.70	18.50	21.27	26.00
Bhutan	0.10	0.34	0.37	0.38	0.4

Source: WATT Poultry Statistical Yearbook

TABLE 1.5 – Egg consumption (supply) in South Asian Countries (kg/person/yr)

Country	Year			
	1985	**1991**	**1996**	**2000**
India	1.0	1.3	1.4	1.5
Pakistan	1.4	1.6	1.6	2.0
Bangladesh	0.6	0.6	0.8	1.0
Sri Lanka	2.0	2.5	2.3	2.4
Nepal	0.8	0.9	0.9	0.9
Bhutan	0.7	0.7	-	-
Maldives	4.0	4.0	5.6	6.7
World	-	-	7.7	8.1

Source: FAO Statistics, 2002

TABLE 1.6 World Chicken Meat Production, 2002 ('000 MT')

Rank	Country	Chicken Meat Production
1	USA	14 764
2	China	9 475
3	Brazil	6 660
4	Mexico	1 914
5	UK	1 250
6	Japan	1 190
7	France	1 155
19	India	595
33	Pakistan	355
2	Bangladesh	99
76	Sri Lanka	82

Source: FAO Statistics, 2002.

TABLE 1.7 Chicken Slaughtering South Asian Countries (million)

Country	Year			
	1961	**1990**	**1998**	**2002**
India	77	371	585	661
Pakistan	10	154	280	310
Bangladesh	30	91	140	141
Sri Lanka	3	20	47	68
Nepal	4	11	13	16
World	-	-	38 133	44 133

TABLE 1.8 Poultry Meat Consumption in South Asian Countries (kg/person/yr)

Country	Year			
	1985	1991	1996	2000
India	0.2	0.5	0.5	0.6
Pakistan	1.0	1.4	2.6	2.3
Bangladesh	0.6	0.7	1.0	0.8
Sri Lanka	0.6	0.8	3.1	3.4
Nepal	0.3	0.5	0.5	0.6
Bhutan	0.2	0.2	-	-
Maldives	-	1.1	1.8	4.1
World	-	-	9.7	10.9

Source: FAO Statistics, 2002

Chapter 2
Commercial poultry production

Archaeological evidence indicates that chickens were domesticated as early as 5400 B.C. even though distribution throughout the world originated from the Harappan Culture of the Indus Valley during 2500 - 2100 B.C. The first use of domesticated stock was cultural – in religion and superstition, in decorative arts and for entertainment. They were used as a source of human food only much later. Even then, people continued to raise the birds in small numbers in backyards. Considering their history of domestication, the commercial exploitation of chickens and other domesticated birds is very recent. It started with the application of scientific principles in breeding for improving the meat and egg production potential of birds.

Commercialization of poultry production in South Asian countries started with the introduction of superior stock birds during the 1950s and 1960s and poultry meat and eggs have now become very common in the diet of the people of the region. People have become increasingly aware of their advantages as food items and the demand for poultry products has increased, raising the scope of commercial poultry production activities.

A chicken egg contains 6-7 g of protein. Egg protein is one of the highest quality proteins. It contains all the essential amino acids required in the diet of human beings and is of such high quality that nutritionists use the egg as a standard of reference against which other protein foods are evaluated. An egg also contains five to six grams of easily digestible fat and it contains both saturated and unsaturated fatty acids. The amount of desirable unsaturated fatty acids are more than those found in most other animal products. Eggs are also low in calories and can be readily included in a nutritionally balanced low-calorie diet. They contain sufficiently high quantities of all the essential vitamins except vitamin C. Fat-soluble vitamins like A, D, E and K and water-soluble vitamins like the B-Complex (thiamine, riboflavin, pantothenic acid, niacin, folic acid and vitamin B_{12}) are also present. Egg yolk is high in cholesterol and carotenoid pigments which play important physiological roles in the body. A shelled egg can be considered the only natural food that cannot be adulterated.

Poultry meat is economical and widely accepted. It permits quick and easy preparation, and has a number of desirable nutritional and organoleptic properties. Poultry meat is not only a good source of protein, but it contains more protein (22-24 percent) than red meats. Poultry meat protein is a high quality protein that is easy to digest and contains all the essential amino acids presently known to be required in the human diet. Poultry meat is low in calories and therefore a good foodstuff for weight-control diets, convalescents and old people who are not physically active. By eating poultry meat as the source of protein in a diet, it is possible to reduce caloric intake and, at the same time, balance other nutritional requirements. Broiler meat contains 150 calories per 100 g of meat. Poultry meat is a source of both saturated and unsaturated fatty acids, but has a higher proportion of unsaturated fatty acids than the fats from red meats. Poultry meat also contains less cholesterol than other foods of animal origin. Poultry meat fibres are tender, easy to chew, grind and digest, and have a mild flavour that blends well with other foods.

For the above reasons, poultry meat and eggs are increasingly preferred in the diet of the people of this region - a preference that is further facilitated by the increasing literacy levels and improving standards of life.

Consequently, backyard-reared poultry or rural poultry alone cannot meet the demand, and commercial production of poultry has become the order of the day. Advances made in poultry breeding, feed and feed processing, poultry nutrition, housing, management and disease-control techniques have resulted in improved productivity and profitability in poultry rearing. Commercial poultry production has finally become established and now supplements rural poultry production activities.

Acceptance into the human diet of poultry meat and eggs on a wider scale, and subsequent endorsement from institutions like the World Health Organization have set a tremendous pace in the growth of the poultry industry which is the forerunner of other agri-based industries.

However, questions of concern are how profitable is poultry production and what conditions are needed for commercial poultry production?

Poultry production (poultry meat, broiler or egg production) needs some skill, but it can be easily mastered. However, the profitability in commercial poultry production depends not only on efficient production, but also on successful marketing of the product. Anyone wishing to attempt commercial poultry production should, apart from mastering the techniques of poultry production, study first-hand the marketability of the product (poultry meat or eggs) in his region or elsewhere to ensure a reasonable profit margin. Production techniques include proper planning when selecting the location and lay-out; proper designing of poultry houses, arranging for quality inputs like chicks and feed, adopting appropriate rearing techniques and taking adequate disease-control measures to ensure high efficiency and productivity.

Profitability in poultry production also involves proper assessment of demand, planning the size of the activity, possible integration of activities to bring down the cost of production, thorough costing of production activities, foresight into market price situations, prudent assessment of cost-benefits and the rate of returns in the activity. These situations vary from country to country and even between regions of a country.

The term “Poultry” denotes all domesticated species of birds including chicken, ducks, turkeys, Japanese quail, pigeons, as well as rarities such as ostrich and emu. Commercial poultry production involves various activities such as the establishment of broiler chicken farms, layer (egg production) chicken farms, rearing Japanese quail or turkeys for meat, rearing ducks for eggs, manufacturing poultry feed, establishing poultry meat shops, as well as poultry or egg trading activities, etc. This manual deals with management techniques for rearing chickens (broiler or layer), Japanese quail, turkeys and ducks.

Chapter 3
Chicken: broiler production

Production of chicken meat is growing into the largest component of the poultry industry in India and nearby countries. Hardly two decades ago, most of the chicken marketed for meat in this region came only from the layer-type spent hen and the native chicken, but in recent years the proportion of broiler meat in poultry meat production has gone up considerably.

People of this region were initially accustomed to the tough, bony poultry meat from nondescript native chickens reared under backyard conditions for long periods. During the years 1965-1980, however, the spent chicken, a by-product of the layer industry, slowly started replacing them. Although hybrid broiler chickens were introduced into this region as early as the 1960s, even sustained propagation by government institutions and the industry could only achieve a breakthrough in the 1980s. The low-fat, low-calorie, high-protein, cost-effective broiler meat now finds ready acceptance, not only among urban consumers, but also in rural households.

The broiler production activity starts from the import of grandparent stock of commercial meat-type hybrid strains by franchise hatcheries. These follow the suggested line of breeding activities and produce high-performing hybrid broiler chicks in two generations which are sold as day-old chicks to the farmers. The broiler farmer buys the day-old hybrid broiler chicks and grows them to market age (6-7 weeks) on his premises, arranging for the necessary infrastructure facilities and other inputs. He ensures provision of optimal growth and safety measures, including appropriately designed poultry houses, feed and water, health cover, etc. and markets them as efficiently as possible.

SYSTEMS IN GENERAL USE

Commercial broilers in this region are reared essentially on deep litter floors. Rearing broilers on slat-floors or in cages is not the general practice.

Two popular systems of rearing broilers are:

- the multiple-batch system;
- the all-in-all-out system.

Multiple-batch system

Under this system, day-old broiler chicks are purchased in batches at weekly or bi-weekly intervals and reared. At any given time, birds of different ages (differing in age by days or weeks only) are being reared on the same farm. Independent broiler farmers, who want to provide a steady and continuous supply of mature broilers to the market every week, adopt this multiple-batch system, as it helps them to link with preferred retailers, and they need not run around to sell every batch of broilers produced. The requirements of rearing equipment like feeders and drinkers are also considerably less under this system, as they can be moved between different batches. However, the presence of different age groups of broilers on the same premises makes it difficult to control the spread of diseases. Because of the presence of microbial material from batch to batch, the overall performance of broilers in number of days to market, efficiency of feed utilisation, percent liveability and consequent total weight at market age, etc., remain poor under the multiple-batch system compared with the all-in-all-out system of broiler production.

However, to ensure a regular supply of day-old broiler chicks and mature broilers for the market, the independent broiler farmers are obliged to adopt the multiple-batch system despite these limitations.

All-in-all-out system

Under this system, the day-old hybrid broiler chicks are received in one batch, grown to appropriate market age and weight on the farmer's premises and sold in one batch to the market, mostly to wholesalers. The farm premises are cleaned and disinfected to receive the next batch of broilers of a single age group. At any time, only one particular batch or age group is available on the farm premises, making it easier to control the spread of disease as procedures to disinfect the premises can be applied promptly. Broilers grown under this system give a superior performance to broilers grown in the multiple-batch system. However, a regular supply of broilers to the market at specified weekly intervals is not possible, and the producer or farmer has to depend mostly on wholesalers to sell his broilers which means that his profit margin is that much lower. For this reason, the all-in-all-out system is preferred for greater quantity broiler production. In addition, broiler farm equipment such as feeders and drinkers are required in greater numbers, as equipment of different sizes is required at different ages.

The system of broiler production adopted by the farmer depends on the number of broilers raised, and the preferred level of integration of broiler production activities. Consequently, the type of broiler production activities most widely practised can be grouped conveniently into three categories:

Smaller independent units

Total farm capacity ranges between 2 000 and 8 000 broilers. The broiler farmer purchases inputs like day-old chicks, feed, medicines, etc., rears the chicks on his farm to the required market age and weight, and arranges to sell them to retailers or wholesalers regularly. A few farmers own retail outlets and attempt to reap as much profit as possible from the low level of activity. The system of broiler production adopted is essentially the multiple-batch system.

Moderately integrated large units

Farm capacity ranges from 10 000 to 40 000 broilers. Farms with this capacity are fewer in number. The farmer gets the required number of broiler chicks at discounted rates because of the volume of purchase. He owns his own feed-mixing unit and produces quality broiler feed at a lower cost. He also adopts the multiple-batch system but produces broilers at a much lower cost compared with independent small farmers.

Vertically integrated broiler production under contract farming

This practice is gaining popularity at present. Most hatchery men, feed manufacturers and even wholesale broiler merchants are obliged to contract broiler farmers either to find a market for their day-old broiler chicks and broiler feed, or to ensure a continuous supply of mature broilers at competitive rates.

The integrator or producer owns a hatchery and a feed plant and contracts broiler farmers to raise broilers from day-old to market age. The integrator supplies the chicks, feed, medicines and vaccines and also arranges for veterinary supervision of the farms. The farmer has to provide the housing facilities, electricity, litter material and the labour required to rear the broilers to market age. He is paid a rearing cost for his services, depending on the body weight of broilers raised and the production efficiency on his farm.

This system of broiler production under contract farming has proved to be beneficial to both the integrators and the farmers. There are also added advantages since the integrator takes care of the activities that require some skill. Because the farmer's role is more simple, uneducated and under-employed farmers in rural areas are encouraged to participate in these contracts, even though the integrator is not under any obligation to continuously provide chicks to any specific farm premises.

Since the high-cost activities like chick and feed production are taken care of by the integrators, they are able to produce quality chicks at a lower cost because of the high volume production. Consequently the cost of broiler production under contract farming remains at least 20 percent lower in comparison with production by independent farmers. Smaller farmers are therefore unable to compete in the field and are obliged to adopt contract farming as well or opt out of broiler production altogether. For the same reason, even wholesale broiler merchants are now inclined to revert to broiler production under this system.

Consequently, broiler production under a vertically integrated form of contract farming is growing in popularity in a few regions in India. This system facilitates the all-in-all-out system of broiler production as the farmer need not worry about marketing since the broilers are not his products, and the integrator owner arranges for the marketing to be taken care of on his behalf.

The size of farms under contract farming range from 2,000 to 20,000 broilers or even more. The broiler farmer is even extended credit facilities by banks to establish farms under contract farming. Such farmers also need to know broiler management techniques to improve the efficiency of broiler production and to receive a higher remuneration than the rearing costs.

PLANNING

The farmer who intends to start a broiler farm has to assess the marketing potential existing in the area as well as the average market price in order to make sure that the broilers he plans to produce are in demand and will command a good price.

He should then decide the size of the farm. It depends on the capital he has available for the business and the economically viable size of the unit. A broiler farm with a capacity of less than 4 000 is not advisable unless the farmer proposes to establish a retail outlet of his own. He has to make his choices in accordance with the facilities he has at his disposal.

The availability of various inputs, like quality chicks, feed, medicines, vaccines, litter material, labour, etc., has to be assessed. After-sale technical and marketing services by the chick and feed suppliers have to be checked. The farmer is advised to consult an experienced qualified poultry consultant for other technical details, and also to visit a few successful broiler farmers in the area.

If he wishes to establish a broiler farm under contract with an integrator, he should know the cost of the inputs expected of him, and compare this with the rearing cost paid by the integrator to see whether it will be viable. He should make sure that the integrator will place chicks without undue breaks.

LOCATION

The land must be elevated, not low-lying, to prevent water stagnation or flooding. The farm should be located in an area with facilities for comfortable rearing of broilers, with the least difficulty in arranging inputs and outputs. It should preferably be located as near to the marketing city as possible. It should also be a good distance from other broiler farms in the vicinity. Advance arrangements need to be made regarding power supply. Since water is essential for the broilers, a sufficient quantity of clean, wholesome, potable water should be available in the area. About 6 000 litres of water is required daily for a 10 000-capacity broiler farm; and the possibility of contamination with sewage water or effluents from factories should be avoided. The quality of the water should be tested in a laboratory for its microbial and mineral contents, and its suitability for poultry confirmed. The minimum extent of land for the proposed site should be available and the necessity for more land for future expansion may also be considered.

BUILDINGS

Buildings are the major capital expenditure and therefore need thorough planning. The various types of buildings required on a broiler farm are:

- Broiler houses;
- Storeroom;
- Office room;
- Staff or watchman quarters;
- Manure pit;
- Burial pit or incinerator.

Broilers need houses to protect them from extremes of climate, theft, predatory animals like wild cats, dogs or bandicoots, etc.; to ensure easy and better management; to facilitate automation and to provide ideal, comfortable rearing conditions.

Optimal environmental conditions for rearing broilers:

Temperature: 22-30°C (or) 70-85°F;

Relative Humidity: 30-60 percent;

Ammonia: Less than 25 ppm;

Litter moisture: 15-25 percent;

Airflow: Open-sided houses with 35 cm high sidewalls and breadth of broiler houses restricted to 7.2 m; otherwise, airflow should be 10-30 metres per minute by turbo-ventilation.

Orientation

The broiler houses should be situated with their long axis in an east-west direction to avoid direct sunlight falling into the building. The rule of thumb is that the long axis of the houses should be parallel to the shadow of a vertically erected pole during the hottest summer.

Elevation

The floor-level of broiler houses should be raised 30 cm (one foot) above the outer ground level to prevent seepage of water into the house. The floor should be made of cement, to prevent damage by rodents and to permit easy and efficient cleaning and disinfecting. Mud floors and sand floors should never be permitted, as they will render cleaning between batches very difficult and will harbour micro-organisms, eggs of parasites, etc., which may cause outbreaks of disease in subsequent batches.

Width

The width of open-sided broiler houses should not be wider than 7.20 m or less than 4.80 m, to permit optimal cross-ventilation. The length of the house may vary depending on the required capacity and the length of the available land. In tunnel- ventilated broiler houses fitted with automatic feeders and drinkers, the width may be up to 12.00 m.

Walls

The long walls on the sides should not be more than 35 cm high above the floor level, with the rest of the area covered with a mesh. Open-sided broiler houses are preferred because of the tropical conditions prevailing in the region. The top of the sidewalls should be tapered and sloping downwards to avoid young birds perching on the walls. The walls should be thoroughly cement-plastered, and well watered to avoid cracks forming. In places of extreme climatic conditions, the walls may be constructed with hollow bricks for an insulating effect.

The space between the top of the sidewall and the roof must be covered with wire mesh (1.25 x 1.25 cm, 20-22 gauge thick), weld mesh (2.5 x 5.0 cm, 12-14 gauge thick) or chain link (2.5 cm, 12 gauge). It should be durable and strong, and close enough to prevent the entry of rodents and predators.

The doors may be fitted with strong G.I. rod supporting-frames of weld mesh at 8-10 m intervals, each one metre in width.

Roof

The roof may be thatched (straw, coconut leaves or Palmyra leaves), tiled or covered with lightroof (asphalt or bitumen), asbestos or aluminium sheets. Thatched roofs are cheaper, but less durable and may leak. They provide a cooler environment during the hot summer. To prevent leakage, the slope of thatched roofs must be steeper. Asbestos or aluminium roofs are durable, but more costly. As houses with these roofs remain hot during summer, the height at the ridge should preferably be about 4.0-4.5 m. Tiled roofing is good for low-capacity farms, and asbestos roofing for larger farms. The broiler houses can also be two-storeyed, with the lower floor having a concrete roof, which will serve as the floor for broilers raised on the first floor.

The height of the roof should preferably be 2.40-3.00 m at the eaves, and 3.60-4.50 m at the ridge. Thatched roofs may have a lower height of 1.95 m at the eaves.

The projection of the roof at the eaves (overhang) should be at least 0.90-1.35 m on either side to prevent direct sunlight and the splashing of rainwater into the buildings. It is better to adjust the overhang to be half the length between the eaves and the top of the sidewall (the height of the area covered by weld mesh).

In regions of extreme climatic conditions, it is very useful to have the roof insulated. Insulation may be provided by a bed of straw on the top of the roof, or by having false roofing at the level of the eaves, in the form of mats spread to cover the entire roof area. Plywood, coir or hardboard as a covering can also be useful. The roof may also be painted white with aluminium paint to reflect the sun's rays and thereby reduce the heat build-up within the house.

In areas where the summer is severe, it is better to have high-roofed broiler houses, or to provide ridge ventilation at the roof. Chimneys can also be provided on the roof at intervals. In areas where winter is severe, it is advisable to have square-shaped broiler houses, which expose a smaller area and help to conserve the heat produced by birds within the building.

Number of houses

An approximate floor space of 1 m^2 for every ten broilers should be provided, and thus enough floor space should be constructed according to the required capacity. Under the all-in-all-out system, depending on the length and slope of the available land, the minimum numbers of houses need to be constructed. These should have a width of not more than 7.20 m and the required length to provide the suggested floor allowance. It is advisable to maintain at least a 9.0 m distance between two broiler houses to ensure proper ventilation.

With the multiple batch system, if chicks are received bi-weekly, the houses or pens should be in multiples of 4+1. If chicks are received every week, the houses or pens should be in multiples of 8+2 to provide sufficient extra space to facilitate a minimum of two-week intervals between the rearing of two successive batches in any house.

Floor space allowance

The floor space requirement per broiler depends on their body weight, housing system and climatic conditions. Approximately 540 cm^2 (0.6 square feet) per kg live body weight is the required floor space for broilers under tropical conditions. Accordingly, at the end of two, four, six and seven weeks of age, floor space allowance of 120, 367, 730 and 945 cm^2 space per bird is required for average body weights of 220, 680, 1 350 and 1 750 g respectively. For a body weight of 1 650 g, 900 cm^2 (one square foot) of floor space is sufficient. In summer, the space allowance may be increased by 20 percent and in winter reduced by 15 percent.

SYSTEMS OF HOUSING

The broilers may be raised on deep litter, in cages or in batteries with slatted or wire floor systems. The space allowances given above are for the deep litter system of housing, which is the most widely used system for broilers. When they are reared in cages, half the space suggested is sufficient. The cages must be fitted at a height of 75 cm above floor level with feeders and drinkers fitted on the sides, running along the length and width of the cages. Cage houses meant for broilers need not have sidewalls, and weld-mesh cover may be provided up to the bottom floor level. The cage mesh size should be 1.25 x 1.25 cm for the floor and 2.5 x 5.0 cm on the sides to allow birds to take feed and water. Many practical difficulties, like injuries to the flesh of the birds or to the attending workers, broiler breast blisters due to the heavy weight of the birds, leg weakness, difficulty in gathering for the market, maintenance costs, etc., have forced farmers to abandon this system of housing for broilers. The emergence of full automation of feeding and watering and environmentally controlled houses may encourage farmers to opt for cage housing for broilers in future, as it ensures a faster growth rate, better feed efficiency and lower mortality levels.

Environmentally controlled broiler houses may be established in future in this region when higher investments are made in broiler rearing for large-sized broiler farms. Such houses will have no windows. Hot air will be removed by exhaust systems and fresh air introduced through inlets by negative pressure. Air temperature, relative humidity, lighting, ammonia level, ventilation rate, etc., will be monitored and controlled automatically. Birds with the best micro-environment will grow faster with better feed efficiency.

EQUIPMENT

The most commonly used pieces of farm equipment in broiler houses are feeders, drinkers, brooders together with chick guards, crates and weighing scales. Flame guns and other cleaning equipment are also used.

Feeders are devices used to hold the feed. They may be conventional, semi-automatic or fully automatic. They can be linear or circular, and made of metal or plastic. Sufficient feeding space per bird has to be provided, depending on their age. The feeder space available with a given feeder can be approximately calculated by multiplying the length by two (for linear feeders) or the diameter by three (for circular feeders), and the required number of feeders per batch calculated in this way.

Suggested feeder space allowances per broiler at different ages are as follows:

0-2 weeks	-	3 cm
3-4 weeks	-	5 cm
> 4 weeks	-	8 cm

Accordingly, for 1 000 broilers, 25 feeders of 60 cm length are needed, 7.5 cm breadth and 3.8 cm height; from 0-2 weeks, 90 cm length, 12.5 cm breadth and 7.5 cm height; from 3-4 weeks and 150 cm length, 15 cm breadth and 10 cm height from 5 weeks to market age.

Water troughs or drinkers are used to provide clean, wholesome water to the broilers. They are also available in different sizes and capacities. They may be troughs or basins kept on the floor in the conventional manner, or hanging drinkers in an automatic system. Sufficient space for these drinkers should also be provided for so that each bird can drink water easily.

Suggested space allowances are as follows:

0-2 weeks	-	1.3 cm
3-5 weeks	-	2.5 cm
> 5 weeks	-	5.0 cm

Space availability in circular drinkers may be calculated by multiplying their diameter by three (approximately), and the required number of drinkers may be provided accordingly. Allowance for space at water troughs should be increased by 20 percent during hot summer months. The drinkers and feeders should be uniformly distributed over the floor area so that the birds do not need to walk more than 150 cm to reach a feeder or 300 cm to a drinker. The height of the feeders and drinkers should be adjusted so that the brim is at the same level as the back of the bird, to avoid wastage and spillage. For the same reason, they must be filled to only two-thirds of their height at any time.

Brooders are used to give warmth to baby chicks during their early stages. Electrical, gas, charcoal or kerosene stoves or centralized heating systems may be used for this purpose. The electrical heating system is the most commonly used system, in which electrical bulbs covered with reflectors are provided at the centre of a circular arrangement made with chick guards. Bio-gas or coal may also be used if these are available at a lower cost. An umbrella-shaped metallic cover (canopy) fitted with electric bulbs is also commonly used. The height of the heating unit may be adjusted, depending on the heat required.

Chick guards of metallic sheets or hardboards (approximately 35 cm in height) are used to limit the movement of the chicks and to confine them under the source of heat. They also prevent the chicks being trampled at the sharp corners during accidental chilling or power failures.

BROILER REARING

The management of rearing broilers includes cleaning and preparing the house to receive day-old broiler chicks, rearing them from day-old to market age, feeding and watering, applying disease control measures and profitable marketing.

Cleaning and disinfecting

When the batch of broilers grown in a house has been sold, the area should be thoroughly cleaned, dusted and disinfected, and left vacant for a considerable length of time (down time) before the next batch of broiler chicks are received in the area. This ensures proper growth of broilers, by reducing the accumulated load of disease- producing organisms in that area. Failure to adopt such measures will lead to a build-up of bacterial load and sub-clinical infections causing a poor growth rate and low feed efficiency in subsequent batches, and may even result in a severe outbreak of disease.

After one batch has been sold, the feeders and drinkers should be removed, washed properly by scrubbing, and cleaned with medicated solutions like 2 percent Lysol, 4 percent Aldepol, 5 percent Formalin, 0.25 percent disinfectant or 0.2 percent Kem-V 260. These need to be left soaking in such a solution, scrubbed clean, washed again in plain water, dried in the sunlight and then stored in a clean place.

The leftover litter material should be removed to a manure pit at a suitably distant location and all adhering particles scrubbed. Water should be sprayed on the floor and sidewalls and the area swept clean. The weld-mesh, bottom of the roof, etc., should be dusted and cleaned to remove cobwebs. If a flame gun is available, the litter, cobwebs and feathers sticking to the floor, sidewalls and weld-mesh, etc. should be burned. Water under high pressure may be sprayed on the floor and fixtures to remove dried droppings. The entire area must then be sprayed with any reputable disinfectant (when quaternary ammonium compounds are used, metal containers must not be used for the solutions). Alternatively, if the cleaned house is empty, it may be disinfected by fumigation with formaldehyde gas. About 750 g of potassium permanganate and 1.2 litres of formalin for each 100 m^2 area may be used. During fumigation the sides have to be covered overnight with thick curtains. The walls and floors may then be whitewashed and the house or pen should be left empty for a minimum of two weeks (down time) before receiving the next batch of chicks in the area.

Arranging brooders

Broilers are received at the farm as day-old chicks and they require additional warmth during that early period for at least 2-3 weeks. To provide warmth, canopy brooders (the umbrella type with electrical-tungsten bulbs), tungsten bulbs, coal stoves or gas brooders may be used.

The common practice is to use a cover with electrical bulbs. The brooder arrangements should make about 24 hours before the anticipated time of arrival of the chicks. The litter material such as paddy husk, groundnut hulls, wood shavings or sawdust to 5 cm depth should be spread and covered by newspaper to prevent the young chicks from eating the litter. Chick guards of about 30-35 cm height should be arranged in a circular fashion. The diameter of these guards may vary from 150-240 cm for 175-400 chicks per unit respectively.

The height of the cover may be adjusted to 30 cm above the floor level initially. The required number of feeders and drinkers need to arrange on the covered floor area. Care should be taken to avoid placing all of them together at the centre under the source of heat. Two linear feeders of 60 cm in size and two chick drinkers may be used for every 100 chicks. Automatic feeders and drinkers may also be used according to the specifications of the manufacturers. Free moving space is needed on the sides of the drinkers and feeders.

The bulbs must be switched on 1-2 hours before the arrival of the chicks in order to ensure a warm environment.

Brooding of chicks

Plan the required number of chicks, book in advance with the hatchery, and contact and confirm the exact date and time of arrival of the chicks. When the chicks are delivered, do not allow the delivery van on to the farm premises. Take delivery at the entrance itself.

Have boiled and cooled drinking water ready. Add 8 g of glucose, 0.5-1 g of permitted antibiotic or antibacterial drug per litre, electrolytes and vitamin mixture at recommended dosage to the water for the first day. Antibiotics and vitamins may be continued for only 3-5 days. Keep medicated water in the drinkers before admitting the chicks into the brooder arrangement. Keep the feeders open for five hours and also spread a little feed on the paper.

Check whether the chicks are healthy and of uniform weight within the suggested range of 40-42 g each. Count the chicks, dip the beak of each chick in the drinking water and place it gently into the brooder arrangement. Check that the chicks move actively, scratching and taking feed and water. Place weak, inactive, unhealthy chicks with matted feathers at the back, and ask for replacements.

If kerosene stoves or coal stoves are used, a metal vessel with sand should be placed over the stove to dissipate heat properly. Heater coils may also be provided for warmth instead of bulbs. They have to be hung above the reach of the chicks.

It is necessary to verify whether the warmth given is sufficient for the chicks. During the first week, chicks require 35°C (95°F) warmth, which may be reduced by 2°C every week. A thermometer kept at the level of the birds will indicate the air temperature. However, a more practical way of assessing the adequacy of the warmth is by watching the behaviour and distribution of the chicks within the brooder guard arrangement. If they crowd under or near the source of heat, then the warmth given is not sufficient. Then a bulb may be added to the cover, or the height of the cover may be reduced. If chicks have moved to the periphery and are reluctant to come to the centre under the heat source, the temperature is too high. Then the cover must be pushed up or a bulb removed. If the chicks feel comfortable at the given temperature, they walk actively throughout the area unmindful of the heat provided and some will rest with their head on one side in the posture called "chick comfort".

In practice, the cover should be put on for 23½ hours in a day for the first 3 days, and switched off for only 30 minutes during night. Later on, lighting for heat may be given during the night only, up to the end of the second or third week, depending on the season. It may be restricted to one week only during peak summer and extended to three weeks during winter or rainy seasons. In such seasons, it is advisable to close the sides of the house with thick curtains during the first week.

Growing management

Newspaper spread on the litter may be removed after three days and the chick guard arrangement may be dismantled after eight days. The drinkers and feeders have to be changed after the second week and at the fifth week, and larger-sized equipment needs to be provided to allow adequate space for feeders and drinkers, as already suggested.

Clean, potable water should be provided. In the early morning, as the first duty in the daily routine, the drinkers should be emptied, cleaned and filled with fresh water. Water must be given twice daily and feed four times a day. Fill the drinkers and feeders only to two-thirds of their capacity. Take care not to spill water on the litter. If conventional chicken drinkers and plastic basins are used, have one spare set and clean the used set in the sun every day.

Feeding of broilers should be done in two phases. During the first three weeks, broiler starter mash with 23 percent of crude protein and 2 900 Kcal per kg of metabolic or metabolized energy (M.E.) must be fed, and this should be repeated after three weeks. Until they are marketed, broiler finisher mash with 21 percent crude protein and 3 000 Kcal per kg of M.E. must be given. The method of preparing broiler mash is described separately. The broilers may also be fed in three phases from 0 to 2 weeks, 3-4 weeks, and from the fifth week to market age. Accordingly, different feed formulations have to be made for the three phases.

During feeding and watering, the birds should be disturbed as little as possible. If possible, the same person should attend to each batch. Feeding and watering may also be done at the same time every day to minimize stress.

Take all possible steps to avoid feed wastage. Provide an adequate number of feeders; make provisions to adjust the height of feeders so that the brim of the feeder or drinker is at the same level as the back of the growing broiler.

Watch the growth of the broilers up to market age by weighing at least ten birds of average size at the end of every week to make sure that they are gaining weight normally and that there is no sudden drop in growth rate. If the growth rate is lower than normal, the farmer has to check the quality of the feed for the presence of toxins, adequacy of protein and amino acid levels (lysine, methionine, etc.). The possibility of any sub-clinical infection should also be monitored. Watch the daily consumption of feed and water, as any drastic change has to be investigated.

TABLE 3.1 Growth performance and feed efficiency of broilers

Age (wk)	Average Body weight	Feed efficiency	Water intake/ 1 000 birds/day (litre)
1	150	0.85	35
2	340	1.04	60
3	640	1.30	120
4	980	1.48	180
5	1340	1.64	230
6	1720	1.82	280
7	2100	2.02	320

Table 3.1 gives the average weight of a broiler and feed efficiency anticipated at the end of the week, as well as the daily water consumption by 1 000 birds at the respective age (although water and feed consumption will vary depending on the season). Feed consumption will go down and water consumption will increase during summer, and during winter or the rainy season, water consumption will decrease and feed consumption will go up. Accordingly, feed efficiency will be better during summer and poorer during winter.

Litter management

Broilers are usually reared on deep litter only. The materials commonly used as litter are paddy husks, groundnut hulls, sawdust, wood-shavings, coir pith, chopped straw, bagasse and even sand. The choice of litter material depends mostly on cost and local availability of the material.

A total litter height of 5 cm is sufficient. The litter should be kept as dry as possible. After two weeks, it is advisable to rake the litter every day in the morning with the help of a spoke, so that caked material is broken up and exposed to facilitate drying. Remove drinkers and feeders while raking the litter, to avoid spillage. Moisture levels in litter material will increase every day because of the water in bird droppings. If it goes beyond 25 percent, excess ammonia will be produced.

If ammonia levels in the air exceed 25 ppm, the birds will be subjected to various stresses. There will be irritation of eyes and nasal membranes leading to conjunctivitis, as well as poor feed intake and growth rate. The birds will be predisposed to diseases like coryza, bronchitis, other respiratory diseases and also coccidiosis. Higher moisture levels in the litter may also cause lameness, disinclination to move, and weight loss.

To assess moisture levels in the litter, squeeze a handful. If the litter forms a cake, the moisture level is too high. If it crumbles into fine dust, the moisture level is very low, which will make the environment dusty. When the moisture level is optimum, it remains as a loose mass.

If the litter remains wet even after raking, add more fresh litter material. The addition of super phosphate at 2 kg per 10 m^2 area will help reduce the ammonia level. The addition of lime powder is not advisable.

Try to prevent excess moisture build-up by ensuring proper ventilation. Keep in mind the distance that should be maintained between broiler houses, and never attempt to recycle old litter for subsequent batches.

Lighting

To provide warmth for brooding, artificial lighting has to be given up to three weeks, as suggested earlier. Afterwards, it is recommended to provide a total photo-period of 16 hours per day (a photo-period is natural daylight + artificial lighting from roof level - one 60 w bulb for every 10 m^2 area). Lighting beyond the natural day length for a certain period is recommended to facilitate additional feed intake and improved growth rate. As birds have the habit of compensating feed intake, lighting beyond 16 hours per day will not be beneficial and will only add to the electricity bill. However, during summer, continuous night lighting except for a one-hour break is recommended.

Summer management

Broilers suffer most during summer because of their lack of sweat glands, feathered body and the high amount of fat below the skin. They suffer when the atmospheric temperature goes above 38°C. Sudden increases in the day temperature will increase their stress more than a gradual increase to the same level day by day. Temperatures beyond 42°C will cause a high death rate among broilers.

Improper design of poultry houses, greater width, side walls higher than the prescribed level, construction of houses closer to each other, asbestos or tiled roofing, high density of stock, etc., will increase heat build-up within the house and add to the summer stress. It is then necessary to reduce the build-up of heat in the building, or increase the rate of removing the heat from the house.

Ridge ventilation, provision of exhaust fans, ceiling or pedestal fans will help in eliminating the excess heat accumulated in the building. Insulation of walls, provision of false roofing, or the spreading of coir or paddy straw on the roof, will be immensely helpful in areas where the summer is very severe.

If the higher temperature is accompanied by relatively high humidity in the air, heat loss from evaporation by the birds is reduced. Spraying water on the birds is therefore not advisable in areas near the seashore. Sprinkling water on the roof, however, will help to bring down the house temperature during the day when the temperature reaches its peak.

The space allowed per bird may be increased during summer by 20 percent thus reducing the density of the stock and 30-50 percent more drinkers may be introduced. It is advisable to remove the feeders during the hot hours and allow feeding only during the early morning and late in the evening. Night lighting may be continued throughout the summer months to facilitate feed intake.

Summer stress leads to less feed intake, a poor growth rate and a higher rate of mortality. Because of reduced feed intake, the required nutrients may not be consumed. It is therefore necessary to reduce the energy level by 10 percent and to increase the levels of amino acids (lysine, methionine, etc.), vitamins and trace minerals in the feed. It is not advisable to store the ground broiler mash for more than 15 days during summer, as some nutrients may be lost.

Cool drinking water should be provided in copious amounts. Ice cubes may be added. Ascorbic acid (Vitamin C at 10 mg per kg of body weight), acetyl salicylic acid or chlorpromazine hydrochloride may be added to the water to reduce the stress. Furthermore, provision of B-complex vitamins and electrolytes in the water will also be helpful in alleviating summer stress of the broilers.

Marketing of broilers

The broiler farmer does not normally sell the mature broilers directly to the consumer. The broiler changes hands a few times before it reaches the consumer. The most common marketing channels involved in broiler marketing are:

Broiler farmer → Wholesaler → Retailer → Consumer

In this chain, the wholesaler enjoys a fixed margin as handling charges for bringing the broilers from the farmer’s premises to the retailer. However, depending on the supply and demand, the price that the farmer gets for his broilers varies considerably at different times of the year.

To overcome the vagaries of the business, some entrepreneurs have preferred to opt for contracted farming under vertical integration. Under this integrated system of broiler rearing, farmers are assured of a fixed income round the year, while the integrator takes care of the marketing activities.

Broilers are marketed as live or dressed birds. Most of the consumers in this region want the broilers to be dressed or freshly cleaned. If broilers can be sold on a dressed weight basis to canteens and hotels then they can be starved for about 12 hours before the time of slaughter.

Care has to be taken when catching the broilers for marketing. It is advisable to catch them in dim light with experienced people. If the broilers are driven for too long before being caught, they will lose weight during the catching and transport process. The broiler crates in which they are carried and stacked in the transport vehicles should be a minimum of 25 cm in height. In a 90 cm x 45 cm size crate, 12-15 birds can be transported depending on their size and the distance travelled. If the road is bumpy, broilers will show a greater weight loss in transit. It is advisable to provide adequate water before they are transported from the farm to retail sellers.

On dressing, a broiler will on an average yield about 72-76 percent of its live weight. The correct temperature of water for scalding (60°C) is essential, as is thorough de-feathering as well as removal of head, shank, intestines, lungs and kidneys. Meat such as breast, back, wings, legs, giblets (neck, liver, gizzard and heart) can also be sold as portions to meet consumer preference. The relative proportion of each portion will be: breast – 30.5 percent, back – 16.5 percent, thigh and legs – 29 percent, wings – 13 percent and neck and giblets – 11 percent.

Vaccination and disease control

Effective disinfecting of broiler houses between batches, and leaving a minimum of two weeks down-time as described earlier, is essential for effective disease control on a broiler farm. A mortality rate of 4 percent up to market age is admissible, but a higher mortality rate than this calls for strict disease control measures from the farmer. When the all-in-all-out system is used, mortality may be as low as 2-3 percent.

Vaccination of broilers against some specific infectious diseases is essential. A vaccination schedule for broilers is given in Table 3.2; the farmer is advised to consult a local veterinarian for the exact schedule to follow.

TABLE 3.2 Suggested vaccination schedule for broilers

SI. No.	Age	Vaccine	Remarks
1.	0-day at hatch	Mareks' disease Vaccine	Make sure that the same has been given at hatchery itself
2.	5th day	F/Lasota (NCD Vaccine)	Drops into nostrils/eye or in water
3.	14-16th day	IBD or Gumboro (Intermediate)	Optional-consult the local veterinarian
4.	28th day	Lasota (NCD Vaccine)	In drinking water

Some precautions must be taken by farmers during vaccination to ensure the proper immune response. Ensure that the vaccine purchased was stored at sub-zero temperature levels in the shop and carry the vials only in ice-filled flasks. Follow the dilution and dosage as per the manufacturer's instructions, and use the reconstituted vaccine within two hours after dilution. Vaccinate during the cooler hours of the day with the minimum of stress to the birds.

Record keeping

Farmers should cultivate the habit of maintaining records to know the actual performance of the broilers. It is advisable to record batch performance on a record sheet in the format given in order to assess the efficiency and profit or loss of the farm.

Date of Receipt: **Nº Received:** **Strain:**

Date	Age in days	Opening Nº	Deaths	Sales	Feed issued	Medicines/ vaccines	Remarks

Date and Age at marketing			
Nº sold	:	Mortality	:
Total weight	:	Av. Weight/bird	:
Rate at which sold	:	Av. feed consumption/bird	:
Income by birds	:	Feed Efficiency	:
Income from gunny, manure	:	(FC/Live weight)	
Total chick cost	:		
Total quantity of feed consumed	:		
Total cost of feed consumed	:		
Cost of medicines, vaccines	:		
Cost of litter, electricity	:		
Other expenses	:		
Total Expenses	:		
Total Income	:		
Net Income	:		

ECONOMIC TRAITS OF BROILERS

The factors or characteristics of broilers that influence profitability in broiler production are termed the economic traits of broilers. They are:

- Body weight at market age;
- Feed efficiency;
- Liveability at market age;
- Dressing yield.

Body weight at market age

This is the average live weight of a broiler when sold to market. It is obtained by dividing the total weight of birds sold by the number of broilers. Since the broilers fetch a price based on their body weight, it is an advantage if the birds are heavy at an early market age (fast-growing).

The body weight at market age depends on many factors, and knowing these will enable the farmer to rear his birds more efficiently.

Strain: Different commercial strains have different growth potentials. A very fast-growing strain may not withstand substandard management, and if the growth is faster, mortality may be high. The farmer should select the strain of birds, which shows a lower mortality rate under his conditions, and higher total aggregate weight at market age.

Disinfecting: Mere cleaning and whitewashing of the broiler house does not constitute disinfecting. It is necessary to apply at least one chemical disinfectant or to fumigate with formaldehyde. In addition, dry heat should be applied on the floor, sidewalls and mesh with a flame gun.

Down-time: The farmer must ensure that each broiler house or pen is left empty for a minimum of 10-14 days after each batch reared is sold to the market and the pen is cleaned. This enables the residual disease-causing organisms to die. If this is not done and repeated batches of broilers are raised in the same area, such organisms multiply and adversely affect the growth and performance of the subsequent batches of birds.

System of rearing: Higher body weight is obtained when the all-in-all-out system is used compared to the multiple-batch system.

Water sanitation: When the bacterial quality of the drinking water for the birds is not optimal, it is advisable to provide only chlorinated or sanitized water for the broilers except when medication and vaccination are administered in the water. If not, the microbes in the drinking water will colonize in the birds' intestines and bring down the growth rate.

Feed and Feeding: Feed is the single most important factor that influences the growth rate. It should contain the required nutrients at recommended levels. It is better to feed the broilers 4-5 times a day. It is not enough to provide the required quantity of feed in one or two instalments only. The act of feeding induces the birds to take more feed. The higher the feed intake, the better the body weight will be.

Night lighting: Even after three weeks, it is better to provide four hours of additional lighting to broilers during the night to facilitate higher feed intake. It is, however, not necessary to provide continuous night lighting.

Watering: If manual drinkers are used, it is better to have a spare additional set so that one set can be cleaned and sun-dried every day before usage. Even with automatic drinkers, the pipelines and basins should often be washed with a mild disinfectant solution.

Floor space: Allot 900 cm^2 per bird from one day old. But restrict the growing area to 360 cm for two days old up to the third week and 600 cm^2 per bird up to the fifth week with the help of temporary partitions. Limiting the floor area according to age per body weight helps the broilers put on more weight.

Growth promoters: Several growth promoters like nitrovin, cyproheptadine and trace mineral supplements are available on the market.

Housing design: The housing design should facilitate proper ventilation, heat and ammonia removal as well as optimal light intensity. The overhang should be of sufficient length to prevent direct sunlight and rainwater from causing damage, and should keep light intensity at optimal levels. Higher light intensity in the broiler houses may hamper the growth rate.

Season or Climate: During summer, as the feed intake decreases, the body weight obtained will also be less. Then more floor space should be provided, and the number of drinkers should be increased. Feed only during the cooler times of the day, and increase the amino acid and the concentration of other nutrients in the feed.

Feed efficiency

The term indicates the quantity of feed required to raise the live body weight by one unit. Since feed involves 70 percent of the cost of production, feed efficiency or efficiency of feed conversion by the broilers, largely determines the profit margin. It is calculated as:

$$\text{Feed efficiency} = \frac{\text{Quantity of feed consumed by a batch (kg)}}{\text{Total live weight of broilers marketed (kg)}}$$

For broilers, a feed efficiency of 2.00 i.e. two kg feed to one kg live body weight is considered optimal. The lower the feed efficiency value, the better it is for the farmer. The factors influencing feed efficiency are:

Strain

Quality of feed: Feed efficiency is at its best when the required nutrients are provided at the appropriate level in the feed. Toxin-free feed must be ensured.

Energy level of feed: If the energy level of the feed is higher, the feed intake will be less but the feed efficiency will be better. For this reason, some feed manufacturers add low-cost animal fat or vegetable oil to broiler finisher mash when better-feed efficiency is desired.

Feeding: Avoiding feed wastage will naturally lead to better-feed efficiency. The height of feeders should be adjusted so that the back of the feeder is level with the back of the growing birds. Always fill feeders to two-thirds of the height of the feeder. Instruct the attendants to be careful not to spill feed during feeding. Feeding four to five times in small instalments will help improve feed efficiency.

Growth promoters: The usage of growth promoters in feed helps to improve feed efficiency.

Climate: In summer, broilers take less feed than in winter and in rainy seasons when they need more feed to maintain body temperature. Accordingly, feed efficiency is better in summer and poorer in winter and rainy seasons.

Floor space: Adjust floor space availability as per age and body weight of the broilers.

Role of microbes: If the microbial quality of water is poor, or disinfecting is not properly done, or if rodent control is not efficient, and feed quality or feed storage conditions are poor, microbes gain entry into the broilers, colonize the intestines, affect the nutrient absorption from the gut, feed upon the nutrients, and bring down feed efficiency. The all-in-all-out system results in better-feed efficiency.

Mortality: A higher mortality rate will bring down the total weight of broilers at market age and lead to poor feed efficiency. Adoption of appropriate disinfecting and disease control measures to keep the mortality to a permissible rate is therefore most important.

Liveability at market age

$$\text{Liveability} = \frac{\text{Number of birds alive at market age x 100}}{\text{Number of chicks purchased}}$$

Under standard rearing conditions, 96 percent liveability is anticipated at market age, since the mortality rate should not exceed 4 percent.

The factors influencing liveability are:

- Strain;
- Housing design;
- Disinfecting and other disease control measures such as medication and vaccination, etc.;
- Standard of management of, for example, brooding;
- Extremes of climate;
- Down-time between batches;
- System of rearing: livability is high under the all-in-all-out system;
- Quality of feed and litter material.

Dressing yield (percentage)

This is the proportion of edible meat to the total live weight, which varies from 72-76 percent. The strain of the bird, energy content of the diet, feeding and watering before slaughter and the length and time of transport are some of the factors that influence the dressing yield.

Chapter 4
Chicken: layer production

Layers are chickens reared for eggs. At the hatchery itself, day-old layer-type chicks are sexed mostly by vent sexing and only female chicks are sold to farmers for layer farming. The day-old male chicks are discarded.

SYSTEMS IN GENERAL USE

a) Layers are reared on deep litter floors, in cages or on different kinds of floors at different ages. Deep litter floor rearing involves rearing egg-type chicks or birds on any one of the preferred litter materials (paddy husks, groundnut hulls, wood shavings, etc.) spread on the floor. Cages of different sizes with different sized mesh need to be fabricated for rearing layer chickens of different ages.

b) The layer-type chicken starts laying at about 20 weeks of age and continues to lay at a good rate for another 52 weeks (a total of 72 weeks). To ensure a constant number of laying birds at all times, farmers tend to buy day-old chicks at fixed intervals until the farm is at its total capacity. Accordingly, the system of rearing layer birds is referred to as the 1+2, 1+3 or 1+1+5 system, etc.

Several commercial strains of layer-type chickens (BV-300, Bovans or Hyline) are available on the market. Their grandparent stocks are imported into the country from poultry breeders in developed countries. They are propagated by franchise hatcheries or breeder firms according to the guidelines of the breeder, and the commercial chicks are obtained, sexed and sold to the interested farmers.

Layer-type chickens require various nutrients at different levels and at different ages, and accordingly, their rearing is classified into three distinct phases, namely brooders (0-8 weeks), growers (9-20 weeks) and layers (21-72 weeks). The management practices to be adopted also vary at these stages.

PLANNING

The farmer should consult a qualified poultry consultant before starting a layer farm. He is also advised to undergo training on layer farming and acquaint himself with the necessary basic facts.

Layer farming requires a considerable investment per bird before eggs are produced and returns are realized.

System of rearing

Layer-type chicks may be reared on deep litter or in cages at all three stages. They may also be reared initially on deep litter up to one or two stages and transferred to cages at a later age.

Buildings

The design of buildings for rearing layer-type birds on deep litter is almost the same as that given for broilers. The specifications for width, length, sidewalls, floor and roof also apply for layer chicks. However, it is better to have a minimum distance of 30 m between brooder and layer houses. Furthermore, for cage rearing, the sidewalls for the houses need not be constructed, and the weld mesh covering may be extended up to the floor so that it permits free airflow for early drying of droppings accumulating at the bottom of the cages. The specifications for cages at different stages are described under the respective headings.

The number of buildings required varies according to the length of intervals between receiving each batch of chicks. Based on this, the layer farm may be established as follows.

1 + 2 pattern - One brooder cum grower house + two layer houses (chicks to be received at 28-week intervals)

1 + 3 pattern - One brooder cum grower house + three layer houses (chicks to be received at 20-week intervals)

1 + 1 + 5 pattern - One brooder house + one grower house + five layer houses and the chicks are to be received at 12-week intervals.

The layer farm may also be established according to the 2 + 6 pattern of receiving chicks at 10-week intervals.

Equipment

The conventional type of feeders and drinkers may be used on deep litter. Available space in a linear or circular feeder or drinker may be calculated as described earlier, and the required number of feeders and drinkers needed for the different ages may be calculated from the space allowed per bird.

BROODER OR CHICK MANAGEMENT (0-8 WEEKS)

Depending on the pattern adopted and the number of layer houses constructed, the total capacity proposed may be divided and the order placed for the required number of day-old layer-type chicks at suggested intervals. For example, if 15 000 is the total capacity proposed according to the 1 + 1 + 5 pattern, 3 000 chicks may be ordered, and received at 12-week intervals.

As for broiler chicks, brooding arrangements should be made to provide layer chicks with the required warmth. The brooder guards must be arranged in a circular fashion on the litter material with the necessary heating arrangements. The house may be prepared beforehand for this purpose and kept vacant for a considerable length of time (a minimum of two weeks). 225 chicks may be let into a brooder arrangement of 150 cm diameter and 300 chicks in a 180 cm size brooder guard circle. Brooder mash with 20 percent crude protein and 2 700 Kcal per kg of metabolisable energy must be prepared and provided. Good quality, potable, medicated water must be provided in the drinker. Check the health of the chicks when they arrive at the farm.

Litter management is the same as described for broilers. Lighting for brooding must be provided for 23 hours for the first three days and afterwards only during the night up to three weeks. Depending on seasonal requirements, adjust the length of lighting. However, layer-type chicks need not be provided with additional lighting after four weeks until they start laying at 20 weeks. If day length is about 10 hours, do not give any additional lighting at all. If chicks are reared during winter and the natural day length is likely to increase as the age of the bird advances, then provide light so as to maintain 10-12 hours per day constantly until the birds start laying. If the total amount of light is allowed to increase day by day up to the start of the laying period, the birds will start laying eggs early and the eggs will be smaller in size and will continue to remain so for a longer period, resulting in a lower price and a consequent loss.

The floor space allowance during the brooder stage is 675 cm^2 per bird. Feeder space allowance required is 1.0 cm per bird up to four weeks, 2.5 cm up to eight weeks. Drinker space allowance per bird for the same periods is 0.5 and 1.0 cm per respectively. Accordingly, the brooder house should be constructed with the required space for the number of chicks to be ordered at specified intervals. The required number of feeders and drinkers must be worked out and provided. Initially, smaller, more shallow feeders and drinkers will have to be provided. After three weeks of age, these should be changed to a larger and deeper size. Adjust the height of the feeders and drinkers to match the height of the growing birds to avoid wastage. Feed and water the birds twice daily at regular intervals.

Carefully watch the growth of the birds and monitor their water and feed consumption regularly. Table 4.1 gives a guideline, though feed and water consumption may vary depending on seasonal variations.

TABLE 4.1 Feed and water intake by 1 000 chicks

Age in(wk)	Feed intake/ week (kg)	Water intake/ day (litre)	Body weight at end of the week (g)
1	40	15	60
2	90	25	105
3	140	45	160
4	200	65	230
5	250	80	300
6	280	95	370
7	310	105	440
8	350	120	530

TABLE 4.2 Suggested vaccination schedule during chick stage (0-8 weeks)

SI N^o	Age in days	Type of Vaccine	Remarks
1	0 day	Mareks' Vaccine	Ensure that it has been given at the hatchery
2	5th-7th day	F/Lasota (Newcastle Disease Vaccine)	Drops at eyes/nostrils
3	14th-16th day	IBD Vaccine (Intermediate/killed)	Eye drops /s/c injection
4	20th day	Infections Bronchitis (IB) Vaccine	Drinking Water (consult Veterinarian)
5	24th day	IBD Vaccine (Intermediate)	Eye drops/ Drinking Water
6	28th day	IB Booster Lasota (NCD) Vaccine	Drinking water
7	45th day	Fowl Pox Vaccine	S/c or I/M injection
8	56th day	Coryza & Fowl Cholera Killed	Optional consult veterinarian

To avoid feed wastage, the chicks should be debeaked. Their beaks must be cut short by electrical cauterization. Debeaking, when carried out properly, need be done only once during the fourth week. It may also be performed at the end of the second week and repeated at 12-14 weeks. The upper beak must be cut to two-thirds and the lower beak to one-third. The cut portion must be cauterized by touching the surface with the hot plate. The tongue should be carefully held back. Perform debeaking during the cooler parts of the day. Provide antistress B-complex vitamins and vitamin K in the drinking water before, during and after the day of debeaking. Adjust the feeder and drinker height to be lower than before, to suit the shortened beak. Engage experienced persons to perform the debeaking properly to lessen the stress and to avoid the need to repeat the operation. Since layer chicks are comparatively more active, they tend to peck at each other's backs (cannibalism), which causes injury and even death. Debeaking helps to prevent such incidents.

The vaccines to be given to the birds at this brooder chick stage are given in Table 4.2.

Take care to buy good quality vaccines kept under proper storage conditions. Ensure correct dosage as per specifications. Vaccinate the birds with the minimum amount of stress. Follow other disinfecting methods and also bio-security measures to avoid outbreaks of disease and control the mortality rate.

Medication for layer chicks includes glucose and electrolytes on the first day and a mild antibiotic or antibacterial along with vitamin tonics for the first five days; later on, no medication need be given unless specifically required. Consult a veterinarian on the choice of the medicines available. Make a pre-mix of the weighed quantity of medicine in a limited quantity of water and then mix it thoroughly in the bulk of the water. Medication can also be administered in the feed.

Chicks can also be reared in cages from 0-8 weeks. Fix the cages at 75 cm above the floor level. Cages should be 180 x 90 cm in size and 30 cm in height. About 100 chicks may be reared in such cages with 160 cm^2 space per chick. The floor must be made of 1.25 x 1.25 cm size weld mesh of 16 gauge thickness. One 100 watt bulb on the top of the cage is sufficient for providing heat for brooding. For the first two weeks, small feeders and drinkers must be kept inside the cage and afterwards they may be fixed outside on the sides of the cage. For the first few days, it may be necessary to keep cardboard on the sides of the cages to prevent small young chicks from falling down through the sides.

GROWER MANAGEMENT (9-20 WEEKS)

Farmers often tend to neglect layer birds at this age. But it must be kept in mind that the reproductive organs of the birds, which will later produce eggs, undergo proper growth during this stage only so it is essential to provide appropriate care during the grower phase.

Growers may be reared in separate grower houses or they may remain in the brooder-cum-grower house. Floor space allowance has to be increased to 1 260 cm^2 per bird.

Feeder space to be given is 6-8 cm per bird. One linear feeder of 120 cm in length and 8 cm in depth must be provided for 40 grower birds. Raise the height of the feeder as their age increases.

Feed them with grower mash containing 16 percent crude protein and 2 700 Kcal per kg of M.E. up to 20 weeks of age. They may take approximately 60-80 g of feed per bird per day. It is not advisable to provide limitless feeding at this age, as the birds may then tend to put on more fat and their egg-laying rate will later be affected. To avoid this, monitor their growth as given below, and if birds are found to be over-weight, feed on alternate days or restrict the quantity of feed (only 75 percent of the normal quantity to be provided per day) to bring down the body weight.

Drinker space allowance during the growing phase is 2 cm per bird. A circular drinker 36 cm high and 8 cm deep with a capacity of 6 litres, should be provided for 50 growers. At this age, 100 birds will take about 1 520 litres of water per day. Provide fresh, cool, potable water twice a day.

TABLE 4.3 Growth pattern of layers in grower state (9-20 weeks)

Age in weeks	Body weight at end of the week (g)	Age in weeks	Body weight at end of the week (g)
9	615	15	995
10	695	16	1040
11	770	17	1085
12	850	18	1150
13	910	19	1220
14	960	20	1295

TABLE 4.4 Suggested vaccination schedule during grower stage (9-20 weeks)

SI N°	Age in weeks	Type of Vaccine	Remarks
1	10th week	K/R_2B (Newcastle Disease Mesogenic Vaccine)	I/M or S/C injection
2	12th week	Coryza + Fowl cholera (Booster-Killed Vaccines)	Optional- Consult Veterinarian
3	13th week	I.B. Booster – Live	Optional
4	14th week	Fowl Pox – Booster Vaccine	S/C or I/M injection
5	16-17th week	K/R_2B (NCDV) – Booster	I/M or S/C injection

Follow the litter management procedures suggested under broiler management. Take care to avoid spillage of water on the litter. Rake the litter often to bring down the moisture level.

If the natural length of day remains constant around 10-12 hours per day, or if it decreases during the growing period, no artificial lighting at roof level is necessary. If the length of day increases, then start giving additional lighting so as to maintain constant day length during the growing phase.

If necessary, repeat debeaking at 12-14 weeks of age following the precautions already given. The suggested vaccination schedule is given in Table 4.4

Often growers reared on deep litter suffer from roundworm infestation of the intestines and sometimes also from tapeworms, especially if the farm is located around wet fields. As a routine precaution therefore, the birds should be dewormed at 16 weeks of age or in the 18th week, a few days before they are to be transferred to laying cages. Otherwise, the worms eat the feed consumed by the birds and their health may deteriorate, which can hamper the onset of egg-laying. Piperazine, robendol, levamisole, thiobendazole and zodex are the drugs used to remove roundworms, while kalbend, panacur, taenil, helmonil and dicestal are used against tapeworms at the recommended dosage levels. Stop watering for two hours before administering deworming drugs and then allow limited levels of medicated water to ensure that the required dosage of medicine is consumed by the birds without any wastage through left-over water.

If necessary, delousing should be carried out by dipping in 0.25 percent weak pesticide (sumithion, malathion or sevin) solutions at 17 weeks, if birds seem to be affected by external parasites. Perform dipping only on hot, sunny days. Take care to avoid dipping the head into the medicated solution. Leave the bird outside after dipping, to facilitate drying by sunlight. External parasite infestation may be prevented by ensuring that the floors are solid without cracks, and painting the wooden supports with a petrol-and-oil mixture or 40 percent nicotin sulphate dilution.

Cull the poorly grown, injured and lame birds regularly. Ensure that mortality rates during brooding are below 4 percent, and 3 percent during the growing phase. Keep proper records on the number of chicks received, the feed intake, mortality rate, day-to-day culling, medicines and vaccines given, etc.

Growers can also be reared in cages. The floor should be made up of weld mesh of 1.25 x 5.0 cm size. In a cage of 180 x 90 cm size, 50 birds can be reared with a space allowance of 325 cm^2 per bird. Feeders and drinkers may be fitted lengthwise on the sides, one below the other.

LAYER MANAGEMENT (21-72 WEEKS)

Grower birds are transferred to layer houses at the end of the 18th week after deworming, dipping and protective vaccinations against Newcastle disease.

Layers can be reared either on deep litter or in cages. When reared on litter, litter material must be provided to a height of 12-15 cm. A floor space allowance of 1 800 cm^2 per bird must be given. Circular or linear feeders may be provided; feeder space allowance of 10-12 cm per bird must be given. A linear feeder 180 cm long and 10 cm deep will suffice for 35 layer birds. A free supply of feed at all times has to be ensured. Layer mash with 17 percent crude protein, 2 600 Kcal per kg of M.E, 2.75 percent calcium and 0.80 percent available phosphorous must be provided.

Circular plastic or aluminium water basins may be used. Use drinker guards on the drinkers at all stages of rearing, to prevent the birds from standing on the edge and tilting the drinker. Provide fresh, cool water twice a day. Provide a drinker space allowance of 2.5 cm per bird. During the laying stage, 1 000 birds will consume approximately 250 litres of water per day. A circular drinker of 45 cm in diameter and 7 cm depth will be sufficient for 50 birds. Automatic drinkers connected to a common water tank can also be provided.

Arrange the feeders and drinkers alternately at an equal distance; take care to adjust their heights to avoid feed wastage. Fill them only to two-thirds of their capacity at any time.

Nest boxes made of G.1 or aluminium sheets may be provided at 45 cm height – one for every three to five birds. The layers must be trained to get into the nest box to lay their eggs as eggs laid on the floor have a higher chance of breakage. The mouth of the box should be 30 cm wide and 20 cm deep. Some litter material may be spread inside the nest boxes. Some farmers tend to use pots as nest boxes as they provide a cooler environment for the birds experiencing stress while laying.

Layer cages

Most often, layer birds are reared in cages. Cages of various sizes are used to house three to five birds in a cage. Currently, reverse cages are used, with their longer sides fitted to remain in front. Lately, raised platform houses are being constructed, to facilitate quicker drying of droppings and their easy removal. The cages are constructed on a platform at a height of about 180-240 cm.

Cages of the following sizes may be made and fitted in rows:

45 x 30 cm	-	for 3 birds
45 x 40 cm	-	for 4 birds
50 x 35 cm	-	for 4 birds
50 x 45 cm	-	for 5 birds
60 x 37.5 cm	-	for 5 birds

These cages are arranged in two or three such rows next to each other on either side. They are called Californian cages. A floor space allowance of 420-450 cm^2 is provided inside the cages. Conventionally, the bottom of the lowermost cage is fitted at 75 cm height from the floor. Nowadays, they are fitted at 180-240 cm height above floor level, with walking platforms constructed on the sides.

The layer cage will be 40 cm in height. The floor is fitted with 2.5 x 5.0 cm 14 gauge weld mesh. On the sides, 7.5 x 7.5 cm 16 gauge mesh is fitted. The bottom floor is provided with a one-sixteenth slope downwards to the front to enable the eggs to roll to the cage front. The mesh rails on the cage floor should run from back to front and not sideways otherwise they will block the free run of the eggs to the front. Drinkers are fitted above the feeders in the front. Feeders and automatic drinker nipples or buttons may be provided in the cages.

Cages are fitted in two or three tiers on either side of the row under the Californian system. Two to three such rows of cages are arranged in a caged layer house. Depending on the number of rows and the number of tiers in each row, the breadth of the caged layer house ranges from 5-8 m. There is no stipulation for the length of such houses, which can be adjusted to the number of birds to be housed. No sidewalls are required for cage houses, as the mesh is stretched down to the floor level to facilitate better ventilation to dry the moisture in the droppings. The ‘elevated cage houses’ or raised-platform cage arrangement widens the gap between birds and their droppings, and facilitates quicker drying and easy removal of droppings.

Cage rearing facilitates easy management, easy collection of eggs, needs less space, gives a lower percentage of broken eggs, better egg weight, a cleaner egg production, easy culling and a reduced mortality rate.

Artificial lighting must be provided during the laying stage by a minimum of one 60 watt bulb for every 20 m^2 area. Start giving 20 minutes of additional lighting per week from 21 weeks of age and continue increasing it until a total day length (natural day length + duration of artificial lighting) of 16 hours per day is reached. It should be maintained at that level until 72 weeks of age. Day length should never be decreased during the laying period.

Egg laying starts at 20-21 weeks and the rate of laying (percentage production) increases every week to reach a level of 90 percent and above after 26 weeks of age, which is maintained well beyond 36 weeks of age, even up to 40-42 weeks. Afterwards, it comes down slowly to reach 70 percent or less by 72 weeks of age. When the egg production goes below 65 percent, it is uneconomical to retain the layers unless the egg price is exceptionally high. They are then sold to the meat market as spent hens.

Egg production may be calculated as the percentage of the total number of birds available at 21 weeks (hen-housed egg production) or the percentage of the number of birds available on each day (hen-day egg production).

Satisfactory egg production levels at different ages during the laying stage are given in Table 4.5 to serve as a guide to verify whether the birds are producing at the optimal level.

The layer type of chickens lay their eggs mostly during the period before noon. Eggs may be collected twice in the morning and once in the afternoon. The frequency of egg collection has to be increased to four or five times daily during peak summer. On large layer farms, it is preferable to have an air-cooled room for the storage of eggs. Specially designed plastic or cardboard trays must be used to collect eggs. Usually collecting trays with a 30-egg capacity are used. It is not advisable to collect eggs in baskets.

TABLE 4.5 Egg production by layers under optimal conditions

Age (wk)	Hen-day Egg Production (%)	Feed Intake/ 1000 birds/day (kg)	Water Intake/ 1000 birds/day (litre)
21	8	75	160
22	20	5	180
23	40	90	210
24	68	95	240
25	83	98	260
26	88	100	280
27	90	104	290
28	92	104	300
29	94	104	310
30	94	104	310
31	94	110	320
32-39	92	110	310
40-47	88	107	290
48-59	84	105	270
60-64	80	105	260
65-70	77	105	240
71-76	72	105	240

ECONOMIC TRAITS OF LAYERS

Economically important characteristics of layer-type chickens are:

- Age at the start of laying;
- Body weight at maturity;
- Number of eggs;
- Egg weight;
- Feed efficiency (per dozen eggs or per kg egg mass);
- Liveability.

Age at the start of laying

For a flock of layer pullets, the age in days at which a 5 percent egg production level is reached, is considered as the age of maturity. It usually falls at 21 weeks of age. Sometimes, the level may be reached even at 19 or 20 weeks, which is not desirable. It happens when additional night lighting is given to growers indiscriminately even after six weeks of age. If laying starts early, the eggs laid are smaller in size, a situation that continues for a long time, affecting the egg price and in turn, the profitability. Adopt a lighting schedule for growers as advised earlier. The strain of the birds and the quality of feed are two other factors that influence the age at which chickens start laying eggs.

Body weight at maturity

This characteristic decides feed efficiency, number of eggs and egg weight. The body weight of layers at the start of laying has to be optimal; it should be neither too low nor too high. Low body weight indicates poor growth of the egg-forming female reproductive tract, which in turn will result in poor egg production and egg weight. Higher body weight at maturity will lead to higher feed consumption and poor feed efficiency. If higher body weight is due to high abdominal fat, this will obstruct the oviduct (egg-forming tube) and will affect egg production. Strain and feed quality affect this characteristic as well.

Number of eggs

Commercial hybrid layers produce around 290-310 eggs in one year from 21-72 weeks of age. The strain of the bird, age and body weight at the start of laying, lighting schedule during growing and laying, feed quality (protein, energy, vitamins, mineral and trace mineral content and toxin-free feed), culling procedure, climate, managerial factors like space allowances, system of feeding, water quality, vaccination and other disease control measures, all influence the number of eggs.

Egg weight

This varies from 52-56 g on average. Egg weight is mainly dependent on the body weight of the birds. Birds at a later stage of production are comparatively older and heavier and lay larger eggs. The first eggs in a clutch (series of eggs laid daily without a break) are always heavier than other eggs in the series. If the total number of eggs laid in a laying cycle of one year is comparatively smaller, individual egg size by such strain of birds is normally larger, and if the egg number is larger, the egg size will be comparatively smaller. To overcome this and to decide which strain is preferable, another characteristic known as 'egg mass' is considered. This is the total weight of eggs laid by a bird in a laying cycle. It depends both on the number of eggs and the average weight of an egg. All other factors such as quality of feed, managerial factors, age, strain, etc., which influence body weight also have an influence on egg weight.

Feed efficiency

This denotes the efficiency of the conversion of feed into eggs. Feed efficiency of layers is calculated in terms of conversion into number of eggs (per dozen eggs) or weight of eggs (per kg egg mass)

$$\text{Feed efficiency (per dozen eggs)} = \frac{\text{Average quantity of feed consumed (kg) by a bird in a laying cycle}}{\text{Average number of eggs per bird in dozens}}$$

$$\text{Feed efficiency (per kg egg mass)} = \frac{\text{Quantity of feed consumed (kg) by a flock}}{\text{Total weight of eggs (kg) produced by the flock}}$$

The feed efficiency of a layer depends on the strain of the bird, average egg number, egg weight (in the latter case), quality of feed (energy, protein and contents of other vital nutrients, presence of toxins if any, inclusion of performance promoters, etc.), managerial care (space allowances, system of feeding, feed wastage, proper debeaking, deworming, insect and rodent control), climate, disease control measures, etc. The average feed efficiency values according to method (i) vary from 1.7-1.8 and according to method (ii) from 2.3-2.4, under average Indian conditions.

Liveability

The liveability percentage is calculated separately for each of the three stages of layer management viz., in brooder (0-8 weeks), grower (9-20 weeks) and layer (21-72 weeks) stages. Permissible levels of mortality during these stages are 4 percent, 2-3 percent and 6-8 percent respectively. Accordingly, liveability levels of 96 percent, 96-97 percent and 92 percent are prescribed as optimal for these stages independently of each other. Strain, feed quality, litter management, vaccination schedule and other disease control measures, disease outbreaks, layout and design of poultry houses, climate, bio-security measures adopted, dead bird and manure disposal, parent breeder management and hatchery sanitation, etc., all influence liveability levels in layers.

Some undesirable characteristics noticed amongst layers are as follows (together with the means of preventing them):

Broodiness

Birds may develop the tendency to sit on the eggs for hatching purposes and make peculiar noises. Their egg production will suffer. To avoid this, collect the laid eggs frequently, ensure an adequate number of nest boxes, segregate such birds and keep them separately for two or three days.

Egg eating

Some birds may break the egg and attempt to feed on it. Ensure adequate floor space, collect eggs frequently, have an adequate number of nest boxes, and ensure the required level of protein and minerals in the feed.

Prolapse

When this occurs, after laying eggs, the egg tube hangs out. Other birds may peck at it and cause injury and death. Follow the proper lighting schedule during the growing period. Segregate the affected birds and restrict their feed. Ensure adequate floor space and reduce any dustiness of feed.

Cannibalism

An indication of this is when birds peck at each other’s backs. Ensure proper density and adequate fibre in the diet. Proper debeaking and light intensity will reduce cannibalism.

Other measures

Keep proper records of egg production. Seek professional help whenever egg production drops abruptly.

At 40 weeks, and afterwards at two-month intervals, deworm the birds regularly. Do not deworm the birds when they are in peak production.

Lasota (NCD) vaccine in the drinking water may be repeated at 40 weeks.

Try to schedule the arrival of the chicks so that the peak production period does not fall during mid-summer (do not buy replacement chicks between November and January).

The mortality rate during the laying period (one year – 21-72 weeks of age) should be below 8 percent. Follow water sanitation, culling and bio-security measures properly.

Identify the non-laying birds and cull them regularly. It is easy to find such birds in cage rearing. On deep litter, the following guidelines may be followed to identify the non-laying birds. The head and comb of such birds will be small and appear shrunken. They may be strongly pigmented in a yellowish or reddish colour. Their stomachs appear more rounded with accumulated fat. Their feather coat will be dense and shiny. By contrast, high producing birds will have bright eyes, large, pale combs, a tucked-up stomach and dirty, fallen feathers. If birds are checked individually, non-laying birds will have only a one-finger space between bony cartilages at the bottom and a two-finger space on the sides. High-laying birds will have two and four finger spaces respectively. Non-laying birds may be identified early and culled to save feed cost.

Fly control

Flies pose a major problem, especially where layers are reared in cages. The wet droppings collected below the cages offer an optimal environment for the flies to lay their eggs and multiply. Birds on litter can consume the flies and control the problem, however, with birds in cages this is not possible.

The flies irritate the birds, reduce the feed intake and affect egg production and are a nuisance to the workers. They also lay their eggs on the eggshells which mars their appearance and they spread several diseases.

To control the fly problem, avoid stagnation of water on or around the farm premises and maintain water pipelines properly. Treat the appearance of watery droppings immediately. Cut and remove the weeds and shrubs around the farm. The drug larvadex may be given to the birds in their feed, to kill the larvae. Fly-control drugs like Anumet, Cythion, Nuvan, Sevin, Sumicidin, Treban, Rukrin and Fudox, may be used according to specifications as a spray or as powder on the droppings once in two weeks. Take care that these drugs do not accidentally get into the feeders or drinkers.

Marketing of eggs

Eggs can be collected and stored at room temperature on the farm premises for three to seven days depending on climatic conditions. Sometimes traders supply feed, take back the eggs and pay the excess money to the farmers. Eggs are usually graded according to their weight. As specified by ISI, four such weight grades are identified: extra large (60 g and above), large (53-59 g), medium (42-52 g) and small (38-44 g). However, in local markets, eggs are graded and sold as pullet (eggs of young layers), small, and normal. It is a highly arbitrary classification and no official grading procedure is adopted or implemented.

Chapter 5
Poultry feed formulation and preparation

Feed is the largest single item of expenditure, accounting for more than two-thirds of the total cost of production of broilers and eggs under the prevailing prices. Moreover, the cost per kilogram of feed is increasing day by day without any proportionate increase in the selling prices of broilers or eggs.

The annual requirement of poultry feed in India is about eight million tons. A major portion of it is prepared on the farm or by custom-mixing. Only about 20 percent of the requirement is met by the organized sector. If both feed formulation and mixing are practised scientifically, the current production level of all birds in the region can be improved substantially.

The poultry farms can be made more remunerative by preparing their own feed. Before the farmer can think of mixing own feed, he should understand what nutrients are, as well as the requirement levels needed by the birds.

Nutrients

Nutrients are essential substances present in different types of foods which perform various life-sustaining functions in the body. They are required for growth, maintenance and the reproductive process and a deficiency of nutrients in the feed below the required level results in the development of diseases referred to as "deficiency diseases".

Poultry require more than 40 such nutrients, which are classified into six major groups based on their chemical nature, their functions or role, and the method in which they are determined. The groups of nutrients are:

- Proteins;
- Carbohydrates;
- Fats;
- Minerals;
- Vitamins;
- Water

These groups of nutrients are present both in the poultry feed and in the bodies of the fowls. However, they are not directly transferred from the feed to the tissues, but are split in the bird's body during digestion, absorption and the rebuilding process.

The various functions performed by each nutrient and the requirement needed by poultry vary between from nutrient to nutrient:

Protein

Proteins are considered the building blocks of the body. They are essential for proper growth and for building health. Most materials used as ingredients in poultry feeds contain some protein. Grains generally contain 8-9 percent of crude protein but cannot meet the bird's total protein requirement. It is therefore necessary to include other ingredients, which contribute higher levels of protein. Oil cakes are good sources of vegetable protein, while dried fish and meat meal supply animal protein.

The amount of protein required by broilers varies considerably according to age and level of performance. There is a high demand for protein at the early stages of development. Moreover, the energy level of the ration also decides the protein requirement; the higher the energy level, the greater the percentage of protein required.

Protein is made up of several amino acids and it is necessary to know the composition of any protein-rich ingredient in terms of its constituent amino acids. Even though more than twenty amino acids have been identified, only ten are considered essential in poultry feed. They are arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. Of these, lysine and methionine are considered as the critical amino acids, since poultry feed which is deficient in these two amino acids severely hampers the growth rate of broilers and the egg production in layers. The requirements of methionine and cystine are considered together, since the deficiency of cystine can be met by an extra supply of methionine.

The amino acid composition of proteins from different protein sources varies widely. The values of most of the ingredients used in poultry feed are available. If there are insufficient quantities of the essential amino acids present in formulated poultry diets, this is reflected in poor growth, poor egg production or poor feed efficiency. Balancing the amino acid input to ensure that the essential amino acids are present at the required levels, is therefore one of the most important factors in formulating poultry feed, because the levels of the amino acids occurring in feed ingredients may not match the birds' requirements. Some may be excessive, and others may be deficient.

Carbohydrates and Fats

Birds require energy or fuel to maintain their body heat, to keep the body systems running continuously and to perform different types of functions. Birds derive their supplies of energy from two major groups of nutrients: carbohydrates and fats/oils.

Carbohydrates and fats are not actually taken into consideration when defining the nutrient requirements for poultry. Instead, the metabolisable energy (ME) value is the one most frequently used to describe the energy value of ingredients and compound rations for poultry. The ME values of most of the feed ingredients have been compiled and are available for ready use. These are calculated as gross energy minus energy voided through droppings (faeces + urine) and gases, and is expressed as kilocalorie per kilogram of feed: 1 KCal = 4.18 KJ.

The energy content of the feed determines the quantity of feed intake by birds. If the energy level is lower, the feed consumed per day is higher, and *vice versa*. The total intake of other nutrients in the feed is therefore also influenced by the energy content of the feed. It is then necessary to adjust the density of different nutrients present in poultry feed, not only to the requirements of the bird but also to the expected feed intake per day which is determined by the energy content of the feed. Since most of the vitamins and minerals are normally provided in poultry feed well in excess of the daily requirement, it is customary to adjust only the protein content to the energy content. This relationship is referred to as the calorie: protein ratio or the C: P ratio, which is more important than the total requirement of energy or protein. It is the number of energy units for every percent of crude protein in the compound poultry feed. If the ratio is broad, the relative proportion of energy content is high, and if the ratio is narrowed down, that of crude protein in the feed is high.

Other factors that influence the appetite of the birds and therefore the feed intake, also need to be taken into consideration when deciding the C: P ratio of the feed. For example, climate and disease are two important factors governing the feed intake. In summer, feed intake goes down and the same happens during bouts of disease. It is then necessary to reduce the energy content of the diet and increase the concentration of the nutrient, especially that of critical amino acids and trace minerals. However, the source of energy also plays a role during summer, and the help of a poultry nutritionist has to be sought to formulate poultry rations suitable for summer or winter. In winter, the energy requirements to maintain body heat are high and therefore the feed intake increases; it is then necessary to broaden the standard C: P ratio. In times of disease the appetite, and in turn the feed intake, is poor. The net intake of all nutrients therefore becomes less. The birds then suffer from nutrient deficiencies and their resistance to disease is lower and the effect of disease on production is more severe.

Vitamins

Vitamins are complex compounds, which play an important role in metabolism. Even although they are required in relatively small amounts, the presence or absence of vitamins makes all the difference between profit and loss in poultry farming. Good growth, the prevention of weakness of the legs and thickness of eggshells all need precise vitamin levels. Vitamins occur in many naturally available feed ingredients. They can also be added as supplements to meet the birds' requirements.

Vitamins are classified into two groups, namely, fat-soluble vitamins and water-soluble vitamins. The fat-soluble vitamins are vitamin A, D, E and K. The water-soluble vitamins are the B complex group of vitamins, and vitamin C. Vitamins in the B complex group are thiamin (B_1), riboflavin (B_2), niacin, pantothenic acid, pyridoxine, biotin, choline, folic acid and cobalamine (B_{12}). Vitamins, A, B_2 and D_3 are called "critical vitamins" for poultry, as any deficiency in their availability severely impairs the growth rate and egg production. The roles of different vitamins in poultry production are listed in Table 5.l.

TABLE 5.1 Vitamins and their functions

Vitamin	Important Functions	Deficiency Symptoms
A	Growth, health of eyes and moist surfaces of the body	Poor growth, respiratory Symptoms
B_1 (Thiamin)	Maintains appetite, helps in digestion, preserves health of nerves	Poor growth, nervous symptoms
B_2 (Riboflavin)	Promotes growth	Poor growth, curled-toe paralysis
Pyridoxine	Promotes growth	Poor growth, convulsions
Pantothenic acid	Heathy skin, growth	Crustations at corners of mouth and feet, fatty liver, kidneys
Biotin	Promotes growth	Crustations at the bottom of feet
Folic acid	Promotes growth, feather development	Poor growth and feather development, paralysis
Choline	Bone development, fat metabolism	Sitting on hock (Perosis)
B_{12}	Normal growth and feathering	Very poor growth
D_3	Utilises calcium and phosphorus in bone development and eggshell formation	Poor growth, curved legs, leg weakness, thin-shelled eggs, reduced egg production
E	Maintains brain structure and anti-oxidant	Crazy behaviours, muscular weakness
K	Blood clotting	haemorrhages

Vitamin supplements must be stored in lightproof conditions at temperatures not higher than 72°F to avoid storage loss. Vitamins A, D_3 and E oxidise easily and can be destroyed by adverse conditions of heat, light, or moisture, and also by contamination or contact with certain minerals. To prevent this, margins of safety are allowed by providing 30-50 percent more of the fat-soluble vitamins than the estimated requirement. By contrast, water-soluble vitamins like biotin, riboflavin, folic acid, pyridoxine and choline are more stable, and losses do not normally arise during the process of milling and mixing. Thiamin (B_1) is sensitive to heat and light.

Minerals

About one percent of the broiler meat and 11 percent of the eggs are made up of minerals, while bones contain about 40 percent minerals. Minerals are also found in all body tissues and fluids, and perform many important functions like the formation of bone and eggshell, clotting of blood, etc. Feed ingredients of animal origin contain more minerals; those of vegetable origin have a lower proportion. As minerals found in common feedstuffs may not supply the birds' requirements, mineral supplements are added to the ration to overcome the possible development of deficiency symptoms.

The minerals required for poultry are classified as "macro", "micro" and "trace" minerals, depending on their requirement level. The macro minerals are calcium, phosphorus, potassium, sodium, and magnesium; the micro minerals are iron, manganese, zinc, copper and iodine, and the trace minerals are cobalt, fluorine, selenium, molybdenum, etc. The importance of different minerals in poultry nutrition is set out in Table 5.2.

TABLE 5.2 Minerals and their functions

Minerals	Important Functions	Deficiency Symptoms
Macro minerals		
Calcium	Formation of bone, blood clotting, heart function, egg production	Poor growth, soft bones, thin shelled/shell-less eggs, poor egg production
Phosphorus	Bone development,	Poor growth, soft bones egg production, use of carbohydrates
Magnesium	Several vital metabolic functions	Slow growth, lethargy, loss of appetite, spasms
Sodium and Potassium	Constituents of blood, bile and body fluids, for growth, digestion, acid-base balance.	Poor growth of muscles (excess: loose droppings, reduced production)
Micro Minerals		
Manganese	Bone formation and use of phosphorus	Staggering gait, enlarged Joints
Zinc	Activation of several body enzymes	Poor growth and feathering, shortening of leg bones
Iron & copper Iodine	Blood pigment formation, body activity, constituent of thyroid	Anaemia, impaired body response, lowered activity
Trace minerals		
Selenium	Muscular functions immunity development	Muscular dystrophy, poor immune response
Cobalt	Constituent of Vitamin B_{12}	Poor growth

Excessive levels of some minerals may also be harmful. In practice, the levels of calcium, phosphorus and salt (sodium chloride) are calculated, and specific ingredients or mineral mixtures are added to meet requirements. Limestone, di-calcium phosphate, shell grit, common salt etc. serve the purpose. The trace minerals are supplied by adding a trace-mineral supplement, and there is no need to consider each of them separately.

Water

Water makes up about 60 percent of the composition of the bird's body. Birds can survive for a long time, even two to three days, without taking in solid mash, but suffer very quickly, within 12 hours, if there is a shortage of water. A free supply of cool, fresh, clear, potable water should therefore be ensured throughout the day.

Nutrient Requirements

As birds are fed in groups, the nutrient requirements are not expressed on an individual basis; but are expressed in unit weight of feed, and hence feed intake by the bird influences the nutrient requirements.

Nutrient requirements of birds are also influenced by the age and size of the bird, production level, energy content of the ration, physical form of diet, sex of the bird, nutritional adequacy of the diet, and environmental temperature. Prescribing a common list of quantities of nutrients for birds at all seasons, for different ages and under all conditions, is therefore an extremely difficult task.

However, bearing in mind all the factors that may modify the nutrient requirements, the nutrient allowances for broilers and layers reared in the tropics are given in Tables 5.3 and 5.4. Some adjustments need to be made based on the existing conditions and the area where the birds are reared.

To allow for variations in composition of feed ingredients, to avoid loss during storage, to allow for nutrients destroyed in the digestive tract, and to allow for stability of the nutrients, an increase in the supply of the nutrients over the minimum requirement is made as a safety margin. Minerals and vitamins are more prone to destruction, as stated earlier. For the majority of the vitamins, usually twice the required amount is added as a safety margin. The minimum requirement of trace minerals may be supplemented above any safety level present in the feed ingredients.

Feed additives

A feed additive or a supplement is a substance or mixture of substances other than the basic feedstuff. It is used in small quantities, usually at less than one percent, in the compounded feeds and supplements certain nutrients and non-nutrients to improve the quality of the feed and the performance of the birds.

TABLE 5.3 Nutrient requirement (minimum) of commercial broilers in tropics and subtropics

Nutrients		Starter Feed (0-3 weeks)	Finisher Feed (>3 weeks)
Metabolizable Energy	(KCal/kg)	2 900	3 000
Crude Protein	(%)	23	21
Amino acids			
Lysine	(%)	1.20	0.95
Methionine	(%)	0.46	0.38
Methionine + Cystine	(%)	1.00	0.85
Minerals			
Calcium	(%)	1.1	1.0
Available Phosphorus	(%)	0.5	0.45
Manganese	(mg/kg)	75.0	75.0
Zinc	(mg/kg)	65.0	65.0
Iron	(mg/kg)	60.0	60.0
Copper	(mg/kg)	6.0	6.0
Iodine	(mg/kg)	0.9	0.9
Selenium	(mg/kg)	0.'1	0.1
Vitamins			
Vitamin A	(l.U./kg)	6000	6 000
Vitamin D_3	(I.U./kg)	1200	1 200
Vitamin E	(mg/kg)	20	20
Vitamin K	(mg/kg)	2	2
Choline	(mg/kg)	1500	1 500
Riboflavin (B_2)	(mg/kg)	5	5
Biotin	(mg/kg)	0.1	0.1
Vitamin B_{12}	(mglkg)	0.015	0.015

TABLE 5.4 Nutrient Requirement (minimum) of commercial layers

Nutrient		Brooder Mash (0-8 wks)	Grower Mash (9-20 wks)	Layer Mash (21-72 wks)
Metabolizable Energy	(KCal/kg)	2750	2700	2600
Crude Protein	(%)	20	16	17
Amino acids				
Lysine	(%)	1.1	0.75	0.70
Methionine	(%)	0.44	0.40	0.30
Minerals				
Calcium	(%)	0.9	0.9	2.75
Available Phosphorus	(%)	0.45	0.45	0.80
Manganese	(mg/kg)	90	50	60
Zinc	(mg/kg)	60	50	75
Iodine	(mg/kg)	1	1	1
Copper	(mg/kg)	12	9	9
Vitamins				
Vitamin A	(IU/kg)	6 000	4 000	8 000
Vitamin D_3	(IU/kg)	600	600	1 200
Vitamin E	(mg/kg)	15	10	15
Riboflavin (B_2)	(mg/kg)	6	5	6
Vitamin B_{12}	(mg/kg)	0.015	0.01	0.01

Functions of Feed Additives

Different feed additives perform different functions. They are added to poultry feed in order to:

- prevent various deficiency diseases, other diseases of nutritional origin, and certain bacterial and parasitic diseases;
- improve the nutritive value of the feed and feed efficiency;
- improve the growth rate and egg production;
- protect the birds from stress and improve their immune status;
- prevent spoilage of feed because of microbes, rancidity and other physical conditions;
- enhance colour, flavour, palatability and general appearance of the feed and make it more attractive to both the farmer and the bird;
- help prevent caking, dustiness and loss of feed during storage, handling and feeding;
- improve the quality of the egg, yolk colour, shell thickness and meat quality;
- save certain nutrients and prevent nutritional imbalance;
- cause thinning of the gut wall and thereby facilitate better absorption of nutrients (in certain non-nutrient feed additives).

Classification

Based on their functions, the feed additives are broadly classified into two categories, namely:

- nutrient feed additives;
- non-nutrient feed additives.

Nutrient feed additives

The nutrient feed additives contain certain essential nutrients necessary for the normal growth and production of the birds. Deficiency of these nutrients in poultry will lead to various anatomical and physiological abnormalities, deficiency diseases, poor growth rate, low egg production and low resistance to disease. They need to be added if the formulated feed is not expected to contain such nutrients at required levels.

The nutrient feed additives can be further classified into the following categories:

Vitamin supplements

a) Fat-soluble vitamins, supplying such vitamins as vitamin A, D_3, E and K.

b) Water-soluble vitamins, such as the B-Complex group of vitamins and vitamin C.

Mineral supplements

a) Macro minerals, such as calcium, phosphorus, magnesium, sodium, potassium and sulphur.

b) Micro minerals, such as manganese, zinc, iron, copper and iodine.

c) Ultra trace elements, like selenium, cobalt, molybdenum and chromium.

Essential amino acids

Additives supplying lysine, methionine and tryptophan.

Protein hydrolysates

A pre-digested protein such as hydrolysed feather meal, hair meal, etc. supplying essential amino acids and other nutrients.

Liver extract

Supplies essential nutrients in the form that is the easiest to assimilate.

Live yeast and yeast extract

Supplies essential nutrients, digestive enzymes and unidentified growth factor (U.G.F.).

Fermentation by-products

Supply various essential nutrients and U.G.F.

Non-nutrient feed additives

This group of feed additives do not have any direct nutritional role, but they are added to the feed to reduce mortality and morbidity caused by various diseases and stress factors; to improve feed efficiency by better digestion, absorption and utilisation of nutrients; to enhance colour, flavour, consistency and quality of feed, and to improve the shelf life of the feed by curbing caking, moulds, mustiness, oxidation and other physical, chemical and micro-biological degradation.

Classification, uses and examples

Non-nutrient feed additives are classified as follows, based on their nature and functions:

Antibiotic feed supplements: are used to control sub-clinical bacterial infections and thereby boost performance. Examples are tetracyclines, tiamutin, lincomycin, tylosin, erythromycin, colistin, doxycycline, bacitracin, flavomycin, virginiamycin, etc. It is advisable to use antibiotics which are not used in the treatment of human and animal diseases. Introduction of probiotics with favourable microbes has now limited the usage of antibiotics in feed.

Non-antibiotic anti-microbial feed supplements: check bacterial infections and promotes performance. Examples: furazolidone, chlorhydroxy-quinoline.

Antimycotic agents: prevent mould growth and production of toxins. Examples: gentian violet, copper sulphate, propionic acid, calcium propionate and sodium benzoate.

Coccidiostats: prevent outbreaks of coccidiosis. Examples: dinitro-ortho-toluamide, salinomycin, robenichne, nicarbazine, monensin and maduramycin.

Anti-parasitic additives: check various parasitic infestations. Examples: Dichlorophan, Niclosamide and Prazquantel.

Anti-oxidants: prevent oxidative rancidity of fats and oils Examples: B.H.T. B.H.A. and ethoxyquin.

Enzymes: help in the digestion of the food. Examples: protease, lipase, cellulase, amylase, phytase and pectinase.

Hormones: promote growth rate, feed efficiency and egg production. Examples: caseated iodine, melengestrol acetate, ethylestranol and stanazol.

Arsenicals: promote growth rate, feed efficiency and carcass finish. Examples: 3 Nitro-4-hydroxy phenyl arsanilic acid.

Absorbents: absorb or bind toxins and prevent their absorption from the intestine. Examples: zeolites, activated charcoal.

Pellet binders: are used for pelleting the feed, in preparation of crumbled feed for broilers. Examples: bentonite, sodium alginate, carboxymethyl cellulose, gelatine, lignosulphonate and guargum.

Deodorising agents: reduce the ammonia production in the litter. Example: yucca extract.

Flavouring agents: improve feed flavour and thereby feed intake, growth rate and production. Examples: essential oils, fish oils, etc.

Pigments: impart an ttractive colour to the feed as well as to the products like egg yolk and skin. Examples: canthaxanthin, leutin, zeaxanthin, etc.

Herbal preparations: tone up the liver, improve appetite and increase disease and toxin resistance power of the birds. Examples: extracts of herbs

Performance boosters: improve overall performance of the birds by various means. Examples: nitrovin, avoparcin, etc.

Immuno-stimulants: stimulate anti-body production, cell-mediated immunity and general resistance to disease. Examples: tetrahydropheny limidazole, immogen, levamisole, etc.

Other miscellaneous feed additives: perform specific functions in the body or feed and thereby improve performance. Examples: electrolytes, egg-up, eggtoner, etc.

Probiotic or Direct Feed Microbials (D.F.M.): Probiotic is a live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance resulting in a better performance in terms of growth or feed efficiency.

Probiotic preparations are made from bacteria, yeast and fungi. Commonly included in probiotic preparations in various combinations are:

- Bacteria: strains of *Lactobacillus*, *Leuconostoc*, *Bifidobacterium*, *Pediococcus* and *Streptococcus*
- Fungi: strains of *Aspergillus,*
- Yeast, strains of *Saccharomyces.*

Probiotics act by suppressing viable counts of pathogenic bacteria such as *Escherichia* nutrients and adhesion site in the intestinal epithelium.

In general, probiotics increase growth rate in broilers, egg production in layers, and reproductive performance in breeders. However, the effect of probiotics is more noticeable in stressed birds than in healthy ones.

Practical implications

In actual poultry feed formulation, a few vitamin and mineral supplements, lysine, methionine, any one coccidiostat, one antimicrobial feed supplement and one or more other category feed supplements are added to the feed in order to improve the performance of the birds. These nutrients (other than the regular ingredient mixture) and non-nutrient feed additives, will together form less than 1 percent of the diet; but add nearly 10 percent to the cost of the feed.

Feed mixing

Mixing his own feed (known as ‘own feed’) will not only reduce the feed cost for the farmer, but will also reduce the medication cost, because he can avoid repetition of similar medicines in the feed and in the water. Moreover, own feed is fresh and he can efficiently utilise farm-grown and other locally available cheap but nutritious feed ingredients.

At the same time, preparing own feed involves an additional workload and capital investment. Since most of the raw materials have to be procured in tons or even in truckloads, mixing own feed may not be feasible or economical if the farm is small and the monthly requirement of feed is less than 20 MT per month. Those farmers whose monthly requirement of feed is in the range of 5-15 MT per month can arrange for custom mixing, if such facilities are available locally or, alternatively, a few farmers in an area can join together and start a common (co-operative) feed mixing unit. Certain feed ingredient dealers have facilities for the grinding and mixing of feed. They will extend these facilities to the farmers at a reasonable cost, if the feed ingredients are purchased from them. The farmers can apply custom mixing according to their feed formulae. Sometimes certain feed manufactures also extend custom mixing facilities to their farmer customers.

Before procuring various feed ingredients, the farmer should be aware of his monthly feed requirement. This can be calculated, based on the approximate feed intake per day by 1000 birds of different age groups.

After calculating the monthly feed requirement, the different feed ingredients must be worked out. For this, one requires a knowledge of the nutrient composition of various feed ingredients and their inclusion levels (Table 5.5). Local availability and the cost will also influence their inclusion.

Most often cereal grains are included up to 50-60 percent as the major source of energy; and vegetable protein sources like oil cakes and animal protein sources like fish and meat meal are included up to 20-25 percent and 10-12 percent respectively. Agricultural by-products are added at 15-25 percent. However, no single ingredient is to be considered as essential. The balancing of nutrients with several ingredients is the aim.

Minerals need not be added individually. A mineral mixture for poultry is available on the market. It contains calcium (28-32 percent), phosphorus (5-6 percent), iron (0.3 percent), manganese (0.27 percent), copper (0.005 percent), fluorine (0.03 percent) and iodine (50 mg per kg). Its inclusion at 2-3 percent will meet the mineral requirements of broiler mashes and chick and grower mashes. Only for layers is shell grit, calcium carbonate (calcite) or limestone with 36-38 percent calcium added at 5-6 percent level in addition to the mineral mixture. Dicalcium phosphate (21 percent Ca+ 18.5 percent P) rock phosphate (17 percent Ca+ 9 percent P), or bone meal (29 percent Ca+ 12.6 percent P) may also be included as a source of calcium and phosphorus in poultry mashes, in which case a separate trace mineral mixture containing manganese, zinc, copper, iodine and selenium must also be added.

Among the list of feed ingredients, select those that are always available locally at a reasonable price. Identify the local season for each feed ingredient and purchase it when its price is low.

The ingredients purchased must be of good quality:

- The ingredients must be dry with a moisture content of less than 10 percent and free from moulds and fungi;
- The ingredients must be free from foreign matter and adulterants like sand, husk, cobs, etc.;
- The presence of immature and damaged seeds in the grains must be minimal (<5 percent);
- The aflatoxin level in the ingredients must be less than 0.02 ppm;
- The fish must be free from sand, salt, burnt fish and other foreign matter like shells, crabs, etc.;

- The mineral mixture must satisfy the ISI specifications.

TABLE 5.5 Percent inclusion and Nutrient contents of the feed ingredients commonly used in poultry feeds

Ingredient	Inclusion Level (%)	Crude Protein (%)	M.E. (Kcal/kg)	Lysine	Methionine	Calcium	Phosphorus
Yellow maize/corn	0-60	8.8	3300	0.24	0.20	0.02	0.10
White Jowar/sorghum	0-40	9.0	3100	0.22	0.18	0.04	0.13
Pearl millet	0-40	12.0	2650	0.45	0.25	0.06	0.12
Broken rice	0-30	8.7	2900	0.24	0.15	0.06	0.12
Wheat broken	0-25	10.0	3100	0.34	0.18	0.05	0.14
Rice polishing	0-30	12.2	3000	0.57	0.22	0.05	0.43
Rice bran (SE)	0-20	13	2200	0.59	0.24	0.09	0.48
Sunflower meal (SE)	0-15	28.0	1900	1.17	0.60	0.28	0.24
Peanutmeal (SE)	0-30	45.0	2200	1.76	0.45	0.20	0.30
Peanutmeal (ME)	0-30	42.0	2500	1.64	0.42	0.16	0.26
Country processed Peanut meal	0-20	38.0	2800	1.49	0.38	0.13	0.22
Soyabean meal	0-50	44.0	2400	2.93	0.65	0.34	0.24
Dry Fish	5-10	45.0	2500	3.28	1.32	6.0	3.0
Meat meal	0-4	55.0	2100	2.80	0.70	6.0	3.0
Molasses	0-4	3.2	2000	-	-	0.12	0.11
Mineral mixture (poultry)	2-3	-	-	-	-	30.0	6.0
Vegetable	0-3	-	7500	-	-	-	-

Feed formulation

Before formulating the ration, remember that no feed ingredient is essential, but all nutrients are essential. The feed formulated must satisfy the recommended nutrient requirements of broilers or layers.

The formulated feed must contain all the recommended nutrients at the least possible cost. For this purpose, one should be aware of the following:

(a) type of feed to be formulated;

(b) the nutrient requirements of the birds at different ages, i.e. the level of different nutrients to be present in that feed;

(c) local availability of different feed ingredients and their cost;

(d) the nutrient composition of the feed ingredients.

Based on cost, quality and local availability, select the ingredients to be mixed in the feed and ensure that their inclusion levels meet the nutrient requirements of broilers or layers.

During the formulation of manual feed, it is sufficient to check the critical nutrient levels like protein, energy, lysine and methionine. If these levels are met, good quality mineral and vitamin mixtures will have been added at the recommended levels. Invariably, the feed will be a balanced one, meeting all the nutrient requirements. If a computer is used in the feed formulation, the level of all the nutrients can be checked.

First, formulate a tentative feed formula, calculate the critical nutrient levels with the help of the data, and compare these values with the recommended levels. If the calculated nutrient levels are on a par with the recommended levels, the feed formula can be adopted as such. If the tentative feed formula is not able to meet the recommended critical nutrient levels, make minor alterations in the feed formula to satisfy the nutrient levels. Check the composition again, and alter the formula if necessary until the recommended nutrient levels are met. Next add the feed additives or supplements recommended. The formula is now complete and mixing the feed can take place.

Own feed should be in no way inferior to company feed in quality, but should be cheaper than the company feed by at least 5-10 percent; otherwise there is no benefit in going for own feed.

Even the best feed formulation will not give good results if the feed ingredients are of poor quality. By experience, the farmers will learn to identify the quality of feed ingredients. Based on the formula, calculate the exact quantities of different feed ingredients per batch. First, weigh all the ingredients to be ground, like grains, oil cakes, fish, etc. Grind them together. Never grind it too fine, since this will lead to difficulty in swallowing and result in the curled-tongue condition. Later add the weighed quantities of mineral mixture, meat meal, rice polishings, etc., which do not need grinding.

Prepare a pre-mix of all the medicines, supplements or additives; mix them with a small quantity of some ground ingredient like rice polish, oil meal or even maize meal, and then add that to the rest of the feed ingredients and mix thoroughly. Avoid dustiness during grinding and mixing to prevent any loss of nutrients. Ensure thorough mixing in a horizontal or vertical mixer.

Make the feed mixing and storage hall rat-proof; and locate an elevated position for it. Finish the floor and wall with seepage-proof cement concrete. When not in use, the doors must be kept closed.

It is always safe to sun-dry all grains, fish, and if necessary the oil cakes as well, before storing. Sun-drying not only reduces the moisture level, but also kills the germs, keeping the aflatoxin levels in check.

Change the feed formula based on the local availability, cost and quality of the feed ingredients. Never make drastic changes in the formula. Rather introduce changes gradually, since drastic changes may affect the feed intake and thereby the growth rate or egg production.

TABLE 5.6 Some typical broiler feed formulations suitable for South Asian countries

Ingredient	Broiler starter feed				Broiler finisher feed			
	(Kg/Ton of Feed)							
	1	2	3	4	1	2	3	4
Yellow Maize/corn	580	260	-	155	610	245	-	105
White Jowar/sorghum	-	100	110	110	-	120	140	110
Pearl millet	-	100	150	150	-	120	150	150
Broken rice/wheat	-	100	150	150	-	120	150	150
Rice Polishing (fresh)	-	-	120	-	-	-	160	60
Sunflower meal (SE)	-	65	-	65	-	65	-	65
Peanut meal (SE)	180	150	-	110	160	90	-	100
Peanut meal (ME)	120	-	190	-	100	-	130	-
Country processed peanut meal	-	-	150	-	-	-	130	-
Soyabean meal	-	95	-	95	-	100	-	115
Dry unsalted fish	95	75	95	50	85	65	85	50
Meat/liver meal	-	30	-	35	-	30	-	35
Mineral mixture	25	25	25	30	25	25	25	30
Vegetable Oil	-	-	10	10	20	20	30	30
Total (kg)	**1 000**	**1 000**	**1 000**	**1 000**	**1 000**	**1 000**	**1 000**	**1 000**

Additives

1. Vit. A B2 D3 Supplement - 100 g/MT
2. Coccidiostat - 500-1 000 g/MT
3. Vitamin/trace mineral supplements (optional) - 2 500 g/MT
4. Probiotic growth promoter (optional) - 250-500 g/MT

TABLE 5.7 Typical layer feed formulation

Ingredient	Inclusion Level (Kg /MT of Feed)		
	Brooder Mash	Grower Mash	Layer Mash
Yellow Maize/corn	170	170	180
Pearl millet	200	250	200
Broken Rice	200	250	185
De-oiled Rice Bran	100	100	80
Sun Flower meal (SE)	80	80	80
Peanut meal (SE)	100	-	-
Soyabean meal	60	70	100
Dry Unsalted Fish	60	50	80
Shell Grit	-	-	60
Mineral Mixture	30	30	35
Total	**1 000**	**1 000**	**1 000**

Chapter 6
Poultry diseases and control

POULTRY DISEASES

Disease is a condition caused by living factors like viruses, bacteria or parasites, or non-living factors such as deficiencies, toxins and other physical or chemical agents. Diseases can be classified depending on the causative factors. Some common poultry diseases and the noticeable symptoms of each are described below. The preventive measures are given, and for necessary treatment, poultry farmers are advised to contact a qualified veterinarian.

Diseases cause severe economic loss in poultry production. The loss is not only due to the death of birds but also due to loss in production. A farmer should always therefore remain on the alert to notice any symptom evinced by the flock so that control or treatment measures can be initiated early and the loss minimised. However, it is prudent on the part of the farmer to take all possible precautions to keep the flock disease-free.

BACTERIAL DISEASES

Coli-bacillosis

This is a common bacterial disease caused by the E. *coli* organism. It can manifest in different forms such as infection of the yolk sac, colisepticaemia, etc. Lethargy and diarrhoea will be noticed. Control of infection of the yolk sac depends on sanitary conditions at the hatchery and provision of appropriate warmth during brooding. The practice of efficient water sanitation methods and the use of clean drinkers are strongly advised. Provide adequate ventilation and manage the litter properly.

Salmonellosis

This disease is transmitted vertically from parent flocks and affects baby chicks with a high mortality. Huddling, pasting of vent feathers and whitish diarrhoea are noticed. Ensure salmonella-free chicks from the hatchery by using sterilised fish-meal and meat meal. Pelleting of the feed will also be helpful. Add furazolidone to the feed to control salmonellosis.

Coryza

Symptoms of this disease are swollen faces and swollen eyes, filled with a cheesy substance. Respiratory distress and poor feed intake are also noticeable. Avoid overcrowding and wet litter. Reduce the ammonia level by proper ventilation.

Fowl cholera

Combs and wattles of poultry with this condition become swollen and bluish. High mortality and morbidity are experienced along with a watery nasal discharge and saliva dripping. Pin-point blood spots on the heart and duodenum and white spots on the liver are present. Whitish diarrhoea is noticed. Control rodents and ensure proper management. Provide good ventilation and stress-free conditions.

Chronic Respiratory Disease (CRD)

Respiratory distress, the sound of rales, sneezing, poor weight gain and nasal discharge are symptoms of the disease. Infected chicks transmit the disease through water and feed. Avoid overcrowding, improve ventilation, ensure hatchery sanitation and screening of parent stock. Mixing tiamutin or tylosine in the feed will be helpful.

VIRAL DISEASES

These are prevented by carrying out protective vaccinations at the recommended age; treatment will not be effective.

Newcastle disease

This is the worst poultry disease. A high mortality rate is evident in all age groups. Respiratory distress, paralysis of legs and wings, greenish diarrhoea and a twisting of the neck will be noticed. Control Infectious Bursal Disease (IBD) and give toxin-free feed. Multiple vaccinations should be given as suggested. Routine screening of sera samples on larger farms is advisable.

Infectious bronchitis (IB)

Respiratory distress, rales and gurgling sounds are evident. Prevent the disease by vaccination.

Infectious anaemia

Young chicks are affected. A mortality of up to 20 percent is noted and the disease predisposes adults to other diseases. Vaccination of the parent stock is required.

Infectious Bursal Disease (IBD or Gumboro)

Young birds are affected. Listlessness, huddling, whitish, pasty diarrhoea and pecking at vents are some of the symptoms. The consequences of this disease are a 10-60 percent mortality rate and the breakdown of immunity, leading to the outbreak of other diseases. Vaccinate young birds at the recommended age. Include immuno-stimulants like Vitamin E. in the feed. Give toxin-free feed.

Marek’s disease

This disease is characterized by poor growth and paralysis of one leg which is stretched backwards. Birds under 16 weeks are affected. An inability to take feed follows, and death ensues. Ensure that protective vaccination is given at a day old in the hatchery.

Infectious laryngo-tracheitis (ILT)

Symptoms like respiratory distress, rales, extended neck for inhalation, nasal discharge, low egg production, and mortality of up to 30 percent are noticeable. Secondary infections can be controlled by antibiotics.

Inclusion body hepatitis (Hydropericaridium syndrome or Leechi disease)

This condition affects broilers at four to five weeks of age and a 30-60 percent mortality is experienced. Straw-coloured fluid around the heart is noted. Control IBD vaccines are available against this disease.

Fowl pox

Raised skin lesions appear at the corners of the beak, as well as at the comb and wattle. The mortality level is low, but recovered birds perform poorly. Vaccination at the appropriate age is suggested.

BROODER PNEUMONIA

Young chicks of 1-2 weeks of age are affected. A high mortality rate of 10-50 percent is noted, with symptoms of gasping, respiratory distress and strong thirst. Yellowish white pin-point filaments on lungs are present. Avoid using mouldy, fungus-infested litter material. Use thoroughly cleaned drinkers and feeders.

MYCOTOXICOSIS

Caused by mycotoxins, this disease is produced by fungi in feed ingredients. Reduced feed intake, poor growth rate or egg production, breakdown of immunity and vaccination failures are the consequences. Sun-dry feed ingredients. Avoid using mouldy ingredients; use toxin binders like zeolites, aluminium si1icate or charcoal in the feed. Add liver tonics. Withdraw fungal-infested feed.

COCCIDIOSIS

Three common types of coccidiosis can occur. The caecal and duodenal type affect younger birds. Birds over 10 weeks of age are affected by intestinal coccidiosis. Mortality is higher in younger birds. Reddish diarrhoea, stunted growth and crouching are noticeable symptoms. There is a loss of raw or digested blood through droppings. Performance is very severely affected because of poor absorption of nutrients through the intestine.

Avoid wet litter. Ensure proper management. Avoid spillage of water. Coccidiostats like superdot, clopidol, cycostat, etc., should be used in broiler mashes and brooder and grower mashes. Coccicidal drugs like salinomycin and maduramycin should be used in broiler mashes only. Preventive water medication with coccidiostats like amprolium, codrinal, etc., may also be adopted. The coccidiostats used in feed may be rotated every three to six months to prevent the parasite developing resistance against the drug in use.

DEFICIENCY DISEASES

Deficiency of protein and vital amino acids and insufficient energy in feed cause poor growth and ruffled feathers. Deficiency of vitamins and minerals also causes disease conditions in birds. A vitamin A deficiency causes respiratory symptoms and conjunctivitis. A vitamin B deficiency causes paralysis and neuritis. A vitamin B_2 deficiency causes curled toe paralysis and a manganese and choline deficiency causes slipped tendon disease.

DISEASE CONTROL MEASURES

Poultry rearing is becoming more and more intensive. This increases the chances of infectious diseases being sustained in different flocks. Consequently, the need for effective disease control measures has gained importance.

It is the responsibility of poultry farmers to provide a comfortable, safe, disease-free environment for the birds. Only in such an environment will the birds have the highest level of body resistance and be exposed to the least number of micro-organisms. Usually, poultry farmers only get alarmed when a high mortality rate is observed on the farm. However, the existence of a disease at even a subclinical level may hinder the performance of the grown birds in terms of body weight or egg yield. Such economic losses, sometimes relatively small and unnoticed, may mean the difference between eventual success or failure in the poultry business. The treatment of a sick flock after the onset of any disease becomes more costly and, more frequently, impracticable. The recovered birds may not regain their production to the original levels and may also continue as a source of infection to other healthy birds. Hence, the adage “prevention is better than cure” possibly applies more to poultry farming than to any other field.

Disease may result from a lack of vital nutrients (deficiency) or an excess of some (toxic) or because of physical stress (managerial). However, diseases caused by micro-organisms like bacteria, viruses or parasites, which are difficult to treat and cause extensive economic losses, can be controlled by effective disease-prevention measures.

The severity of an infectious disease depends both on the condition of the bird and the number and virulence of the organisms causing the disease. The condition of the bird determines the resistance offered to the disease. The condition depends on prior exposure to other diseases, especially those that impair the immune status (IBD, Mycotoxicosis, etc.), nutritional status (which needs to be sound, with quality feed and environmental conditions) optimum feed consumption, differences in strain, environmental stress (extremes of climates during summer and winter, adequate space allowances, etc.) and the type and timing of treatment. The higher the number of organisms in the birds’ environment, the more severe the outbreak of the disease. Some organisms quickly overcome the birds’ resistance. This is known as “virulence”. When birds are suffering from stress, even a few, less virulent organisms can cause a disease.

It is therefore the duty of the farmer to provide an appropriate environment (proper layout of houses, design of houses, ventilation, space allowance, quality feed, disinfecting procedures, bio-security measures, vaccinations and medications, etc.) to help the birds to develop optimum body resistance and to minimise the organisms in the birds’ environment, which are the two basic principles in disease prevention.

Readers are advised to refer back to the layout and housing management tips at this stage. Maintaining the quality of feed provided is also a major disease-prevention measure. Details on vaccination schedules are given in the chapter on management.

SOURCE OF INFECTIONS

Disease-producing organisms gain entry into poultry farms through various sources. To take appropriate control measures and prevent their entry, it is important that the farmer becomes aware of such sources.

Human

Men and women constitute one of the greatest potential causes of disease. Footwear, hands, clothing and contaminated equipment are the main sources involved in introducing disease. Service personnel who move from farm to farm for day-to-day operations, such as debeaking, vaccinations, etc., are potential carriers of infection. Take care that they do not visit your farm after attending other farms. Avoiding visitors may not always be possible, but proper cleaning and sanitising of hands, footwear and clothing during such visits are essential. Even an innocent visit by the farmer to a neighbourhood farm can contribute to the transmission of infection.

Carrier birds

Birds that have apparently recovered from a disease may still retain the disease-causing organisms in the body and can spread the disease as carriers. Aged birds, which are comparatively more resistant and apparently healthy, may also spread infections to younger birds on the farm.

Eggs

Some diseases are egg-borne and transmitted from parent to progeny through the ovum of the egg, e.g. salmonellosis, mycoplasmosis and colibacillosis. Order chicks only from a well-maintained, certified hatchery.

Equipment

Solid vehicles and equipment, egg trays, chick boxes, etc. can carry disease-causing organisms between farms, houses or pens, e.g. Fowl pox, Infectious Bursal disease, Marek's disease, avian influenza, etc.

Feed

Feed ingredients like fish-meal may contain organisms such as *Salmonella, E. coli,* etc., or may be mouldy, containing mycotoxins. This can be controlled by careful selection of feed ingredients or by pelleting prepared feed.

Water

Water remains the single major source of infection, especially for *E. coli* infection. A supply of potable water, free from pathogenic micro-organisms and substances that affect palatability, is essential.

Birds and insects

Wild birds are capable of transmitting infectious diseases by contaminating feed, water and litter with infectious agents. Many insects and rodents can also transmit diseases, e.g. Salmonellosis.

STRESS

Stress in poultry is the greatest threat to farm economy. Stress factors may be short- or long-term. Sudden changes in weather conditions, equipment changes, electrical failures, changes in lighting schedules, absence of drinking water, debeaking, transport, handling, deworming and vaccinations are short-term stress factors. Housing with improper ventilation, inadequate lighting, high concentrations of ammonia, overcrowding, shortage of feeders and drinkers are long-term stress factors.

Stress causes reduced feed intake, affects the immune status of the birds, and may lead to production losses and outbreaks of disease. The farmer should take appropriate corrective managerial measures to reduce stress.

MANAGEMENT FACTORS IN DISEASE PREVENTION

The following managerial factors help to reduce the spread of disease and stress to the birds.

Isolation

It is not advisable to rear birds of different age groups in the same house. Wherever possible, it is advisable to practise the all-in-all-out system.

Proper layout of houses, appropriate designing to prevent any entry of rodents, proper ventilation, and the designing of feeders and drinkers to avoid spillage, are basic essentials in disease prevention.

Litter management

Wet litter is a potential source of disease transmission. Maintain proper litter conditions as suggested earlier.

Quality chicks

Ensure that chicks are received from a hatchery where adequate preventive care is taken of breeder birds to guard against mycoplasmosis, salmonellosis and infectious bursal disease. Check for a history of vaccination against Marek's disease. Look for signs of dehydration. Ensure that the received chicks are healthy and are within the normal weight range.

Proper nutrition

A good balanced feed prepared according to nutrient requirements at different ages will ensure proper health and good immune status in birds. Addition of coccidiostats, and vitamin and mineral supplements are essential.

Water quality

Poultry farmers often fail to provide the birds with good quality water. Both the microbial and chemical quality of the water need to be tested before establishing a poultry farm in a given area.

Microbial contamination of water may happen at the source, for instance in ponds, rivers, open wells and the public water supply system, or during transportation and storage, as well as in the overhead tank or bins. Unhygienic practices on the farm result in the spread of disease. The microbial load shoots up during flood conditions. Faecal contamination of water will add to the presence of coliform organisms. Mineral levels in water depend on soil conditions, and show only minor fluctuations based on the season and the water table. They lead to hardness in water and affect the taste and palatability.

The desirable quality guidelines for drinking water on poultry farms are as follows:

Maximum Water quality level	Permissible	Desirable level
1. Total hardness	350	60-180
2. pH	6.0-8.0	6.8-7.5
3. Nitrate	25 mg/litre	10 mg/litre
4. Nitrite	4 mg/litre	0.4 mg/litre
5. Total bacterial count	1 000/ml	0/ml
6. Coliform count	50/ml	0/ml
7. Calcium chloride	250 mg/litre	60 mg/litre
8. Sodium	500 mg/litre	50 mg/litre
9. Sulphate	250 mg/litre	125 mg/litre

The removal of excess dissolved minerals by cheaper and simpler methods is not practicable, and the farmer should change to other water sources in case of excess minerals in the water.

Chlorination is the best and cheapest method to get rid of micro-organisms. Five to eight grams of bleaching powder with about 35 percent available chlorine should be added to 1 000 litres of drinking water to maintain a chlorine level of 1 to 2 ppm at delivery. A minimum contact time of one hour should be given before offering the water to birds.

Where storage facilities are not available, liquid chlorine preparations like chlorine dioxide, 5 percent sodium hypochlorite (sanitech), etc., may be used at a level of one ml per

10 litres of water. Lodophores containing 1.6 percent available iodine are also used as water sanitizers at the same dosage level.

Products containing quarternary ammonium compounds like quat, quatovet, encivet, sokrena, etc. may be used as water sanitizers as per the manufacturers' specifications.

By providing sanitized water to the birds, the chance of water-borne infections is reduced and the cost of medication is saved. The life of pipelines and storage tanks is also increased, and the overall growth of the birds and egg production efficiency will be improved.

Dead bird disposal

The main principle involved in the prevention and control of current and emerging diseases is the scientific disposal of dead birds. Mortality is inevitable on every poultry farm, and it varies with the prevailing disease and sanitary conditions on the farm. When birds die, their carcasses remain as a source of infection for pen-mates and other birds on the farm (or other farms). All carcasses should be removed from the pen as soon as possible. Diseased and ill birds also discharge infectious material into the environment and act as reservoirs for disease-producing organisms. It is essential to eliminate ailing birds from the flock rather than jeopardize the health of the remainder of the flock.

The habit of throwing dead birds on to the nearest manure pile or into an open field is dangerous and unscientific for the following reasons:

- The smell of the carcasses attracts street dogs and cats, which consume the infected carcasses and harbour the enteric organisms infectious to poultry. Because of their free movement, these animals are capable of carrying contaminated material or a portion of a carcass to neighbouring farms, with disastrous results;
- Vultures and other wild birds invade the carcasses and become potential carriers of the disease-causing agents from one farm to another or even from one country to another country if they migrate;
- The carcasses lure insects and flies, which act as transmitters of infectious agents;
- The disease agents carried by rainwater contaminate other water sources;
- The surrounding area of the farm is contaminated with feathers and bones, causing soil pollution;
- On decomposition, the carcasses may emit a foul smell and cause air pollution.

The disposal of carcasses of birds dying from known or unknown causes, should be carefully attended to. There are many methods for the efficient disposal of carcasses such as burying, pit disposal, incineration, septic tank disposal, or composting.

In general, the following points should be observed while disposing of the carcasses:

- Remove the dead birds from the flock as soon as possible;
- Do not deposit carcasses in or near a flowing stream;
- Take the necessary precautions to prevent spillage of infectious material from the carcasses during transportation from the farm or post-mortem room to the disposal site;
- Take sound bio-security measures at the disposal sites to prevent disease transmission.

Moreover, with the present concern for the environment, the poultry industry needs to pursue efforts to protect the environment. Therefore, all methods that allow for environmentally safe and scientific ways of disposing of carcasses should be considered.

Litter removal

After the pen is emptied, deep litter and caged layer droppings should be removed to a field far from the poultry shed, and spread to dry in the sun. It should be disposed of as soon as possible for manure or other purposes and not allowed to remain accumulating for a long period. Composting is better, since the heat produced will destroy the pathogens.

Disinfecting

To disinfect is to free from pathogenic micro-organisms. A disinfectant is an agent that destroys pathogenic organisms, and that can be applied on inanimate objects or used as a footbath. Phenol, cresol, chlorine compounds and iodophors can be used for disinfecting surfaces as well as the egg room, feeders, drinkers, buildings and footwear; liquid formalin at 5 percent level, or formaldehyde gas by fumigation, will also serve as an effective disinfectant.

Sun-drying may be practised for washed equipment; for cement surfaces dry heat in the form of flame is recommended. Copper sulphate as a 0.5 percent solution is effective against fungi.

Quarternary ammonium compounds are good disinfectants when used according to directions. However, they are not effective in hard water. They can be used for disinfecting surfaces, washing egg rooms, feeders and drinkers and other equipment.

Rodent control

Keep rodents out from the initial stage of farming itself, since once the farm is infested, it is difficult to get rid of them. Remove piles of unused equipment and empty gunny bags as they serve as breeding places for rats, mice and squirrels. Remove spilled feed daily. Store feed in well-ventilated, rodent-proof rooms. Use traps in the initial stages and later rodenticides. Rodenticides should be used at night according to specifications.

Insect control

Counter measures against insects are part of maintaining a sanitary environment, as insects play a significant role in transmitting disease-producing micro-organisms, tapeworms, etc. Flies sit on the birds, irritate them, prevent them from taking water and feeding normally, causing stress which results in reduced egg production especially where cage rearing is practised. Insect or fly control measures include:

- avoiding stagnation of water on or around the farm premises; provision of proper drainage facilities;
- attending immediately to leaky drinkers, water lines, etc.;
- using insecticide sprays or dusting at required intervals;
- treating the birds and checking the feed and water quality to avoid watery droppings.

Keep the surroundings clean by covering the area with treated soil devoid of vegetation or by growing grass lawns. The synthetic and natural pyrethroid insecticides, organophosphorus compounds and carbamates, are the main ectoparasite and fly control chemicals used for direct application in poultry houses on litter or droppings. They can be applied as dusts or spray as per the manufacturers' instructions, but care should be taken to ensure that feed and water are not contaminated with them.

Bio-security

This means preventing the entry of disease-causing organisms into a designated area or farm. Bio-security measures include the provision of special clothes while working on the farm, insisting that employees take baths and change into clean clothes before entry, the exclusion of visitors from farms, the exclusion of wild birds and backyard chickens from poultry pens, the provision of foot-baths (5 percent phenol), proper disposal of dead birds, adoption of the all-in-all-out policy, and thorough cleaning and drying of equipment.

Chapter 7

Institutional support for poultry production

CREDIT INSTITUTIONS

Arranging the necessary finance for investment in the poultry production business is a problem faced by many entrepreneurs. Obtaining finance from local moneylenders is not a viable proposition. Nationalized banks in India, however, extend credit facilities for poultry enterprises. The Indian government has enlarged the scope for such facilities by creating a separate National Bank for Agriculture and Rural Development (NABARD), which extends refinancing facilities to the lending banks and the Agriculture Finance Corporation has recently also been established. Financial aid covers items that include the construction of sheds, the purchase of poultry equipment, chicks, feed, medicines, land development costs, fencing, water and electricity, servant quarters, transport vehicles, processing and cold-storage facilities.

The entrepreneur is required to submit a detailed project proposal along with his application for credit (loan) requirements, indicating the scope, viability, and size of the proposed unit, and include statements on proposed expenditure, anticipated income, cash-flow and repayment schedules.

The proposal should also give an introduction to the project, its objectives, location and address, the type of arrangements regarding various facilities (transport, availability of inputs, electricity, labour, technical consultancy, etc.)

The nationalized banks usually extend credit facilities towards broiler and layer production, as medium-term loans, repayable within three to five years. The interest rate depends on the extent of the loan and is likely to be changed within a narrow range, depending on guidelines from the Reserve Bank of India. It is necessary for every poultry farmer to know about the required amount of credit and the profitability of the business into which he is venturing.

INSURANCE

It is advisable for broiler and layer farmers to take out insurance cover for their flock of birds, against deaths from certain diseases and other accidents. All four insurance companies in India, namely, the United India Insurance, New India Assurance, National Insurance and Oriental Insurance companies extend such insurance cover for poultry production. The details of poultry insurance schemes at present are as follows:

Scope of the cover

Insurance cover provides indemnity against the death of birds due to accidents including fire, lightning, flood, cyclones, strikes, riots, civil commotion, terrorism, earthquakes and disease contracted or occurring during the policy period.

Applicability

The insurance scheme is applicable to poultry farms consisting of all types of exotic and crossbred poultry birds in India.

The scheme applies to poultry farms consisting of a minimum number of birds as follows:

Under bank finance

For all types of birds – 500

General

Broilers - 100 per batch

Layers - 500 per batch

Hatchery - 2 000 per batch

All birds on the farm should be covered. After issuing the policy, if additional birds are introduced on the farm, immediate notice must be given to the insurer; otherwise any claim will be repudiated.

Age group

Broilers	- 1 day to 8 weeks
	1 day to 6 weeks
Layers	- 1 day to 20 weeks
	21 weeks to 72 weeks
	1 day to 72 weeks
Hatchery or breeder farm	- 1 day to 72 weeks

Premium rates

Premium rates are no longer fixed on the basis of the size of the population but are instead applied to the value of the flock:

Broilers	1 day to 8 weeks	- 1.5 percent of the peak value
	1 day to 6 weeks	- 1.2 percent
Layers	1 day to 20 weeks	- 3.2 percent
	21 to 72 weeks	- 3.5 percent
	1 day to 72 weeks	- 5.5 percent
Hatchery or breeder farms		- 5.0 percent

The premium rate will be applied on the peak value of the birds in each of the above categories to arrive at the premium payable per bird.

Insured sum

The value of the bird is fixed in relation to the age of the bird, and a valuation chart is prepared. The insured sum is fixed according to the valuation chart which is calculated on the basis of the maximum value selected per bird.

Policy exclusions

The policy will not pay for the losses caused by:

- Malicious or wilful injury, negligence;
- Transit by any mode of transport;
- Improper management;
- Theft and clandestine sale of birds;
- Intentional slaughter of birds;

- Consequential loss;
- War and nuclear perils;
- Marek's disease, Newcastle disease, Fowl pox and Infectious Bronchitis unless the birds have been protected against them;
- Loss of production, malnutrition, undergrowth, cannibalism, loss due to huddling and piling of birds;
- Avian Leucosis Complex (ALC).

Veterinary examination

A veterinary certificate from a qualified veterinarian is necessary for acceptance and granting of insurance cover, as well as for the settlement of claims.

Important conditions

- All birds on the farm should be insured.
- Poultry farms should have a veterinary facility of their own or on a consultancy basis.
- The birds should be given properly balanced and standard food, water and light.
- Debeaking and deworming should be carried out regularly, and records to that effect must be maintained.
- The minimum number of birds prescribed has to be maintained. All the birds should be covered on a flock basis, and thus no identification is necessary.
- The farmer must keep all the essential records on the farm.
- The farmer must not resort to replacement of chicks in affected sheds.
- The cages must be maintained properly and of normal standard.

Claim procedures

In the event of the death of birds, immediate notification must be given to the company. The following documents are to be furnished within 15 days:

- A claim form duly certified by a veterinarian;
- Daily records of mortality, feeding, etc.;
- Purchase invoices for the birds;
- Other proof to substantiate the loss, like photographs, medical bills, etc., as and when required. In the case of an outbreak of any disease, notice must be given to the company within 12 hours, and all birds must be segregated and produced at the request of the company representative or any person who has been authorised by the company to carry out an inspection.

Daily mortality details must be sent to the company on a weekly basis, failing which, the report will be treated as nil for that particular week.

Protective cover, in the form of insurance policies, is also available for ducks and Japanese quail.

EXTENSION AGENCIES

The extension activity of taking technology to the farmer's doorstep is carried out mainly by three different institutional arrangements:

State Agricultural Universities

The Indian Council of Agricultural Research, which is the main body governing research in agriculture in India, has a separate extension wing to ensure that identified technologies reach the farmers in time for adoption. For this purpose, Krishi Vigyan Kendras (Farmers' Training Centres) are established in several districts of the country and conduct periodical need-based training on specific local technology requirements. There are also about 32 state agricultural universities, including three veterinary and animal science universities, which were established under the "Land Grand College" pattern of the United States of America. Research, education and extension are the three major identified functions of these universities.

They also conduct extension activities through their constituent colleges and development centres. In addition, their attempts to reach out to farmers include the effective utilisation of mass media (radio and television) as well as print media (newspapers and magazines). Farmers listen to or read about the programmes, and also visit constituent units of the universities to get the required knowledge and training regarding poultry production. Recently, the Tamil Nadu Veterinary and Animal Science University has attempted to provide Internet connectivity to poultry farmers to enable them to get the necessary information through that network.

State Departments of Animal Husbandry

Departments of Animal Husbandry in various states of India extend veterinary services to the livestock and poultry maintained by farmers. State departments have also established poultry extension centres and demonstration units to perform extension services to the poultry-farming community. Extension officers are employed at "panchayat unions" governing village administration, to help grassroots farmers in planning and management of poultry farms. The state departments also reach out to the farmers through mass-media campaigns and field visits, establishing face-to-face contacts with the farmers.

Non-governmental organizations

Several non-governmental organizations are also engaged in extension services to popularize poultry production. They are aided by international agencies. Locally, the Indian Council of Agricultural Research promotes the activities of such organizations. NGOs have established good grassroots-level contacts with village farmers, and they promote poultry production to increase the income of rural families and to improve their nutritional status.

Institutional support for poultry production comes from many other sources as well. Even international organizations like the Food and Agriculture Organization of the United Nations are providing training manuals to benefit small farmers. Further extension works are being undertaken through specific projects like the Small Holder Poultry Development Project in Bangladesh. Producer co-operatives and marketing federations in different regions also extend support to augment poultry production.

Chapter 8
Rural poultry production

There has been a remarkable growth in the Indian layer industry during 1981-1990 and in the Indian broiler industry during 1991-2000. Industrial poultry production is being progressively concentrated into fewer and fewer hands, through self-integrated layer farming or vertically integrated contract broiler farming practices, which are gaining popularity in the region.

However, rural poultry production still continues to play its own role. In India, in 1993, the proportion of “desi” birds to the total chicken population was estimated at around 44 percent, while its contribution to the total annual egg production was 12 percent. In spite of their low productivity, desi birds continue to be reared by rural families for a variety of reasons:

- It is a low-cost vocation practised for centuries in villages in the region with virtually no input costs;
- A section of urban and peri-urban consumers still prefer eggs or meat from country (native) chickens and are willing to pay a premium price for these products;
- Small numbers of chickens and small ruminants serve as safety kits for financially starved rural families and are sold during emergencies to get cash-in-hand;
- Commercial poultry production has made little impact on rural poultry production, as the number of birds raised in rural areas has not decreased as a result of the growth of the commercial hybrid poultry population. There is a separate market segment for meat and eggs from rural poultry reared under free-range conditions. Multi-colour desi birds and their brown-shelled eggs still fetch premium prices in the local markets in India.

Systems in practice

Rural poultry is reared under a backyard system. The number of birds reared varies from 5-40 depending on the available space and the safety arrangements that can be made. Where possible, a small thatched hut with a bamboo-stick door is provided to house the small number of birds. Otherwise, they are covered in bamboo baskets during the night. Under all kinds of temporary housing arrangements, the birds are let out during daytime to scavenge around and feed on spilled grains, insects, domestic waste, etc.

Breeds reared

In specific areas, popular local breeds are reared such as the Kadakanath, Aseel and Naked Neck, as well as the crossbreeds derived from them. Usually nondescript native breeds are reared. The production performance of these breeds is relatively poor. They barely produce 40-60 brown-shelled eggs in two cycles, from which about 1 015 chicks are hatched, and the rest of the eggs are sold or consumed as table eggs. The native hens still exhibit signs of broodiness and sit on their eggs for hatching. Egg production ceases during that period. The native chickens are preferred for their tasty meat, and they are sold from 6-8 months of age for meat purposes, when they weigh around 700-1 400 g. Apart from these dual purposes, a few fancy breeders rear breeds like the Silky or Frizzle for show or fancy purposes. Breeding fancy birds is also adopted as a profitable small-scale venture by some rural farmers. Breeds like the Aseel are preferred for their fighting qualities. Cockfighting is still a regarded as a form of entertainment in villages in some areas.

Some of the educated farmers in rural families now prefer to rear the improved varieties of birds developed by local research stations. Their productivity level is medium but much higher than that of the native chickens. They also have comparatively good disease-resisting abilities, and are suitable to the backyard rearing conditions. Examples of these are the Giriraja, Grahalakshmi, Nandanam Chicken 1 and 2. They have multi-coloured plumage like native breeds, and hence receive ready acceptance by rural families. They are also dual-purpose birds, reared both for their meat and eggs.

Feeding and watering

Rural birds reared under backyard conditions are usually not fed supplemental feed. They have to roam around and find their own feed from spilled grains and insects on the ground. Water is usually provided in a plate during the night, or else they drink from open gutters, which also exposes them to the danger of many diseases. However, their adaptability to the conditions and their high disease-resistance potential usually save them from such eventualities.

Marketing

As no input costs are involved, the rural birds are not marketed at any definite age. The time of marketing is decided by the when they fetch the maximum price (festival seasons) or when the farmer needs money. As the farmer does not have access to the urban market, he has to sell his poultry locally or depend on a middleman to take his product to the cities. In both cases, the price he gets is comparatively low. However, since only his or his family's labour is involved in raising the birds without any feed costs, what he receives is his profit.

Gender involvement

Women play a significant role in rural poultry production. Besides generating income and employment, poultry production helps the socio-economic upliftment of rural women. In most rural families, women are responsible for rearing poultry and livestock for their households. They undertake feeding the birds sparse-grains, keeping count, and housing them securely at night. They often do the marketing on their own as well, in this way supplementing the income of their families. They nourish their children with poultry and livestock products produced domestically, and help to avert protein deficiency in their families.

There are several advantages to rural poultry production, both at macro and micro levels. They are:

- Rural poultry production ensures that the production activity remains broad-based and consequently that the income from poultry production is widely distributed;
- Rural poultry production activities are less intensive, more eco-friendly, and help maintain sustainable poultry production practices;
- The promotion of poultry production in rural areas can prevent the migration of people to urban areas;
- Poultry meat and eggs are important sources of high-quality protein in the diets of growing children, women and nursing mothers in rural areas who would otherwise consume only energy-rich cereal grains. Rural poultry production therefore helps to prevent protein malnutrition in rural families;

- Rural poultry production is a source of supplemental income to rural families and it helps to offset seasonal idleness in agricultural employment.

Since rural poultry production improves the economic and nutritional status of the rural poor, ensures distribution of income and availability of quality products locally, empowers rural women and remains eco-friendly, it needs more attention. Efforts to remove existing constraints in rural poultry production will help to promote it in the rural communities. The constraints are as follows:

Very low productivity

The nondescript native chickens have a very low production potential. If this is improved, even marginally, it will help to increase the income of rural families. As improved hybrid commercial strains cannot be taken to villages and expected to thrive on scavenging, it is only appropriate to make use of moderately producing pure-bred strains of dual-purpose breeds, available from research institutions. In this way, the production potential of native chickens under backyard rearing can be improved without harming the disease-resistant qualities of the native germplasm in order to withstand the substandard local managerial conditions.

Males of pure-bred strains of Rhode Island Red, New Hampshire and Plymouth Rock, etc., which have been maintained as closed flocks for over 35 years, and which have adapted to native climatic conditions, can be introduced into local areas to upgrade the local germplasm. The current efforts are aimed at introducing such strains (for example, the Giriraja, Nandanam Chicken, Grahalakshmi, Gramapriya, etc.) only as purebreds into rural environments, and not at upgrading the native chickens and improving their performance potential. However, upgrading native chickens through the introduction of males of improved stocks will help to improve their production potential, without losing the advantage of the disease-resistant capabilities of native chickens. In addition, such attempts will also face less resistance from rural folk.

Higher mortality levels

The stocks of poultry reared in rural areas experience heavier mortality rates in spite of their known natural disease-resistance qualities. The main cause of these incidents has been Newcastle disease. A lack of awareness among the rural people about vaccination requirements remains the major impediment. Ensuring routine vaccinations against Newcastle disease, and routine deworming of birds that exist on scavenging, will help greatly in preventing high mortality rates and improving the productivity of these stocks.

Poor quality feed

Most of the native chickens under backyard rearing thrive on spilled grains, which are rich in energy and poor in protein. Even when in lay, they are not supplemented with minerals even though their requirement is much higher during breeding or laying season. For example, about 2.5 g of calcium is present in the shell of each egg, which needs to be supplemented through feed; otherwise the bird draws from its reserves as much minerals as possible and stops egg production once it is exhausted. Similarly, a lack of protein supplements also brings down production even though the stocks are genetically capable of laying a few more eggs.

Poor marketing system

Native chickens reared under backyard rearing in rural areas are sold only through a middleman who moves around villages collecting chickens and sending them to retailers in urban areas. A new concept of a “Farmers’ market”, started in Tamil Nadu and nearby

Andhra Pradesh states, is proving to be a frontrunner in providing farmers with direct sale of their agricultural and other products, thus enabling a maximum share of the price of the products to go to the producer farmers. Such attempts may be streamlined and farmers encouraged to develop the direct sale of eggs and poultry meat, especially if the native chickens are upgraded through the planned introduction of moderately superior strains as the production level of native chickens will then probably exceed local demand.

Extension services

The agencies doing extension services in villages, like the state department of animal husbandry, extension wings of state agricultural or veterinary universities and non-governmental organizations, should concentrate on more effective ways to emphasize the need for vaccination against Newcastle disease, introduction of males of moderately improved purebred strains adapted to local conditions, routine deworming, provision of supplemental feed (protein sources, mineral sources, etc.) during breeding and laying seasons, and other appropriate technological measures that are at present lacking at the grassroots level.

The rural or household type of poultry-rearing increases the availability of nutritionally superior local poultry products like egg and poultry meat, improves the income of rural households, and creates employment opportunities in rural areas. The constraints faced by the rural or backyard poultry farmer are quite different from those experienced in industrial poultry production, and measures to overcome the rural constraints need to be evolved and put into place.

With almost 60 percent of the population in South Asian countries living in rural areas, with livestock- and poultry-rearing ensuring the sustainability of the rural poor, it is essential that rural poultry be substantially improved. Addressing the above issues will ensure that the benefits of economic growth are more widely spread, and that the poorest communities in rural areas, such as agricultural landless labourers, and the small and marginal dry-land farmers, stand to gain through the employment of women and rural youths.

Chapter 9

Japanese quail, turkey and duck production

JAPANESE QUAIL PRODUCTION

The term “quail” refers to a group of small-sized birds, which generally crouch or run rather than fly to escape from danger, the term itself meaning “to sink, shivering from fear”.

Japanese quail, *Cotumix coturnix japonica*, is a sub-species, of which the domesticated species is widely reared throughout the countries of the world for meat and eggs. The Chinese and the Japanese cherish quail eggs. Many countries are showing great interest in developing the production of Japanese quail for the meat and egg market.

In earlier times, Japanese quail were domesticated for their singing abilities. Written records of domesticated quail in Japan date from the twelfth century. During their imperialist era, the Japanese took quail with them into various parts of Asia, especially China, Korea and Taiwan. The Japanese quail caught the attention of researchers in the United States of America only after World War II.

Common quail have been used as food since biblical times. The presence of quail as a preserved food has been recorded in a tomb in Egypt dating back to about 3000 B.C.

According to the Old Testament, at the time of the Jewish exodus through the Sinai desert, led by Moses, it is stated: “Now a wind went out from the Lord, and it brought quail from the sea and left them fluttering near the camp, about a day’s journey on this side and about a day’s journey on the other side, all around the camp, and about two cubits above the surface of the ground. And the people stayed up all that day, all that night, and all the next day, and gathered the quail….” *(Numbers 11:31-32)*

In India, many broiler farmers, who had smaller holdings, and who were forced out of broiler farming because of the growing tendency towards integrated broiler production under contract farming, found quail farming a viable alternative with much potential, and consequently Japanese quail rearing for meat and eggs is now gaining popularity in the Southern States of India.

Advantages

The reasons for the popularity of Japanese quail farming are as follows:

- Japanese quail rearing does not require specially designed house as they can be comfortably reared even in vacant rooms meant for human habitation.
- The required floor space is much less, and the capital requirement therefore is much less.
- The quail are ready for the market as table birds at five weeks of age. Quail also start laying from the seventh week. The return on invested capital is therefore realized much earlier.
- Japanese quail are comparatively more resistant to diseases than chickens and do not normally require any vaccination, deworming, etc. which means their management is easy.
- Because of their smaller body size, the quail consume less feed and therefore maintenance and recurring costs are also less.

Thus, Japanese quail farming can be undertaken with less capital investment and little skill, and the returns will be realized earlier.

Japanese quail rearing

Japanese quail can be reared on the floor or in specifically designed cages. Under the floor rearing system, the roofing can be made of thatch or tiles, while the floor has to be made of cement or concrete flooring to facilitate easy cleaning and disinfecting. When Japanese quail are reared for table (meat) purposes, about 5 quail per square foot area (floor space per bird: 180 cm^2) can be raised. In a 10’ x 10’ (0.9 m^2) room, about 500 Japanese quail can be reared up to market age (5 weeks). Alternatively, two weeks rearing on the floor, followed by cage rearing up to market age, can also be practised.

Rearing Japanese quail for meat

Japanese quail chicks are purchased as day-old chicks, reared up to the age of five weeks, and sold to the market for meat. In a thoroughly cleaned and disinfected room, brooding arrangements are made in advance, to receive the chicks on the anticipated date. Litter material like paddy husks or groundnut hulls is spread to about 2.5 cm depth, and empty gunny cloth or a corrugated sheet is spread over it. A brooder guard in the form of a cardboard sheet or metallic sheet about 20 cm high is arranged in a circle over the gunny sheet on the litter material. It is fastened properly.

Japanese quail chicks are very tiny and cannot adjust themselves to a chilly or cold environment. Adequate warmth must therefore be ensured by the provision of electric bulbs at the centre of the brooder guard arrangement, or by coal-stove heating or gas brooding. The room must remain covered up to the roof on all four sides, with full walls and windows. Open-sided houses with mesh arrangements must be closed with thick screens to conserve the heat. In a brooder guard circle of 3 feet diameter (90 cm), about 150 chicks can be accommodated. It is not advisable to allow more than 300 chicks inside one circle. An electric bulb with a hood cover can be provided at 15 cm height at the centre of the circle, providing approximately 1 watt per chick. The heating arrangement has to be continued day and night during the first week, but only during the night in the second week. The brooder house temperature at the level of the birds has to be about 98°F, which may be reduced by about 3°F every 3 days. During the winter and rainy seasons, heating has to be continued during the third week as well, while during the summer, the practice may be restricted to only 10 days. From the third week onward, Japanese quail chicks do not require night lighting.

Drinkers and feeders should not be kept under the source of heat inside the brooder circle. A drinker space of about 0.3 cm, and a feeder space of 0.6 cm per bird, must be provided during 0-2 weeks, and this has to be increased to 0.6 and 1.2 cm respectively from 3-5 weeks of age. The drinker size should be adjusted so that the gap between the brim of the plate and the cup should not be more than 1 cm, otherwise the chicks will get into the drinker and drown. Up to two weeks, two chick drinkers of 10 cm diameter and 1.5 cm high on the sides, each of 500 ml capacity, and two feeder plates of 22 cm diameter and 2 cm high will be sufficient for 150 chicks in each brooder circle. From the third week, a linear feeder 45 cm long, 2.5 cm high and 10 cm wide, and a drinker of 15 cm diameter and 2.5 cm high at the brim and 1 200 ml capacity will be sufficient for 75 quail chicks.

Cage rearing

Two differently designed types of cages are required to rear Japanese quail chicks up to market age. A brooder cage is required to rear them from day-old to 17-18 days of age and a grower cage from 18-19 days to market age. The cages are designed as multi-tier cages (four or five tiers arranged one over the other) with about a 10 cm gap between each tier, and a droppings tray fitted into the gap. Each tier can further be divided into smaller compartments. A brooder cage can be constructed as four or five tiers of 180 x 120 x 25 cm, and each tier can be divided into four compartments of 90 x 60 cm each. About 100 chicks can be reared in each compartment, and 400 chicks in each tier. Provision must be made for heating bulbs in the centre of each compartment. Appropriate side feeders and drinkers are provided inside the compartment itself. The grower cage can be 240 x 120 x 25 cm size, with each tier divided into four compartments of 120 x 60 cm each. About 60 quail can be reared in each compartment up to market size. Feeders and drinkers are fixed outside the cage units.

Feeding is done three times a day and watering twice a day without limiting the intake. Japanese quail chicks should not be left without feed or water at any time of the day. This will affect their growth rate and increase the mortality rate.

Growth rate

The average growth rate, feed consumption and feed efficiency of meat-type Japanese quail can be seen in the following Table, and the quail performance on any farm can be compared with this. The required managerial corrections can then be made to ensure optimum performance.

TABLE 9.1 Growth performance of meat-type Japanese quail

Age (week)	Body weight (g)	Cumulative feed consumption (g)	Feed efficiency
1	28	30	1.1
2	55	85	1.5
3	85	170	2.0
4	120	300	2.5
5	155	450	2.9

Diseases

Japanese quail are comparatively more resistant to infectious diseases than chickens. Fowl cholera, coli-bacillosis, enteritis and mycotoxicosis are some diseases that affect Japanese quail. However, more deaths (up to even 20-25 percent) occur during the brooding age (0-14 days) owing to managerial errors, especially failure to provide adequate warmth, the entry of chilly air, too many chicks in one brooder unit, improper drinkers, etc. If adequate care is taken, the mortality rate up to market age can be restricted to 8-10 percent.

Feed

Ingredients required to prepare Japanese quail feed are the same as for broiler-type chickens. But Japanese quail need more protein and amino acids, as they grow very fast. In addition, the size of feed particles has to be finer for birds up to two weeks, as Japanese quail chicks are very small. Beyond two weeks, broiler starter mash can be used.

TABLE 9.2 Nutrient requirement of Japanese quail under tropical conditions

Nutrient	Quail broiler feed		Quail layer feed		
	0-2 weeks	**3-5 weeks**	**0-2 weeks**	**3-5 weeks**	**6 weeks & above**
Metabolisable Energy (Kcal/kg)	2800	2900	2750	2700	2650
Protein (%)	27	24	24	20	19
Minerals					
Calcium (%)	0.8	0.6	0.8	0.6	3.0
Av. Phosphorus (%)	0.3	0.3	0.3	0.3	0.45
Vitamins					
Vitamin A, (IU)	8000	8000	8000	8000	8000
Vitamin D_3 (ICU)	1200	1200	1200	1200	1200
Riboflavin, (mg)	6	6	6	6	6
Amino acids					
Lysine (%)	1.30	1.20	1.20	1.10	0.80
Methionine (%)	0.48	0.45	0.45	0.40	0.33
Methionine + Cystine %	0.75	0.70	0.70	0.65	0.60

TABLE 9.3 Suggested feed composition for Japanese quail

Name of ingredient	Level of inclusion (kg)		
	Quail Starter Mash (0-2 weeks)	Quail Finisher Mash (3-5 weeks)	Quail Layer Mash (>5 weeks)
Maize/corn	35	38	42
Pearl millet/sorghum	14	14	15
Peanut meal (SE)	15	13	8
Soya bean meal	25	20	12
Sunflower meal (SE)	-	6	8
Dry fish	8.5	6.5	6
Mineral mixture	2.5	2.5	2.5
Shell grit	-	-	6.5
Total (kg)	100	100	100
Vit. AB_2D_3 (g)	10	10	10
Manganese sulphate (g)	5	5	5
Choline chloride (g)	-	-	50
Trace mineral mixture (g)	250	250	250

Protein and energy: Protein and energy constitute about 90 percent of the total cost of the diet, and any attempts at economizing on the diet mean reducing the levels of the protein and energy. One of the most important factors in the formulation of quail rations therefore is that the energy-protein ratio must be balanced in such a way as to get the maximum production with the minimum wastage.

Amino acids: The essential amino acids that are likely to be deficient in practical cornsoya diets for quail are lysine, methionine and cystine in the starter and grower diets, and methionine and cystine in the layer diets. Particular care must therefore be taken in maintaining the levels of these amino acids.

Minerals and vitamins: Minerals and vitamins are only 5-6 percent of the total cost of the diet, but a deficiency of a single mineral or vitamin limits the performance of the bird. Usually, calcium and phosphorus are balanced in the diet, and other minerals (sodium, copper, iodine, iron manganese and zinc) and vitamins (vitamin A, D3, riboflavin, pyridoxine, folic acid, pantothenic acid and choline) that are likely to be deficient, are supplemented in the diet to well above the minimum requirement, to ensure a safety margin.

Fat: Because of the high protein, high-energy quail rations, it may at times become necessary to add fats and oil to the diet to boost the energy content. To minimize the adverse effect that added fat may have, choline and vitamins B_{12} and E must be supplemented in the diet. It is also advisable to add ethoxyquin or butylated hydroxy toluene (BHT) at a level of 0.0125 percent.

Crude fibre: Although quail do not make good use of crude fibre, a certain quantity is required to form the necessary bulk to satisfy their hunger. Quail can make fairly good use of rations containing up to 8 percent fibre.

Aflatoxin: Quail have been reported to be more resistant to aflatoxin than ducklings and turkey poults, but less resistant than chickens. Quail may tolerate a dietary aflatoxin level of 0.2 ppm during the starting and growing periods (0-5 weeks) and 0.3 ppm in layers.

Feed medication: Quail are generally considered to exhibit greater resistance to most diseases and parasites, making the routine usage of medicated feeds for quail much less common than for chickens.

The salient points to be kept in view for efficient feeding of quail are:

- Quail can be fed an all-mash feed in dry, wet or crumbled form. At present, all-mash feed in dry form is preferred, because of increased managerial problems with the wet form and an increased cost in the pelleted or crumbled form;
- Fine grinding of feed ingredients is essential during the first two weeks; later, medium grinding may be adequate;
- The feeding must commence the moment quail chicks arrive;
- It is normal to feed the quails as much as they want;
- For the first 2-3 days, the feeding trough should be filled to overflowing, and some feed spread above the paper floors. This helps the chicks to start eating. Later, galvanized feeders 5 cm wide and 5 cm deep with welded wire strips placed over the feeder to prevent feed wastage, can be used successfully;
- Designing the feeding trough so that it is suitable to the number of birds and the age group helps in minimizing feed wastage and also helps in the adequate feeding of the birds. The design should also prevent the birds from entering the feeder, and keep feed spillage to the minimum;
- The desired floor and feeding space per age group should be made available to the birds, so that they are able to consume the required quantity of feed;
- Feeders should never be filled to more than half the volume, and feeding should preferably be done twice daily;
- Water can be provided in a plastic jar inverted into a small enamel dish, or it can be made of galvanized aluminium sheeting. Clean fresh water must be provided at all times, with the required drinker space per bird;

- Feed efficiency will always be poor if a flock is under stress. Avoiding or combating stress reduces feed wastage;
- The feed required up to 6 weeks of age is about 500 g per chick, and thereafter it is about 25 g per bird per day. Feed conversion in the quail from hatching to 6 weeks of age ranges from 3-4 g of feed per gram gain in body weight. During the laying period, it requires about 3 kg of feed per kilogram of eggs at maximum lay;
- In hot weather, feed consumption is less. It is better to give high protein and high vitaminized feed during summer. Feeding should be done during the cooler parts of the day to promote feed consumption.

Quail meat

Japanese quail can be sold to the market at five weeks of age as live birds or as dressed or cleaned meat. The practice of hot water dipping and defeathering is not followed, and the skin is removed along with feathers, after the birds have been bled, by slitting the necks. It is not advisable to market Japanese quail weighing less than 150 g. Cleaned meat will be 70-74 percent of the live body weight.

Quail meat contains more protein (22-24 percent) and less fat (about 2 percent) than most other kinds of meat, like mutton, chicken, etc. Therefore, it is good for growing children and youths, and also for convalescing and health-conscious adults. Quails carry more meat in the breast region (41 percent) and also contain a high amount of calcium. Quail meat can be stored in deep freezes at -20^{o}C for about six months after drying (30 mt) and chilling (4h). Quail meat can also be canned and pickled.

Quail meat is tasty and therefore considered as a delicacy. It is highly suitable for preparation in various different ways, and is liked by people of all religions, all groups and all ages. For these reasons Japanese quail rearing for meat is proving popular among people seeking self-employment.

Rearing Japanese quails for eggs

Japanese quails can also be reared for eggs. A female Japanese quail reaches maturity and starts laying eggs at seven weeks, and continues to lay many eggs up to one year. Japanese quail eggs are tinted with black or grey spots. Each egg weighs about 10-12 g. Adult female Japanese quail can be reared on the floor or in cages. On the floor, four birds per square foot area (floor space: 225 cm^2) can be reared, while in cages five birds can be reared (f.s. 180 cm^2).

For floor rearing, a good-quality litter material, like paddy husks or groundnut hulls is spread to 5 cm depth on the floor, and the quail are reared on this. Feeder space of 1.6 cm and drinker space of 0.8 cm per bird are provided. Feeding and watering are done 2-3 times a day. Night lighting must be provided for four hours per day in addition to daylight. As female quail lay eggs during the evening hours, mostly between 4 p.m. and 7 p.m., the eggs can be collected by 7.30-8.30 in the evening. Otherwise, if egg collection is delayed until the morning of the next day, the eggshells may be damaged or cracked because of the frequently moving and active birds. Japanese quail eggs can be stored at room temperature for 5-7 days during normal seasons.

For cages, the cage floor must be fitted with 1.25 x 1.25 cm weld mesh, while the sides and top can be fitted with 7.5 x 2.5 cm mesh. Feeders and drinkers are fitted outside the cage. The cage height is adjusted to 20 cm. The cages can be arranged one over the other with a 10 cm gap in between, to fit the dropping trays. These trays must be cleaned every alternate day.

The floor of the cage compartment must be given a slope of 1/16 on the front side from the middle to ensure that eggs will roll downward to the front, which makes egg collection easier.

Adult female quail are bigger than male quail, and can be easily identified by the black or dull grey and white spots on their breasts, while in males, the breast is mostly uniform fawn in colour with light white spots. Male quail can be separated and sold for meat at five weeks of age, while the female quail are retained for table egg production. If eggs need to be hatched on a breeder farm, a sex ratio of 1:3 for male to female may be adopted and the excess males sold early for meat.

Feed for laying quail should contain 19 percent crude protein with 2 650 M.E. Cal/ kg. Laying starts at seven weeks and reaches a peak of 80-85 percent from 12-24 weeks of age. Japanese quail continue to yield eggs up to the end of one year, and about 260 eggs are laid during that period. Adult mortality rate is minimal. Fowl cholera, mycotoxicosis, egg peritonitis and heat stroke are some common diseases affecting adult Japanese quail.

Quail egg marketing

Quail eggs are tasty, and, weight for weight, they contain more yolk than chicken eggs. They can be served as boiled eggs for table purposes, and children are very fond of them. Quail eggs contain higher proportions of high-quality protein and fat. They can also be sold after pickling.

TURKEY PRODUCTION

All over the world turkeys are reared for their tasty meat. In many Western countries, turkey meat is the choicest white meat, because of its leanness and delicacy. Domestic turkey production started in Europe in the 16th century. The consumption of turkeys at Christmas is a tradition which was spread to other countries by the British and Spanish.

In India, turkey production is still in its infancy. Because of the structural changes that are taking place in the broiler production in South India, the small farmers who were eased out of the market are now looking to turkey production as an alternative means of employment, particularly as people are searching for diversified food items. The tendency to accept processed frozen food is now also growing in this region.

At present, Indian institutions, like Central Asian Research Institute, Izat Nagar, Uttar Pradesh, Department of Animal Husbandry, Kerala, Central Poultry Breeding Farm, Hessarghatta, Karnataka, Poultry Research Station, Nandanam of Tamilnadu Veterinary and Animal Sciences University, Chennai, University of Agricultural Sciences, Hebbal, Bangalore and Haryana Agricultural University, Hisar, are promoting turkey production among Indian farmers. Turkey meat has a tremendous commercial viability in the Indian consumers' market, because of its low fat and cholesterol content, compared with other meats available in the market.

BREEDS AND VARIETIES

From the sixteenth to the twentieth centuries, turkeys were spread throughout the world as domestic birds. Seven standard varieties, popularly called breeds of domesticated turkeys are recognized by the American standards of perfection for poultry, namely: Bronze, White Holland, Bourban Red, Narragansett, Black, Slate and Beltsville small white. A dozen more non-standard varieties, including wild turkeys, are also available. At the moment, only three varieties of turkeys are commonly used commercially: Large white (Broad-Breasted White), Bronze (Broad-Breasted Bronze) and small white (Beltsville white).

Sex differentiation

- Sexes can be separated by vent sexing at the time of hatching.
- Males of the species are usually heavier than females.
- Mature males of all varieties have conspicuous black beards attached to the skin of the upper region.
- Dewbill or snood, a fleshy protuberance near the base of the beak, is large, plump and elastic in males. It is relatively small, thin and non-elastic in females.
- Male poults (young turkeys) display a temper, and are easily startled even at day-old age, and this continues throughout their lifetime. This behaviour is not seen in female turkeys.

Procurement of poults

Poults should be ordered from a hatchery which has disease-free breeder flocks. They should be hatched from eggs dipped in antibiotics (gentamicin or tylosin) to control egg-transmitted organisms.

Poults should be toe-clipped on the inside and front toes of each foot at the hatchery. Toe clipping prevents back scratches, when the birds climb over one another at the feeders and drinkers or in crowds during rearing.

The eggs of a normal turkey are tinted and weigh about 1.3 times more than chicken eggs. The incubation period is 28 days for turkey eggs. This period is 12-24 hours less in the case of light varieties of turkeys.

MANAGEMENT

Intensive system

The management of turkey production is similar to that of chickens. The building should be located at an elevated place, and cement floors are preferred. Turkey poults grow rapidly and for the best performance they should never be overcrowded. About 900 cm^2 of floor space per poult is required during the first 3-4 weeks, and thereafter up to the eighth week the floor space is increased to 0.135 m^2 per poult. A compartment of 3 x 3 m will therefore be suitable for housing 100 poults up to 4 weeks of age, when they may be transferred to a compartment of 3 x 4.5 m for further floor brooding until 8 weeks. From 9-12 weeks of age, the floor space must be increased to 0.18 m^2 per growing poult, and thereafter until sixteen weeks of age, the minimum floor space allowance is 0.23 m^2 per poult. After sixteen weeks, they require 0.36 m^2 per turkey. For small type turkeys, the floor space requirements may be reduced slightly. The floor space is reduced to almost one-third under the range system, since only a small shelter is required to protect them from rain and sun.

Turkeys require warmer conditions than chickens, and a temperature of 95^{0}F should be maintained during the first week of brooding. After this age, the brooder temperature may be reduced approximately 5^{0}F weekly until it reaches 70^{0}F or the equivalent of the prevailing environmental temperature. Artificial heat may be discontinued during the sixth week in winter brooding, and in the fourth week in summer brooding. Debeak the birds at about 10 days of age. Remove the upper part of the beak halfway between the tip and the nostrils with an electric debeaker.

The turkeys of a heavy breed or variety may be marketed for meat at approximately 16 weeks, when hens usually reach a live weight of about 8 kg and toms weigh approximately

12 kg. Similarly, friers or roasters can be produced by slaughtering at an earlier age according to the demand of the local market. Native nondescripts weigh much less, with males at 6 kg and females at 4 kg at 16 weeks; however, some retailers prefer these weights.

Nutrition and feeding

The turkey grows very rapidly. The male of the fastest growing commercial bird on the market will multiply its day-old poult weight 22 times by 28 days, and 320 times by 140 days. Achieving such a rapid growth rate requires a high nutrient intake. The turkey has a very low fat content compared with other commercial avian species. For this reason, turkey diets have a smaller energy to protein ratio than those of other species.

Balanced feed for turkeys may not be available commercially as easily as that of chickens; however, experienced farmers can easily prepare their own feed in consultation with a poultry nutritionist. As turkeys require more protein, minerals and vitamins than chickens to support their fast growth, turkey rations are more costly than chicken rations. Since the energy and protein requirement of the two sexes vary, they may be separated to obtain better results. Poults give more trouble than chickens with respect to feeding. The sooner they are fed after hatching, the better. If they don’t find feed and water easily, starvation or dehydration can occur. Turkeys must always be fed on troughs or hoppers, and never on the ground.

Paper is laid underneath the feeders for the first few days to prevent them from eating the litter. The use of smooth-surfaced paper is not recommended, since slippery surfaces, used over prolonged periods, can cause foot and leg problems in young poults.

From seven days to three weeks of age, use small feeders. Provide 5 cm of linear feeder space per bird. From three weeks to market age, the poults should have access to larger feeders about 2.5 cm deep and providing 7.5 cm linear feeder space per bird. Hanging tube-type feeders are excellent for turkey poults.

Usually, poults are started on either glass or plastic fountain-type drinkers or automatic drinkers. From one day to three weeks, they should have access to three drinkers of 1 or 2-gallon capacity per 100 poults. From three weeks to market age, they should have two 5-gallon fountains per 100 poults, one 4-foot automatic drinker or its equivalent. For smaller flocks, adjust the number and size of drinkers as necessary.

TABLE 9.4 Feed for turkeys

Age of poultry (week)	Type of feed	Crude Protein (%)	Energy (Cal/kg)
0-5	Starter diet	28	2 800
6-8	Grower-first diet	26	2 800
9-12	Grower-second diet	22	3 000
13-Market age	Finisher diet	16	3 300
13-24	Holding/pre-layer diet	12	2 750

Reproduction

Most modern turkeys have been selected for rapid growth and breast conformation. While the breeders have successfully achieved the desirable conformation, the reproduction performance has been seriously affected. Since toms are not able to achieve natural mating properly, artificial insemination is commonly used to obtain the desired fertility levels. The number of eggs produced per hen housed in a season generally depends on the genetic background of the stocks used, as well as on climatic conditions, feeding regimes and management conditions including artificial lighting. The average age at which the first egg is laid is around 26-28 weeks. There is evidence to suggest that egg production is adversely affected when it starts below the minimum age. With adequate artificial light, the turkey hens lay as many as 100 eggs in the first 24 weeks with optimum fertility and hatchability and 60-70 poults are the optimum from each breeder hen. The breeder diet should contain 14 percent of crude protein with 2 650 KCal/kg of metabolizable energy in South Asian countries.

B. Semi-intensive and range system

Turkeys are also reared under range systems in the backyards of rural households. Popular commercial production is through a semi-intensive system. Under this system, turkey poults are reared up to four to six weeks of age in closed, confined houses, after which they are allowed to forage for a few hours in an open yard during the day and then housed in the shelter for the rest of the day and night. Growers and breeders are reared under this type of semi-intensive system.

TABLE 9.5 Floor space allowances for turkeys under semi-intensive system

Age	Space per bird	
	Shelter	Open yard
7-12 weeks	0.09 m^2	0.18 m^2
13-16 weeks	0.16 m^2	0.32 m^2
17 weeks-market age	0.22 m^2	0.45 m^2
Breeders	0.27 m^2	0.54 m^2

When the turkeys forage, they consume the sparse cultivated grass and greens available in the open yard and the feed cost is reduced. The farmers claim that they are able to get better fertility and hatchability under the semi-intensive system than under the intensive system. The feeders and drinkers are provided inside the shelter in a shaded environment. Turkeys are better foragers than chickens, and can digest fibre better than chickens. They are therefore also fed cut legumes like lucerne (alfalfa), desmanthus, stylo, etc., in the yard, which helps to reduce the feed cost.

DISEASES

Turkeys are completely resistant to Marek's disease and Infectious Bronchitis. Newcastle disease, cowl pox and coccidiosis occur in a mild form.

Some of the commonly encountered diseases in turkeys are mycoplasmosis, fowl cholera, erysipelas and possibly haemorrhagic enteritis and avian influenza. Turkeys are protected against fowl cholera and erysipelas by vaccination. It is difficult to control mycoplasmosis (caused by *Mycoplasma meleagridis*), since the disease is transmitted through eggs and semen. This disease can be eliminated or reduced by using Mycoplasma-free turkey breeding populations, and by dipping the hatching eggs in antibiotic solutions (Gentamycin or Tylosin).

In case of a disease outbreak, the sick birds must be isolated. If the outbreak occurs during the brooding period, the brooder house must be thoroughly cleaned; and if the outbreak occurs in birds in the yard, the flock must be moved to clean ground and the veterinarian should be consulted for treatment. Normal mortality under standard management up to maturity is 6-10 percent, and the farmer should not be unduly alarmed by the sporadic death of one or two birds in a flock. If fowl pox is prevalent in the area, vaccinate the growers between 6-8 weeks of age. Breeders must be given booster vaccinations by about 7-8 months of age.

To ensure success in turkey production, the farmer should select a breed that suits the market demand, and buy from a good-quality flock. He should ensure that a reliable heating system for brooding is provided and take adequate additional care during the early stages (up to six weeks). He should start fattening the birds and adjust the marketing age to match the peak demand seasons, for which he should have planned carefully.

DUCK PRODUCTION

Ducks are important members of the poultry sector in South Asian countries; about 55 percent (FAO Statistics, 2001) are found in the Asia-Pacific region. Of the Asian countries, China possesses the highest duck population. In most South Asian countries, only indigenous ducks are reared for their eggs, with meat being a by-product. The traditional extensive system of duck rearing is still the most dominant in this region.

In India, duck production is mostly concentrated in the eastern and southern states, like Assam, West Bengal, Tripura, Tamil Nadu, Andhra Pradesh, Kerala and Orissa. Duck rearing in these areas is popular for the following reasons:

- Availability of waterways and ponds. Chickens or other types of livestock do not flourish in marshy wetland areas, which are ideal for duck rearing;
- Ducks are prolific layers. Even native breeds with a high disease resistance lay 160-180 eggs in a year under the nomadic extensive system of rearing;
- Duck eggs are 10-15 percent larger than chicken eggs;
- Ducks continue to lay at a higher intensity even during their second year of laying, which reduces the cost of replacement;
- Ducks lay most of their eggs during the night and early in the day, which suits the nomadic system of rearing;
- Ducks can move around in groups, remember the position of the ponds, and come back on their own, and they can also be easily shepherded;
- Ducks consume spilled grains in harvested fields, and insects and snails in wet fields by foraging, and so supplement part of their feed requirement on their own, which greatly saves feed cost making them economical to maintain;
- Ducks require less care and attention in management than chickens;
- Ducks are hardy and resistant to most of the avian diseases.

BREEDS

Most of the domesticated breeds of ducks are the descendants of the wild mallard. Most of the indigenous ducks are nondescripts of which “Sythet mete” and “Nageswari” are the common native breeds. Apart from these, distinct local varieties have also been identified. In Assam, “Pati”, “Deo”, “Hanh”, “Raj Hanh” and “Nageswari”. Similarly in Kerala, “Chara”, and

"Chemballi" are some local varieties. But so far, these breeds or varieties have not been improved either for egg or meat production.

The improved varieties of ducks are classified according to the purpose for which they are used. The meat-type ducks include Pekin, Aylesbury, Muscovy, Rouen, Cayguga, Buff and Swedish breeds. The egg-type ducks include Indian Runner and Khaki Campbell. The ornamental classes include the Call, Crested White and Black East India breeds.

It was only during the late twentieth century that efforts were made to introduce exotic ducks, especially Khaki Campbell for eggs and White Pekin for meat. Even then, it did not change the population ratio between native and exotic ducks in India. The poor acceptance of Khaki Campbell by duck farmers was due to their poor egg size and the increased susceptibility to diseases, compared with desi ducks.

Drakes (male ducks) are identified by their typical "belching" sounds, and the presence of drake feathers in the tail region, while females produce "hak" sounds from about six to seven weeks of age.

Although the domestic ducks of Asia are indigenous, their production practices are so highly developed that some stocks would be better classified as middle-level. The farmers face various difficulties such as financial problems, unfavourable seasons, migration, etc. The minimum egg production reported by most of the farmers is about 140-150 eggs per duck per year. However, the annual egg production under the nomadic system of rearing, averages 180-200 eggs. The male-to-female ratio ranges from 1:15 to 1:25 but one drake for one dozen ducks results in good fertility. Indigenous ducks, the "Sythet mete" and "Nageswari" breeds, produce 200-220 eggs per year.

Duck development programmes in India

Duck development programmes began on a small scale during the early 1960s. A few extension or demonstration centres were established to popularize the improved varieties of ducks and to train the farmers; 3 000 Khaki Campbell ducklings were imported. The Regional Duck Breeding Farm at Haringhatta, West Bengal, was established. In 1971, eight Khaki Campbell ducklings were imported from the United Kingdom. These superior egg-layers were distributed to states such as Assam, Andhra Pradesh, Haryana, Jammu and Kashmir, Kerala, Orissa and West Bengal. The Regional Exotic Duck Breeding farm was established near Agartala (Tripura) in 1976, and in 1981 2 978 Khaki Campbell ducklings were imported from the United Kingdom.

The farm established at Sumbal-Kashmir, was then developed into a modern duck breeding and hatching facility with Khaki Campbell and White Pekin Ducks from the United Kingdom. The Kerala state government has established a modern duck-breeding farm at Thiruvalla in addition to the farm at Niraman.

In 1986 the Tamil Nadu Agricultural University established two Duck Research and Development Centres at Kattupakkam and Trichy in Tamil Nadu. Duck-breeding farms were established in the West Bengal and Sipajhar regions of Assam, to boost the economy of the weaker sections of the rural community.

The Indian Council of Agricultural Research (ICAR) has established a National Research Centre at Bhubaneswar, Orissa, for the improvement of duck production, by studying the adaptability of exotic duck breeds under Indian agro-climatic conditions. Recently, under

National Agricultural Technology Projects, ICAR has sanctioned projects on "Productivity Enhancement of Ducks" in Kerala, Tamil Nadu, Andaman and Nicobar.

EXTENSIVE/NOMADIC SYSTEM OF DUCK REARING

The present system of rearing ducks in India is the extensive system. Most of the duck farmers belong to the agricultural landless labour group which has duck farming as its only source of income. Scientific housing and feeding systems are therefore not practised. These rural duck farmers obtain financial assistance from their landlords and/or egg vendors. The loan is repaid more often than not in the form of eggs and spent birds.

The flock size is usually expressed in terms of dozens, averaging 15 dozen with a range of 10-25 dozen ducks. The ducks are allowed in the harvested paddy fields or waterways for foraging, and held in bamboo enclosures during the night, or sometimes herded into a raised house. During lean seasons, ducks are hand-fed with grains such as paddy and sorghum, and at times unsalted fish, palm pith, etc., are also given.

The eggs intended for hatching are collected clean, without soiling or contamination and sold at 8-10 percent more than chicken eggs. Many wholesale duck vendors candle the eggs before transporting them.

Hatching duck eggs is synchronized with rice harvesting. It is seasonal and occurs during October-November and January-February months. The farmers use broody hens for hatching. About 20 eggs are set per hen, and the incubation period is 28 days. Hatchability of above 60 percent is normally achieved. Some experienced farmers achieve 80-85 percent hatchability of the set eggs.

The ducklings are generally removed from the broody hen on the second day and confined in temporary sheds up to 7 days, while they are hand-fed with broken rice grains and rice bran. After 7-10 days, they are allowed on the waterways and only after a month are they herded to forage on harvested paddy fields and wet areas, until they are ready to lay at about 6 months of age. Farmers normally maintain their flocks for two years of production, or purchase layer ducks which have completed one year of production and are being kept for another year. The surplus drakes and spent ducks are sold for meat purposes.

In many places, considerable losses occur because of the migration of flocks in search of fresh feeding resources and hand-feeding during lean seasons and in between harvest seasons. In developing countries, the duck can be useful as a scavenging bird, utilizing large amounts of insects, thus having the two-fold benefit of improving feed utilization efficiency and reducing insect problems in the field. In China, ducks are specially trained to ingest grasshoppers, which would otherwise destroy agricultural lands.

INTENSIVE/SEMI-INTENSIVE SYSTEM OF DUCK REARING

Incubation and hatching

A mating ratio of 6-8 ducks per drake in layer breeding, and 4-6 ducks in broiler breeding, is advisable. Hatching eggs are collected 15 days after drakes are allowed to mate. Nests must be clean to ensure that they are free from *Salmonella,* which is common in duck eggs. Egg-type ducks start laying from 20-22 weeks of age. It is advisable that ducks are at least seven months old when they start laying eggs. The optimum weight of hatching eggs for ducks is 70-75 g. Since duck eggs are more porous, fumigation is advised only for 20 minutes after collection. The incubation period is 28 days. Muscovy ducks require 35 days for incubation. During the incubation period, the temperature should be kept at 37°C to 37.5°C with proper ventilation, and humidity should be 70-75 percent. High humidity can be maintained by sprinkling the eggs twice with lukewarm water during the second week, and every other day during the fourth week. Duck eggs must be turned at an angle of 180^{o} compared with the 90^{o} for chicken eggs. Duck eggs require cooling during incubation. The best results are obtained when the eggs are cooled to 32^{o}C for a maximum of 30 minutes per day, starting from the fifth day of incubation. Generally duck eggs have a lower hatchability than chicken eggs.

Egg production

Khaki Campbell and Indian Runners are used for commercial egg production. Egg-type ducks should have an upright carriage and considerably lighter weight. In varieties with orange or yellow bills, there is some loss of pigment, as they lay around 250-300 eggs per annum.

Meat production

White Pekin, Aylesbury and Muscovy are the well-known meat breeds. The White Pekin grows very fast and within seven weeks, attains a body weight of 2.2 to 2.5 kg. It does well in confinement and lays a good number of eggs with optimum fertility.

The commercial duck meat lines are the progeny of medium-sized females having a high rate of reproduction, and males with a considerable potential for growth. Male lines are derived from Aylesbury or Pekin and female lines from Pekin or White Pekin.

Brooding

Ducklings can be allowed on the free range after three weeks of age. Up to three weeks, any brooder house suitable for chicks can be adapted for ducklings. A 250 capacity chick brooder is suitable for 125-150 ducklings. The temperature under the brooder should be 29-35^{o}C (90-95^{o} F) for the first week, to be reduced by 3^{o}C (5^{o}F) every week until the ducklings require no further heat, usually at about 2-3 weeks of age depending upon the season.

Management

TABLE 9.6 Feeder space, floor space and waterer space requirement per bird of ducks (intensive system)

	Floor space (cm^2)		Feederspace Linear (cm)		Waterer space Linear (cm)	
Age	**Meat type**	**Egg type**	**Meat type**	**Egg type**	**Meat type**	**Egg type**
Up to 3 wks.	900	740	5	5	2.5	2.5
4 – 8 wks.	1 800	1 500	10	8	5.0	4.0
9 – 20 wks	2 700	2 250	12	10	6.0	5.0
Adult	3 600	3 100	15	12	7.5	6.0

The layer ducks can be reared under the free-range, semi-intensive or intensive system. The free-range system saves feed but it requires large areas of land. The semi-intensive system and the intensive system are therefore more popular. Under the semi-intensive system, 135 m^2 of covered area and 1.35-1.80 m^2 running space are needed for each duckling. Wire-net fences or partitions not more than 60 cm high are quite adequate for control. Watering and feeding arrangements may also be made in the run.

The intensive system may involve either a floor house or a cage house. The floor house may be a deep-litter or wire-floored house. Wire-floored houses are more hygienic for ducks, because the deep litter can frequently become wet from the watery droppings and splashing from drinkers.

The space requirement in a wire-floored house is about 70-75 percent of a deep litter house. In the-semi intensive system, provide a concrete water channel, 60 cm wide and 30 cm deep, parallel to the rearing and layer houses on both sides. Laying nests of 30 x 30 x 45 cm are essential for clean eggs; and for every 3 ducks one nest is provided. Though the duck is a waterfowl, water for swimming is not essential at any stage of duck rearing.

Feeding and nutrition

Damp or wet mash feed is to be provided twice a day at 8 a.m. and 5 p.m. Dry mash cannot be swallowed and must never be used. Ducks should never have access to feed without water.

TABLE 9.7 Nutrient requirement of layer ducks

	Crude protein (%)	M.E. (KCal/kg)
Starter mash	21	2 850
Grower mash	17	2 750
Layer mash	18	2 800

Khaki Campbell ducks consume about 12.5 kg of feed up to 20 weeks of age. During the laying period, daily consumption varies from 120-150 g per bird, depending on the production period and the availability of greens.

Ducks are very susceptible to aflatoxin, and the minimum toxic dose for ducks is 30 ppb or 0.03 ppm or 0.03 mg per kg of feed. Ducklings are sensitive to aflatoxin B.

Important diseases of ducks

a. Pasteurellosis (duck cholera)

b. Duck plague (duck viral enteritis), Herpes virus

c. Botulism – C-type toxin liberated by *Clostridium botulinum,* C-type antioxin is used for the treatment of sick birds.

d. Duck virus hepatitis, picorna virus, small RNA virus.

e. Aflatoxicosis.

Vaccination schedule

1. Duck cholera	S/C 1 ml	3-4 weeks
Adult 2 ml	After one month of first vaccine (booster dose)	
2. Duck plague	S/C 1 ml	8-12 weeks

Performance of Khaki Campbell ducks

- Age at first egg: 120 days
- Age at 50 percent production: 140 days
- Annual egg production: 300 eggs
- Egg weight at 40 weeks: 66 g
- Body weight at 40 weeks: 1.8 kg
- Daily feed consumption per bird: 120-150 g
- Duckling mortality: 2-3 percent (0-8 weeks)
- Grower mortality: 0.2-0.5 percent (0-20 weeks)
- Adult mortality: 5-7 percent (20-72 weeks)

Performance of broiler duck

- Day-old weight: 60 g
- Body weight at 4 weeks: 1.2-1.4 kg
- Body weight at 6 weeks: 2.0-2.2 kg
- Feed consumption up to 6 weeks: 4.5-4.75 kg
- Mortality (0-6 weeks): 2-3 percent

CONSTRAINTS IN DUCK FARMING

- Lack of scientific knowledge on duck husbandry practices
- Non-availability of quality ducklings
- Non-availability of feed
- Absence of proper bio-security measures
- Lack of financial resources
- Lack of an organized marketing system

Chapter 10
Environmental and social consequences

The poultry industry has become the fastest growing segment of agriculture in almost all the South Asian countries. Even though there are several economical advantages, intensive poultry production also has the potential to have adverse effects on human beings and the environment:

- Intensive poultry production requires huge amounts of vaccines and antibiotics, which pose a real threat to human and animal health, because of the resistance to antibiotics that could develop as a result of their systematic over-use.
- Intensive poultry production provides a fertile breeding ground for microbes in these countries, which often result in outbreaks of food-borne diseases and the transmission of animal diseases.
- Large-scale operations and automation reduce employment opportunities in rural areas and villages. Small farmers are less competitive. Large agri-businesses increase in size and power, often controlling both the supply and the markets, raising the prices. In addition, intensive production leads to the depopulation of the rural areas and increases problems in the urban areas.
- Intensive farming results in a move away from mixed farming systems, which have less of a risk factor and are more sustainable for small rural farmers.
- Intensification eliminates traditional native breeds with the result that the diversity of poultry germplasm is dwindling rapidly. Each variety that is lost takes with it irreplaceable genetic traits that may hold the key to disease resistance or survival in substandard conditions and extreme climates.
- Water scarcity is a major problem in most of the regions of South Asian countries, and poultry production is highly water-intensive.
- There is little or no control over environmental pollution in many of these countries. Poultry wastes lead to soil, air and water pollution.

ENVIRONMENTAL FACTORS

The sustainability of livestock farming in the world is dependent on both environmental and economic viability. There are many situations where environmental and financial goals are in direct conflict. The environmental consequences of intensive poultry production are often ignored. Waste from poultry farming causes pollution through different means:

Poultry manure: Deep litter manure and cage layer droppings from poultry are disposed of in different ways. In most of the South Asian countries, poultry manure is not disposed of properly, leading to soil pollution, air pollution and pollution of water resources.

Dead birds: Sporadic death of birds is quite common on poultry farms. Especially under intensive poultry farming, the number of dead birds in a single day can be hundreds, since even under standard management a 4-6 percent mortality rate among broilers and 10-12 percent among layers is experienced. These dead birds, if not disposed of properly, pose a danger to other flocks and farms, and cause soil, air and water pollution.

Toxic chemical residues in eggs and tissues: Egg and poultry meat may contain residues of chemicals used on feed ingredients of plant origin, chemicals used in poultry feeds and cleaning agents which, when consumed, pose dangers to human health. Antibiotics fed as growth promoters may also cause antibiotic resistance in human beings. Micro-organisms like *Salmonella,* present in eggs and meat, may cause food poisoning in human beings.

Noise and odours: Poultry farms cause sound and air pollution which can adversely affect poultry, animal and human welfare.

Fly menace: Flies are attracted by the moisture and warmth of poultry droppings and lay eggs on them. The fly menace is a common problem in cage layer farming in tropical countries and affect poultry and human welfare.

Debris from hatcheries: Waste from processing plants and dust from poultry feed plants also act as pollutants.

POULTRY MANURE DISPOSAL

A growing concentration of egg production units results in the production of poultry waste on a large scale. Assuming that a layer annually produces 18 kg of dry matter, current annual poultry waste production could be estimated around 4,500 thousand MT in India. This also poses problems of handling and disposal for many poultry producers, with the public becoming more aware and concerned about environmental pollution.

Two main types of waste are produced by poultry enterprises depending on the rearing system adopted on the farm: poultry litter and cage layer waste. Poultry litter is the waste from deep litter systems and does not have much nutritive value, since it contains mostly used litter material. Cage layer waste consists mainly of excreta collected under the cages, spilled feed and feathers. Cage rearing of layers is the most widely followed system for layers.

Recycling poultry waste

The use of poultry waste as a source of manure for crop production has been the preferred system for recycling nutrients. In recent years, poultry nutritionists have explored the possibility of recycling poultry waste as a feed for the poultry itself. Poultry droppings, until now considered as waste, or used sparingly as manure, may prove to be an alternative for conventional feed ingredients.

Poultry excreta is commonly referred to as dried poultry droppings, cage layer excreta, dried poultry waste or dried poultry manure. Dried poultry waste reportedly contains about 30 percent crude protein, of which about 60 percent is from non-protein nitrogenous sources. It has more mineral value. Poultry waste has a high water content and there is a need to develop suitable and economical processing technology to remove excessive moisture and destroy harmful pathogens from the organic waste. It is high in fibre and low in metabolizable energy.

The true digestibility coefficient of crude protein in poultry litter is about 64 percent. Some of the constituent amino acids were found to range from 24.7 percent (for valine) to 76.4 percent (for serine). The absorption of calcium and phosphorus was characteristic of the individual bird and ranged from 1.2-45.3 percent for calcium and from 7.5-46.2 percent for phosphorus.

Poultry droppings may contain various types of microbial organisms and moulds. Therefore, before poultry manure can be recycled as poultry feed, it needs processing. The drying and duration of storage may also help in altering the microbial load in fresh droppings.

Drying

Probably the oldest method of processing waste for refeeding is the drying of poultry manure in natural air conditions under sunlight. This is the cheapest and most feasible method in a tropical country. Moreover, fresh poultry droppings have a lower moisture content than manure from other livestock, making sun drying the most effective processing method.

Air-drying requires varying lengths of time depending on the climate and especially on the level of humidity. Drying the manure with heat has also been attempted. The manure may be dried at temperatures ranging from 149-385°C. Drying with heat results in a highly significant loss of energy and a significant loss of nitrogen. Thin bed drying of poultry manure to 30 percent or lower moisture levels was found to prevent the breeding of flies, to reduce obnoxious odours and to maintain the nutrient value of the manure particles. The faster the manure is dried, the higher is the nitrogen value.

Heaping

Deep stacking of poultry waste produces considerable heat and had been shown to destroy coliforms. The maximum temperature was reportedly attained in 4-8 days. When litter from the broiler house is placed in a heap, the heat which subsequently develops, is sufficient to destroy the pathogenic organisms that are present.

Pelleting of feed

Pelleting is a feed-processing procedure that is employed by the feed manufacturing industry to improve farm animal performance. Changes occur to the feed when it is subjected to severe physical compression. Cage layer droppings contain a certain amount of undigested fibre portions. Disruption of cell walls that encapsulate nutrients by pelleting has proved to be advantageous.

Enzymes in feed

Dietary enzymes have a beneficial effect on feed utilisation if the feed mixture is made up of ingredients of low digestibility.

Poultry manure as organic fertiliser

Particular areas of concern to poultry and egg producers include confined poultry feeding operations and nutrient management for manure, litter and soil (water). Studies have shown that poultry manure and litter can compete economically with commercially available fertilisers, if properly used and if transportation costs are not too great.

Nutrients enter the poultry farm in the feed. These nutrients then pass from the animal into the manure, and from the manure into the soil. Food sources such as plants grow in the soil and obtain their nutrients from the soil. These plants are then consumed as feed and the cycle is repeated.

The cycle occurs because only portions of the nutrients are digested by poultry, with the remainder of the undigested nutrients passing into the manure. Because poultry operations are frequently concentrated in localized areas, the amounts of nitrogen (N) and phosphorus (P) generated in the litter and manure often exceed the fertiliser requirements for crop production on adjacent farms. When the continual application of poultry manure and litter exceeds the nutrient requirements of the crops, enrichment of nitrates in ground water and phosphorus in surface water can occur. There has also been some disagreement as to what represents an acceptable content of phosphorus in the soil.

With proper management and controlled transportation costs, poultry manure and litter can be sold and used as fertilisers, feed or as sources of energy. However, if proper procedures are not followed for managing the litter or manure after their removal from the chicken house, valuable nutrients can be lost. Methods such as stockpiling uncovered manure during the winter season for application to cropland in the spring can result in up to fivefold reduction in the nitrogen content of the manure.

When poultry litter and manure are applied to the soil surface, about half of the nitrogen and other components are available for plants to use. Excess phosphorus presents a special problem because, as a result of its low solubility, it tends to be immobile in the soil. Consequently, it does not leach, but adheres to the soil particles, contaminates the surface water and causes erosion.

Poultry growers frequently do not appreciate the large amounts of nitrogen being applied to the soil when spreading manure and take little or no account of its nutrient content when planning application rates of the manure, litter and subsequent inorganic fertilisers.

A key to successful waste management is good nutrient management, which takes into account the nutrients present in poultry diets, excreted nutrients, and loss of nutrients during storage, transportation and application to the land as well as use of the nutrients by the plants.

The nutrient content of poultry diets should also be analysed whenever poultry feed formulations is developed. The primary function of dietary protein is to supply the amino acids required by the animal for structural and functional purposes. A large part of the nitrogen losses is a consequence of an imbalance in the amino acid make-up of the dietary protein or of inefficiencies in digestion and absorption. It therefore follows that the excretion of nitrogen in the faeces and urine can be influenced by dietary manipulation.

The use of synthetic amino acids and the application of ideal proteins and digestible amino acids could reduce both dietary protein concentrations and nitrogen excretion by poultry and ammonia production from their manure.

Phosphorus is one of the mineral elements that constitutes the inorganic part of plant and animal tissues. It is essential for the formation and maintenance of bones and exists in both organic and inorganic forms. Significant amounts of phosphorus are present in cereal grains and vegetable proteins. 50-80 percent of phosphorus is stored in plant feed sources as phytin or phytic acid and is largely unavailable to monogastric animals.

Phytase is one enzyme that assists in increasing the available phosphorus content of plant sources and decreases the need for supplemental dietary phosphorus. This, in turn, leads to a reduction in phosphorus excretion.

Feeding enzymes such as carbohydrases, lipases and proteases can also modify feed ingredients by improving dietary nutritive values and thereby reducing manure production.

Composting

Collecting poultry manure in pits under cages or slat or wire floors is gaining favour as a practical and economical way to handle poultry waste. The manure may be allowed to accumulate for several years through the process of composting. Aerobic bacterial action occurs. Many compost pits have been in operation for several years without manure removal.

The top foot is composed of fresh manure, the bottom foot is in an anaerobic condition and the central portion is undergoing composting.

The essential requirement in managing the deep pit is that the fresh, wet material be adequately aerated to remove the moisture. To further the composting process and to prevent odours, the pit must be watertight so that seepage water cannot enter. Care must be taken to prevent drinkers from leaking or overflowing into the pit, for such overflow prevents proper bacterial action in the accumulated wet manure. When the procedure operates correctly, there is little or no odour arising from the pits and manure removal may be delayed for years.

Pond disposal

Fresh poultry manure may be flushed into an open, shallow pond. Bacterial action reduces the waste material to a smaller volume. As bacterial growth occurs only during the warm months, the use of ponds is seasonal. The resulting solution may be spread in its liquid state on farmland. When aerobic action takes place, the lagoon produces little odour; but as the sludge builds up, anaerobic activity takes place and odours may be pronounced.

Aeration

The oxidation method is used for poultry by placing a continuous-flowing trough under the birds. Water is poured into the trough to keep the manure fluid and pumps keep the sludge circulating. The effluent is aerated by paddles. The addition of oxygen by the paddles increases the activity of aerobic bacteria, greatly reducing the incidence of any odours. After 4-6 months, the material is removed in liquid form and usually spread on the land. The material is practically odourless.

DEAD BIRD DISPOSAL

Dead birds on poultry farms should not be carelessly thrown out in the open. It will lead to the spread of infections and also cause major pollution problems. Various safe means of disposing of dead birds are:

Burying

This is a suitable method of disposal of birds for small farms that may not be able to afford to construct an incinerator. Where environmental regulations allow, a deep hole may be dug and the carcasses buried deeply so that they cannot be taken out and to prevent worms from carrying infections from the carcass to the surface of the ground. The best and easiest way is to dig a deep narrow trench. Each day’s collection of dead birds can be deposited and covered until the trench is filled. The dead birds can also be buried deep in the ground in plastic bags which will further reduce the chances of infections spreading.

Pit disposal

This is an effective and convenient method for disposal of dead birds which is within the means of poultry raisers. A decomposition pit can be used for small losses, but care should be taken in choosing the location of the pit:

- The pit should be a reasonable distance (150 feet) from the poultry houses and the well that provides the water supply;
- It is important that the roof or walls will not collapse easily;
- Flies and other insects must not be able to enter the pit and, above all, there must be no danger of small children falling into it;

- The area selected should have reasonably good drainage. Any area that might flood and fill the pit with water should be avoided.
- The pit cover should be sealed with tar paper or plastic and be strong enough to hold at least a foot of soil overlay where ground water levels are close to the surface (delta, lowlands, shorelines).
- The pit should be near the post-mortem room.

The success of this method will depend on the careful construction of the pit. It can be any size depending on the size of the flock. The most practical size is about 1.8 m square by 2.4 m deep. A pit of this size will serve for the disposal of dead birds over several years on a poultry farm of average size.

When constructing the pit, first dig an area of 3 m long and 3 m wide. A pit of 1.8 x 1.8 x 2.4 m is dug in the centre, leaving a 60 cm shelf on each side on which a concrete roof for covering the pit is laid. In the centre of the roof, a drop tube 30 cm square by 90 cm high is made, through which dead birds are dropped into the pit. A tight fitting lid should be made for the upper end of the tube to prevent the escape of foul odours and the entrance of flies. The tube should be extended 60 cm above the ground level and at least 30 cm of earth should be filled in over the roof and around the drop tube so that the water will drain away from the tube. If the soil is firm and well-compacted, casting to keep the edge of the pit from crumbling may not be necessary.

The dead birds in the pit will decay and as this happens, there will be room for more birds. When the pit becomes full, it should be sealed by filling the drop tube with earth. It is better to construct two such pits at the same time so that the other is available when the first is full.

Incineration

This means burning of the carcass. An incinerator is a furnace used for burning. Incineration is the preferred method of disposal, provided the carcasses are completely burnt. In this process electricity, firewood or oil is used. The design of the incinerator depends on the fuel used for the operation.

Electrical or oil-fired incineration is the best available technology for efficient and immediate disposal of carcasses. The major advantages of this method are:

- rapid destruction of disease-producing organisms, leaving only a small amount of ash, which can be distributed on the land;
- smokeless and odourless burning with minimal air pollution;
- negligible operation cost. Many commercial models of incinerators are available with a capacity ranging from 10-125 kg per hour.

Various types of homemade incinerators operated by firewood have also been used successfully. This type of incinerator is inexpensive, but consumes more firewood and may create undesirable soil and air pollution by producing more ash and fumes.

Septic tank disposal

This method of disposal consists of breaking down the carcasses and waste products in an electrically heated septic tank by the action of mesophilic bacteria. These bacteria multiply best at 32.2°C-37.8°C and accelerate decomposition. Heat is applied at 37.8°C and requires 2-3 kwh per day of electricity to maintain this temperature for the two weeks needed for destruction of all but the bones of the carcasses. The bacterial action and speed of decomposition can be accelerated by adding lime and hot water at intervals. Usually a tank of 2 000 litre capacity is required for a flock of 10 000 birds.

Composting

Composting is a controlled, natural process in which beneficial organisms (bacteria and fungi) reduce and transform organic waste into a useful end product called "compost".

Composting of poultry carcasses requires two types of composting bins, a primary or first stage composting bin and a secondary composting bin. Each day the dead birds are sequentially layered into the primary bin with used or caked litter, wheat or paddy straw and water in proportionate amounts. A one-foot layer of litter is first placed on the concrete floor of the bin. A layer of straw is added to aid aeration and to supply an adequate source of carbon. A single layer of carcasses is then placed into the bin and water is added to maintain the moisture. Finally, the carcasses are covered with a layer of manure. Thereafter, successive layers of litter, straw, carcasses, water and manure are added until the primary bin is full. Once full, a final cover of litter is placed over the carcasses.

The temperature of the compost increases rapidly as bacterial action progresses, rising to 60-70°C within 10 days. The increase in temperature has two important effects: it hastens decomposition and kills micro-organisms. The temperature begins to decrease in the primary bin 14-21 days later. At this point, the material is moved to the secondary bins, aerated in the process and allowed to proceed through a second rise in temperature. After the second heating cycle, the composted material can be safety stored until further use. When properly managed, composting is a bio-secure, relatively inexpensive and environmentally sound method for the disposal of poultry carcasses.

AIR AND WATER POLLUTION

The high stocking density in the modern poultry house may lead to reduced air quality with high concentrations of aerial pollutants. Pollutants include organic and inorganic dust, pathogens and other micro-organisms, as well as gases such as ammonia, nitrous oxide, carbon dioxide, hydrogen sulphide and methane. Most gaseous pollutants originate from the breakdown of faecal matter and the concentrations will therefore, at least in part, depend on the ventilation efficiency and rate, as well as the stocking density and movements of the birds.

Atmospheric ammonia is a major aerial pollutant of poultry buildings. Ammonia is a colourless, highly irritant, alkaline gas, which is produced during the decomposition of organic matter by bacterial deamination or reduction of nitrogenous substances. Ammonia often accumulates in high concentrations when poultry are confined in buildings and provided with artificial heat and ventilation. Ammonia is water-soluble and can therefore be absorbed by dust particles and litter as well as by mucous membranes. It is toxic to animal cells and the known symptoms of ammonia poisoning include conjunctivitis, coughing, sneezing and dyspnoea.

The current exposure limits for ammonia of 25 ppm are set on the basis of human safety rather than animal welfare. Ammonia exposure can:

- cause irritation to the mucous membranes in the eyes and the respiratory system;
- increase the susceptibility to respiratory diseases;
- affect food intake, food conversion efficiency and growth rate.

The litter type, management, humidity, pH and temperature affect the ammonia concentration and emission. Distribution of ammonia within the poultry house depends on the ventilation system, particularly the air circulation, as well as poorly maintained water drinkers, bird stocking density and flocking behaviour. Components of the aerial environment such as temperature, humidity, dust and pathogens may interact with ammonia and affect the welfare of the poultry.

Environmental factors such as aerial pollution may play an important part in the development of respiratory infections in poultry. Exposure to ammonia concentrations of 60-70 ppm may cause keratoconjunctivitis. Keratoconjunctivitis not only causes pain, but also hunger and thirst, because the bird's ability to find food and water is reduced. Impaired vision may also adversely affect breeder flocks.

Food consumption of both laying hens and broiler chickens decreases during exposure to ammonia and does not return to normal until approximately 12 days after the cessation of ammonia exposure.

After exposure to ammonia, there is a reduction in live weight gain, an increase in carcass condemnation and undergrading as well as a delay in the maturation of pullets.

Minimizing the emissions of ammonia from manure also reduces the impact of agriculture on the environment. A high atmospheric concentration of ammonia can result in acidification of land and water surfaces, causing damage to plants and reducing plant biodiversity in natural systems. Ammonia emissions from manure have been found to coincide with odours, which are a nuisance in areas of intensive livestock operations. Reducing ammonia emissions by altering manure management will also reduce the problems caused by unpleasant odours.

Decomposition of poultry manure results in the release of volatile (VOC) and reactive organic compounds (ROC) into the air. Currently there is much concern about the release of ROC and their effect on the ozone layer.

When manure disposal or storage is practised near water sources for a long period, seepage during rainy seasons washes the contents of the manure into the water resulting in a deterioration of the chemical and microbial quality of the water. It is suggested that the water supply in regions where poultry are grown should be analysed for mineral and microbial contents to determine its suitability for consumption.

FLY MENACE

The fly menace is a problem faced on poultry farms and surrounding areas, especially in cage layer farming. Birds reared on litter floors consume the larvae of these flies and the problem is not so intense; such a biological control system is not operative in cage rearing.

Flies cause irritation to the human labour force and reduce their efficiency at work; they cause stress to the birds leading to reduced feed intake and consequent production loss; they spread disease among birds and humans; they deface the appearance of eggs and equipment and cause loss by many indirect means.

The fly menace can be controlled by reducing stagnation of water on farm premises, preventing leakage of pipelines, attempting to control wet litter problems early, ensuring proper ventilation at base level, frequent removal of cage layer droppings during the wet seasons and by spraying insecticides on the droppings underneath cages and on stagnant water. The insecticides need to be selected carefully and sprayed in appropriate dilutions. Fly monitoring and control programmes need to be adopted with care and regularity.

SOCIAL FACTORS

Several social factors peculiar to the region also influence the growth or development of the poultry industry. These social factors are more important in the rural environment and therefore influence family scale rural poultry production more than high-intensive industrial production. Some of the social factors of importance are:

HEALTH HAZARDS

Drug Residues

Residues of harmful substances in poultry products might constitute a threat to human welfare. The conception or misconception of facts on residues will adversely affect the market for these products. The situation is complicated, because the after effects are not always immediately observable; but have a cumulative effect over a prolonged period. People become overcautious, especially those who are not well-informed about the possibility of these residues and their consequences. The presence of residues of antibiotics and antibacterials, hormones, beta-agonists, anticoccidials, pesticides, anthelmintics, etc., needs to be controlled through detection by laboratory analyses followed by appropriate legislative measures. This will aid in preventing related health hazards and also overcoming problems in marketing.

Food Poisoning

Because of their high nutritive value, poultry meat and eggs are very important in the diets of human beings. However, they may also act as potential sources of food poisoning, primarily because of *Salmonella* infections. Poultry products are highly perishable and improper storage leads to microbial spoilage and consequent food poisoning. Immediately after laying, the eggs are almost sterile but can be contaminated by the environment within a matter of hours. Initial infection of the eggshell and a gradual penetration through the pores of the shell can lead to contamination. Poultry meat is infected from its body system because of diseases, contamination of the carcass with gut contents, unhygienic conditions prevailing in the slaughter-houses and retailing units, long hours of exposure in an open environment at room temperature during display, and improper cold-storage conditions. Legislative controls need to be implemented and educating farmers and the retailers on the hygienic measures needed in South Asian countries may also prove helpful.

DEMOGRAPHIC FACTORS

Level of education

The level of education determines the speed at which knowledge and information on new and useful technologies are accessed and adopted. The rate of adoption of new knowledge affects the productivity and efficiency of poultry production.

Gender

In India, 60 percent of activities related to livestock and poultry rearing are carried out by women. Women take an active part in farm oriented activities, while men are actively engaged in commercial activities. However, women gain less access to training programmes on poultry production techniques than men in spite of their leading role in farming activities. As a result, attempts to improve productivity in rural poultry farming suffer.

Leadership

The role of village leadership in rural areas is also important. If the leadership is innovative and risk taking, it is easier for extension agencies to make technological improvements in rural poultry production.

Religion

In South Asian countries, religions influence poultry production. In some religions, consumption of meat is prohibited, while others encourage meat eating. Consequently, the demand for poultry products varies and this influences the growth of poultry production in such areas. Religion can also influence the level of involvement of women in poultry production activities.

ECONOMIC FACTORS

Cost

Cost factors affect both the processes of technological identification and technological dissemination. The high cost of implementing useful technology is an impediment to its adoption. In rural areas, the unit size of poultry farms is so low that it makes the cost of using any technology like vaccination, deworming, etc., very high.

Lack of resources

The availability of laboratories to analyse feed, poultry products, etc., determines the marketability of such products and also the cost and efficiency of production. Only a few less developed countries have strong adaptive research and extension systems. The input supply systems also need to be geared up to get the maximum pay off in extension. Lack of transport facilities lead to the establishment of poultry farms near urban areas with high market potential which in turns leads to urbanisation.

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