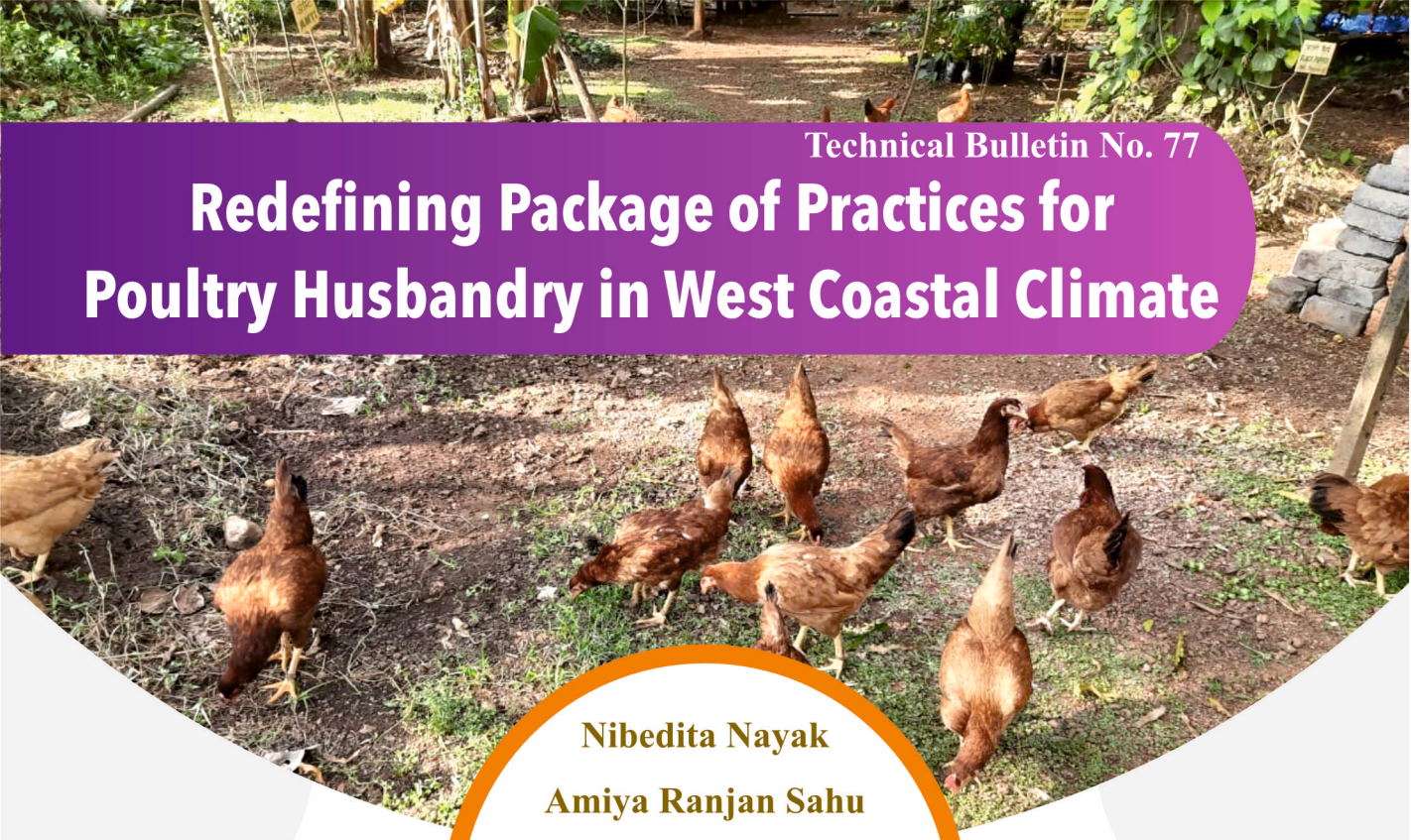
Technical Bulletin No. 77

Redefining Package of Practices for Poultry Husbandry in West Coastal Climate



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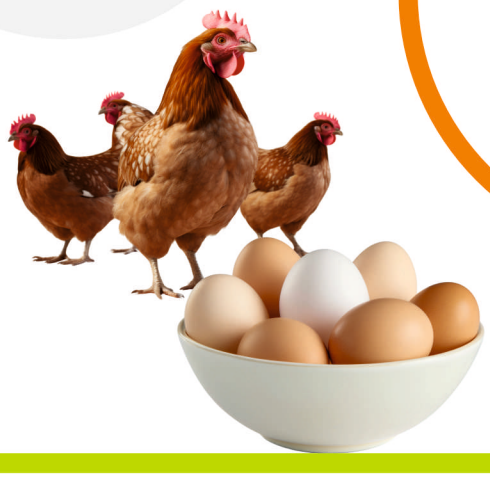

भाकृअनुप - केन्द्रीय तटीय कृषि अनुसंधान संस्थान
(भारतीय कृषि अनुसंधान परिषद)
ओल्ड गोवा - ४०३ ४०२, गोवा, भारत

ICAR-CENTRAL COASTAL AGRICULTURAL RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
Old Goa – 403 402, Goa, India

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भाकृअनुप – केन्द्रीय तटीय कृषि अनुसंधान संस्थान

भारतीय कृषि अनुसंधान परिषद

एक्वा, आल्टो पोंपा – 403 402 (भारत)

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Foreword

Poultry is an integral part of family income for poor and marginal farmers contributing to their livelihood and nutritional security. Structure and functioning of poultry farming and industry in India varies from region to region. The Southern region accounts for about 57 percent of the country's egg production, Northern and Western regions contribute to about 26 percent, and Eastern and Central regions of India account for only about 17 percent of poultry production. It can be used as a powerful farming enterprise for the alleviation of rural poverty, eradication of malnutrition, and creation of gainful employment in vast rural areas. Poultry has the best conversion rate of feed to human food and the smallest environmental footprint in terms of energy and water use per kg of meat or eggs produced.

The hot and humid climate of the west coast with heavy rainfall poses a significant challenge to poultry production especially in the changing climate scenario. In the context of climate, the magnitude of such problems with variability in time scale reduces the productivity of poultry flocks and causes shifts in disease dynamics. In this regard, a baseline survey was conducted to study the constraints faced by poultry farmers and their perception of climate change on poultry production in the region. Results of the survey also pointed towards an urgent need to develop the climate resilient redefined package of practices for poultry husbandry specifically under west coastal climate. In this context, this technical bulletin is a welcome move and will provide viable solutions to the queries and needs of farmers, poultry growers, scholars and other stakeholders in addressing the critical issues related to poultry husbandry in the west coast region.

I congratulate the authors for bringing out this bulletin in such a crucial period of climatic variability and threat to the food web. I hope this publication will provide practical solutions for improving the poultry farming and income of the poultry farmers.

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ACKNOWLEDGEMENTS

This technical bulletin entitled “Redefining package of practices for poultry husbandry in west coastal climate” is prepared based on the farmers’ feedback on constraints in rearing backyard poultry in the changing climate scenario. The authors of this bulletin are very grateful to the Director, ICAR-Central Coastal Agricultural Research Institute, Goa for all the support to undertake the institute project on “Augmenting backyard poultry production through technological interventions in breeding, feeding and management aspects pertaining to Indian west coast” and encouraging to redefine the Package of Practices in the form of a technical bulletin. We are sincerely thankful to the Directors and staff of ICAR-Directorate of Poultry Research, Hyderabad, and ICAR-Central Avian Research Institute, Bareilly for extending required support, valuable suggestions and providing parent stocks of poultry germplasms for field evaluation and propagation. We also place on record our appreciation and gratitude to the Department of Animal Husbandry and Veterinary Services, Goa for all kind support during the survey of poultry farmers in the region. We also sincerely acknowledge the great help received from Dr. Ranganath, SMS (Animal Sciences), KVK Sirsi, Uttar Kannada (Karnataka) and Dr. Sandeep S. Desmukh, SMS (Agricultural Extension) KVK Lanja, Ratnagiri (Maharashtra) in documenting the field observations and recording data from farmers in coastal districts of Karnataka and Maharashtra. We thank to KVK, North Goa and CDDO (WR), Mumbai for organising various collaborative training and demonstration programmes to enhance the skills of the poultry farmers. We sincerely thank all the young professionals, project staff, and contractual staff associated with the Institute poultry unit and Animal and Fishery Science Section for carrying out all the experiments and recording the data. The tremendous efforts and hard work of farmers maintaining the poultry germplasms and their wholehearted cooperation are also highly acknowledged. At last, we would like to express our deepest sense of gratitude to the PME cell, scientific, administrative, technical, and supporting staff of ICAR-CCARI, Goa for their tremendous support and cooperation throughout the period of the research project by which it was possible to compile this document.

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INTRODUCTION

Poultry rearing has always been an integral component of livestock production system in India and this sector is one of the rapidly expanding sections of the agricultural sector in the country. Over the course of last few decades, this sector has witnessed a dramatic change in terms of structure and functioning which has been its transformation from a backyard activity into a major commercial agri-based industry. Poultry farming is also very popular among rural people because of the small investment, short generation interval, low or zero input and family labour system. Rural poultry farming is essential for the livelihood and nutritional security of many resource-poor farmers often being the only asset they possess. It also fulfils a range of functions that are difficult to value in terms of money; they provide pest control and manure, improve soil fertility.

In the context of west coast region of the country, poultry farming holds immense potential because of favourable market conditions, coupled with the rich natural resources available along the coast, which provide an ideal setting for thriving poultry farming operations. These regions also have a wealth of opportunities to increase poultry production through scientific management and the adoption of modern and sustainable technologies. By embracing modern farming techniques and technologies and establishing efficient supply chains, coastal farmers can significantly boost their productivity and profitability. These in turn can boost productivity, feed efficiency, and health management, making poultry farming more rewarding and sustainable. Despite its rapid expansion, the poultry sector faces many challenges due to rising feed cost, emergence of new diseases, fluctuating market price of egg and broilers. These issues need to be resolved to make the poultry sector as a viable farming enterprise.

In this backdrop, there is a greater need to compile the important aspects of scientific poultry husbandry in the west coast region of the country which can serve as a reference guide for those interested in the poultry farming in the region. This technical bulletin on "Redefining Package of Practices for Poultry Husbandry in West Coast" provides a comprehensive guide to scientific poultry farming covering important aspects like basic tenets and general management of poultry farming, poultry breeds and breeding strategies, housing and economic feeding management, artificial insemination technology and health management. It also includes information on improved poultry varieties and impact of climate change on poultry production. We hope this technical bulletin will serve as a consolidated knowledge resource and reference guide for those considering poultry rearing as a new farming enterprise and also for poultry farmers and other stakeholders to improve farm management skills and to increase the chances of having a profitable and sustainable poultry farming enterprise.

1 Breeds of poultry suitable for rearing in west coastal climate

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Introduction

India is endowed with a sprawling coastline that stretches across nine states (Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha, and West Bengal) and two union territories as well as its numerous islands. This vast coastal expanse presents a unique canvas for various agricultural ventures with poultry farming emerging as a particularly promising and transformative occupation for rural farmers. In the context of India's coastal regions, poultry farming holds immense potential to revolutionize the socio-economic fabric of these communities. The favourable climatic conditions, coupled with the rich natural resources available along the coast, provide an ideal setting for thriving poultry operations. By embracing advanced farming techniques and establishing efficient supply chains, coastal farmers can significantly boost their productivity and profitability.

Production status in India

In India, the production status of poultry products reveals a significant gap between current availability and recommended standards. The per capita availability of eggs in India stands at 93 eggs per person per year, which falls short of the recommended 181 eggs per person per year. Similarly, the availability of poultry meat is 3.5 kg per person per year, significantly below the recommended 11 kg per person per year (ICMR, 2009). These disparities highlight the need for enhanced production and distribution efforts to meet nutritional guidelines and improve food security.

Poultry breeds and varieties suitable for coastal climate

Indigenous poultry birds developed from different geographical regions in India

are registered as a breed by ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana. Total 20 chickens, 3 ducks and 1 geese have been registered till date. The details of breeds and improved varieties of poultry available and suitable for rearing in the coastal climate is given below:-

Kadaknath

Kadaknath is a chicken breed originated from Madhya Pradesh and reared in all over India. It is known as Kalamasi due to the black coloured meat and blood. The skin, beak, shanks, toes and soles of feet are slate in colour. It gives brown coloured eggs. Adult birds lay 70-80 eggs per year.

Fig. Kadaknath chicken

Aseel

This is a chicken breed originated from Andhra Pradesh and found in many parts of country. Due to its fighting ability and better adaptability, it is preferred by the farmers. Aseel is reared under backyard poultry management systems and is a vital source of meat and income for small-holder poultry farmers. The bird is also used by the people for cock-fighting.

Fig. Aseel bird

Characteristics

- Body weight at 20 weeks: 1,220 gms.
- Age at sexual maturity: 196 days.
- Average annual egg production is 92.
- Average egg weight at 40 weeks of age is 50 gms.
- Hatchability of fertile eggs: 63%.

Gramapriya

Fig. Gramapriya chicken

Gramapriya is an improved layered type backyard chicken that available in two varieties (white and coloured). The white variety is prized for its prolific egg-laying capacity, yielding up to 200-225 eggs in 72 weeks. On the other hand, the coloured variety, while laying fewer eggs, exhibits striking multi-coloured patterns and longer shanks. Renowned for their lower predator susceptibility, moderate body weight, and ability to produce brown eggs, the coloured Gramapriya chickens excel as dual-purpose birds, suitable for both egg and meat production. These distinct physical traits contribute to their versatility and value in poultry farming. The eggs produced by Gramapriya chickens are of medium size, typically weighing around 55-60 grams each. These chickens exhibit rapid growth, reaching a body weight ranging between 1.2 and 1.5 kg by the age of 12 weeks. Under free-range conditions, Gramapriya hens demonstrate their economic value by laying up to 150-160 eggs per year.

Srinidhi

Fig. Srinidhi chicken

Srinidhi is a dual-purpose improved chicken variety developed by ICAR-Directorate of Poultry Research, Hyderabad. It is known for its multi-coloured plumage and reminiscent of desi brown eggs. It has long shanks to avoid predator attacks in backyard conditions. Body weights ranging from 400-500 grams at 6 weeks to 2200-2300 grams at 40 weeks under restricted feeding. Egg weights vary from 48-50 grams at 28 weeks to 52-55 grams at 40 weeks. These birds begin laying eggs at 165-170 days, achieving an annual production of 140-150 eggs with a survivability rate of 95% up to 6 weeks. Overall, Srinidhi exhibits robust performance, making it a favourable choice for backyard poultry farming.

Vanaraja

Fig. Vanaraja chicken

It is a dual-purpose variety developed by ICAR-Directorate of Poultry Research, Hyderabad. It has attractive plumage pattern and preferred for backyard rearing. Birds attained moderate body weight of about 1.2 Kg at 12 weeks of age and hens produce around 160 eggs in a laying cycle. This bird was supplied to many farmers in Goa in last few years and propagated in farmers' field.

CARI Nirbheek

Fig. CARI Nirbheek chicken

CARI-Nirbheek is developed from the cross between Assel breed and CARI Red at ICAR-Central Avian Research Institute, Bareilly, Uttar Pradesh. These birds are suitable for free-range in backyard poultry systems. They boast a robust physique, notably, their fighting characters and activeness contribute to their ability to defend against predators effectively. Additionally, their adaptability to various climatic zones across the country underscores their suitability for backyard production in diverse environments. They lay brown eggs with an annual output ranging from 180 to 200 eggs. The brown eggs they produce closely resemble desi eggs.

CARI Debendra

CARI Debendra is a medium-sized dual-purpose chicken variety developed to cater to the needs of both meat and egg production. Produced through the crossbreeding of a coloured synthetic broiler line as the male line and Rhode Island Red as the female line, CARI Debendra embodies the desirable traits of both parental breeds. CARI Debendra is well-suited for rural poultry farming due to its better

survivability and moderate egg production ability, contributing to the sustainability of small-scale poultry operations. CARI Debendra demonstrates efficient feed conversion, optimizing feed utilization and contributing to cost-effective production. CARI Debendra is characterized by low mortality rates within laying houses, reflecting its robust health and adaptability to commercial production environments. CARI Debendra's attractive bright plumage colour enhances its appeal to Indian consumers. Meat of CARI Debendra has lower carcass and abdominal fat compared to broiler meat, making it a preferred choice for health-conscious consumers.

Fig. CARI Debendra chicken

Krishibro

Krishibro *is*a multicoloured broiler with attractive plumage. It is having better livability, good FCR and growth rate. *It* weighed around 1 kg at 8 week of age and 1.9 kg at 16 week of age in hot and humid climate of Goa. The average egg weight is 55 g and dressing percentage is 72%.

Fig. Krishibro chicken

Ornamental birds

Ornamental/ Fancy birds are miniature breeds usually very docile with an attractive appearance. Some are with caps on the head, some have silver, golden or silkie feathers. Some are with sprout surplus feathers around or on their heads or feets which makes them look absolutely amazing. These birds are often reared as ornamental birds though some are good layers and meat-producing birds. The different breeds are Silkie, Millie Fleur, Polish Cap and Frizzle etc.

Silkie - Satin fluffy

Fig. Silkie bird

It is known as Silky or furry chicken. The origin is from China. Silkies are very gentle, friendly and have amazing little personality with a stunning appearance which makes them a great pet. Body of the Silkie is tinny with an attractive color of the feather that makes people to fall in love with them. It has been used as medicine for warming the body and strengthens the immune system. Also good for woman fertility. It has a black skin and bones due to hyper pigmentation with blue earlobes, comb is of walnut type and has five toes. Produces 100-120 cream or tinted eggs/annum. Meat of this variety possesses Carnitine (anti-aging property). Male weighs around 900-1000g & female weighs around 750-850g.

Frizzle

Fig. Frizzle bird

It is a friendly and hardy ornamental chicken that originated from Asia. Also known as curly chicken - over-frizzled, with brittle feathers resembling pipe-cleaners. They are fun, conspicuous and lovable. They have a short strong beak yellow/horn in colour; eyes are bright and red in shade. The Frizzle has a single comb and has clean legs and feet which should be yellow in colour. There are four toes to each foot. It is docile, poorly mobile and average layer. Egg production is 120-150 eggs/annum. Male weighs around 3.2-3.6kg and females weighs 2.25-2.7kg.

Belgian Millie Fleur *(Living flowers of the garden)*

It is also known as Barbu d' Uccle / booted bantam. Originated from Belgium. A very delightful and talkative bird with red/orange eyes. Each bird has a muff and beard which extend around the head, giving the appearance of an 'owl head'. It possesses beard and shanks are feathered. Egg production is 150-200/ annum. The colour of the egg is white or tinted.

Fig. Belgian Mille Fleur (brown)

Fig. Belgian Mille Fleur (white)

Fig. Belgian Mille Fleur (black)

Polish cap

It is originated from Poland/Netherlands. A very beautiful and unique type of bird with V-shaped comb**.** It has a magnificent crest of feathers, which often resembles a hat that covers almost the entire head of the bird (*Pom-Pom Hairdo)*. Their crest makes their vision indistinct and thereby becomes more susceptible to predators. Polish roosters weight about 2.75 kg and hens about 2 kg.

Fig. Polish Cap (white)

Fig. Polish Cap (black)

Ducks

Ducks are reared traditionally and contribute a significant livelihood after chicken farming in the poultry sector. The traditional system of duck keeping is still dominant in the country and even after four decades of modernization of commercial chicken production, the duck production in India remains unchanged as a traditional enterprise. Though various duck breeds like Khaki Campbell, Indian Runner, White Pekin and Muscovy are available at different research stations, indigenous duck varieties are still preferred by the farmers. Also known as desi ducks, indigenous ducks constitute more than 90% of the total duck population and are the second largest species contributing towards egg production in India. As per 20th livestock census (2019), the desi duck and improved variety of ducks contribute 0.89% and 0.26% of eggs respectively to the total egg production. Breeding and selection have led to the improvement of duck breeds. Ducks are mostly concentrated in the Eastern and Southern states, mainly coastal region with non-descriptive indigenous stocks, which are poor layers. West Bengal and Kerala are the major consumer states for duck egg and meat.

Indigenous duck breeds namely Pati, Maithilli and Andamani are registered till date. However, the nondescript duck germplasms like Kuttanad, Chara, Chempally, etc. reared in the framers' field. The exotic breeds of ducks like Indian Runner, Khaki Campbell are used for egg production. White Pekin, Muscovy, Aylesbury, etc. reared for meat production in some of the farmers' fields.

Kuttanad ducks

Kuttanad ducks are local to Kerala and maintained in the institute poultry unit of ICAR-CCARI, Goa. Dual purpose indigenous breed with plumage colour varies from grey brown to bronze with spots. The performance of the ducks maintained in the institute poultry unit is evaluated. Annual egg production is around 220. Body weight at 6 week is 1.15

Fig. Kuttanad ducks in institute poultry unit

Fig. White Pekin ducks in farmer's field of Goa

kg and at 12 week is 1.80 kg. Age at first egg is 135 days. Egg weight at 40 week is 70 gm. The fertile eggs and the ducklings were supplied to farmers of Goa in last few years.

Japanese Quail

Japanese quail *(Coturnix coturnix japonica)* has created a huge impact in the poultry sector and many commercial quail farms have been established throughout the country, both for egg and meat production. This Institute has been maintaining pure lines of quail (broiler and layer types) and supplied for commercial exploitation.

Fig. CARI Uttam

Fig. CARI Ujjala

2 Breeding strategies for backyard poultry: Science and practices

Amiya Ranjan Sahu
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Introduction

Rural mass is predominantly the poor, marginal farmers and landless labourers that constitutes 72.2% of total population in India. Backyard poultry farming is an old age profession of rural families in India. It is the enterprise with low investment giving higher economic returns. It is mainly looked after by women, children and old aged persons of family. Poultry meat and eggs is the best and cheapest source of protein and ensure the nutritional security of family members in rural India. The preference of coloured birds is always there which fetches premium price from egg and meat. Backyard poultry contributes only 15-16% of total egg production in India (BAHS, 2022). However, its impact in terms of providing nutritious status, ensuring good health and socio-economic upliftment in rural community is immensely significant. Government of India initiated several schemes realizing the potential of backyard poultry farming in terms of nutritional security, alleviation of protein malnutrition, promotion of economic equity and women empowerment in rural India.

Advantages of backyard poultry farming

- Employment generation for small and marginal farmers in villages.
- Enhances soil fertility in backyards from the free ranging chicken manure.
- Egg and meat products from backyard-coloured birds fetches premium price as compared to intensive poultry farming.
- Alleviates protein malnutrition among children, pregnant women, nursing mothers and old aged persons.
- It can be easily adopted by resource poor facilities with very low investment.
- Native chickens are sturdier and well adapted to local environment.

Selection of breeding flock

Selection is the process in which certain individuals in the population are preferred as parents for the production of next generation. The main objectives of selection are to increase annual egg production potential of laying hen and meat production from broiler type birds. It is also to increase feed conversion efficiency for production of more egg and meat per bird, to increase the quality of egg and meat. Finaly it is intended to increase the thermotolerance and disease resistance of birds.

Economic traits for selection of breeder birds

Layers

- Fertility
- Hatchability
- Viability
- Part and Annual egg production (40, 64, 72wks of age)
- Egg quality traits
- Feed efficiency
- persistency

Broilers

- Body weight at various ages
- Feed efficiency
- Fertility
- Hatchability
- Viability
- Slaughter traits

Strategies for selection of native chicken

Selection of native chicken is firstly for improvement of economic parameters like body weight, egg number, fertility etc., so that the rural farmer gets maximum return out of his small sized backyard chicken units. Secondly, selection is for maintenance of characters specific to native chicken viz., appearance including

plumage colour, egg shell colour, shank length, broodiness, disease resistance, egg and meat quality etc., So that native chicken retains its prime status in the market.

Poultry Breeding

Poultry breeding is a meticulous process aimed at achieving specific objectives related to egg and meat production, feed efficiency and product quality. The primary goals include increasing the annual egg production potential of hens, maximizing meat production per broiler, enhancing feed conversion efficiency for improved egg and meat yield, and elevating the quality of meat and eggs. Selection, a fundamental aspect of breeding, involves preferentially choosing certain individuals from the population to serve as parents of the next generation. Different methods of selection are employed based on the heritability of traits and the stage at which they are expressed. These are Individual Selection (Mass Selection), Pedigree Selection, Family Selection, Progeny Selection and Sib Testing. Different methods of selection is also applied in poultry breeding such as Tandem Method, Independent Culling Levels, Selection Index, Restricted Selection Index and Molecular Techniques. Each method offers distinct advantages and considerations, contributing to the overall improvement and sustainability of poultry breeding programs. Breeding of native chicken need to be viewed as operating at three different levels such as, farmers level, institution level and industry level.

Farmer level: Rural farmer level units are very small in size and most of the farmers lake any scientific knowledge to undertake planned breeding of native chicken. To avoid inbreeding and harmful effects on reproductive parameters, small holder farmer units should exchange their cocks every year with another unit under veterinary supervision to avoid inflow of birds from a diseased flock and also to maintain the purity of the flock.

Institution level: At the institutions, commercial breeding strategies based on quantitative inheritance of economic parameters can be continued to improve the performance of native chicken. It may be selective breeding within the purebreds or crossbreeding with improved strains without threatening the appearance and other qualities of preference (coloured plumage, brown egg shell, long shank etc.) among native chicken. Hence, restrictions need to be applied in selection where necessary to

ensure that the appearance, meat and egg quality are retained in the native chicken. Selection is also need to be practiced keeping in mind the housing and feeding environment under which the progeny of the selected population to be reared.

Industry level: Industry has not taken much care about developing improved strains of native chicken so far, because of the lower and distributed demand. Some lay emphasis on faster growth while some concentrate on appearance and meat quality. Breast angle, shank length and egg number are some of the additional parameters considered.

Methods of mating in poultry:

1. Flock Mating: Flock mating is a common method used in most poultry breeding practices. In this method, approximately 20-30 males are housed with 250-300 females in separate pens for each male. The males have free access to mate with the females within the flock (Pandas et al., 2015). Flock mating allows for natural mating behaviour and may increase genetic diversity within the flock, but it can also result in uneven mating patterns and limited control over specific mating. This method is mainly practiced in the backyard system of rearing.

2. Pen Mating: Pen mating involves allowing a larger number of females to mate with a single male in a smaller flock setting. This method offers more controlled mating opportunities and allows breeders to monitor individual male-female interactions more closely. Pen mating reduces competition among males and may result in more consistent mating outcomes, but it requires careful management to prevent over-mating and aggression among males.

3. Stud Mating: In stud mating, a male is housed in a pen, and females are individually brought to the male one by one for mating purposes only. After mating, the female is removed from the male's presence. This method ensures controlled mating and allows breeders to track the mating history of each female. Stud mating minimizes the risk of multiple mating and facilitates accurate record-keeping, but it can be labor-intensive and may limit natural mating behaviours.

4. Shift Mating: Shift mating involves shifting males from one pen to another for a certain period of time. This method allows males to mate with females in different pens, providing genetic diversity and reducing the risk of inbreeding within

a single pen. Shift mating promotes genetic variation and allows for controlled mating patterns, but it requires careful coordination to avoid stress and disruption to mating behaviour during shifts.

5. Artificial Insemination: Artificial insemination is a highly controlled method where semen from selected males is collected and used to inseminate females. AI allows breeders to control the genetic makeup of the offspring more precisely, reduce the risk of disease transmission, and maximize the use of superior genetic material. AI offers unparalleled control over mating outcomes and facilitates the use of elite genetics, but it requires specialized equipment and expertise, and may not fully replicate natural mating behaviours.

Production of chicks for next-generation

Egg is a biological structure meant for reproduction in birds. It protects and provides complete nutrition for the developing embryo and serves as principal source of food for early chick. Fertile egg is obtained after successful meeting of male and female birds. Then the egg is set for incubation which means efficient transition of fertile egg into a live and healthy chick. The process of hatching eggs production should be followed strictly with proper bio-security measures to get optimum hatchability and quality chicks. The farmers must practice chick production from the fertile eggs either by natural incubation or by artificial incubation by an incubator and hatcher.

Hatching eggs should be collected from the nest or cage at least two times a day which may increase depending upon extreme weather conditions. Eggs should be collected frequently to avoid any contamination with the nesting material. Sand paper or spraying of disinfectant can be used to clean eggs. The best sanitation method after receiving eggs in hatchery is fumigation. Hatching eggs can be fumigated at 2x concentration for 20 mins while in setter except between 24 hrs to 96 hrs (1x conc. contains 40ml formalin with 20g of KMnO4 for 1000ft3 of space). Eggs should not be stored more than a week to avoid drop in hatchability. Eggs are setted in incubator and transferred on 18th day to hatchers: Candling should be done at 7th day and 18th day to find out the infertile eggs and discard them in order to save space and energy. Eggs are tested in front of sharp bright light and assessed for any cracks in shell,

position of air cell, yolk and albumen, presence of blood vessels etc. The porous eggs shell allows light to pass through indicating transparent or opaque type. Transparent is infertile while opaque indicates fertile eggs. Individual Candler or mass Candler should be used for this purpose. Chicks should be observed several hours before hatch time. They should be pulled out by hand when they are about 5%wet around the neck. After removing chicks from hatchery, the temp of holding room should be maintained at 75°F, 75% to reduce chilling and dehydration. Hatcher compartments along with debrises should be fumigated and cleaned properly after pulling out hatch.

Record Keeping

Record keeping is the most essential part of a poultry farm. It is maintained for monitoring and evaluation of the business. Records should provide all needed information, simple, easy to understand, without any repetition and confusion. To achieve the productivity and profitability of poultry farming the data is recorded and maintained in form of different registers.

Performance sheet:

The performance sheet is prepared in the register to represent production details of bird as mentioned below:

Date of receipt: No. received: Strain:

Date	Age in days	Opening No.	Deaths	Sales	Feed issued	Medicine/ 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 wt)	
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	:		

3 Artificial Insemination technology for sustainable poultry production in coastal region

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ICAR-Central Coastal Agricultural Research Institute, Goa

Introduction

Insemination using artificial means (AI) is the most important reproductive technology in the livestock sector and comprises of deposition of quality semen into the reproductive tract of female using artificial means. This process starts from the collection of the semen ejaculate from the proven male and its quality estimation with respect to sperm motility, concentration and viability and subsequent deposition of semen into female reproductive tract. AI technology is a well-developed and widely adopted technique for rapid genetic improvement in farm animals. Nevertheless, it is not so successful and widely adopted in poultry sector because there are very few standard and efficient techniques for processing and long-term storage of rooster semen. Breeding using AI in poultry is evidently a vital technique specially for broiler and other improved backyard strains or varieties, where fertility is low due to heavy body weight. It's acceptance in poultry sector has increased in popularity for commercial and research use. AI allows for incompatible birds to mate wherein mismatch arises when roosters are heftier than female birds and in natural service, this can result to injury of the female birds. Similarly, lower fertility can result from lower libido and failed mating during hostile climatic stress conditions. Wider adoption of backyard farming along with improved rearing practices and techniques like AI can undoubtedly boost productivity and profitability in poultry farming particularly in the coastal region. The poultry artificial insemination technology has been developed and standardized by ICAR-CCARI, Goa and evaluated in backyard varieties raised under coastal climatic environments. Developed technique includes procedures for male birds training, collection of quality semen and subsequent artificial insemination

of tested semen in backyard poultry varieties.

Key advantages of AI in poultry:

1. AI allows efficient use of male birds and extensive use of genetically superior male birds.
2. With AI, mating ratio can be increased manyfold. One male of high genetic merit can be used to breed a greater number of females and increasing broiler production.
3. Artificial mating permits incompatible birds to mate wherein mismatch arises when males are heftier and under natural conditions this may result to mating injury to female birds.
4. Technology can be useful in cases of pecking by heavily muscled roosters and improved varieties
5. Valuable proven roosters with leg wounds can be used for breeding.
6. Cross breeding can be made successful in natural conditions, but some hens will not mate with a rooster of a dissimilar colour unless they are raised together. In these situations, Artificial insemination aids in effective crossbreeding.

Method of semen collection in poultry

Semen collection is an important component in poultry artificial insemination. Selected healthy male birds needs to be initially primed and trained by massage method three weeks prior to actual semen collection. Collection of rooster semen is effected through dorso-abdominal massage procedure. Rooster is restrained in a horizontal way by an assistant at a convenient height. Technician should place left side index and thumb fingers on both sides of the cloaca and mildly massage. Using the right hand, collecting funnel is held and with index and thumb fingers, soft side of abdomen is massaged below the pelvic bones. With continuous massage, bird will protrude the copulatory organ (phallus) from cloaca. After complete phallus protrution, left hand fingers are used to squeeze out the semen ejaculate into a small glass funnel. It is important to minimise semen contamination with feather or faecal matter.

Different factors impacting semen quality and production

Differences exist in semen production among different poultry species and even among individuals within strains and breeds. Unlike in mammals, rooster sperm is typically immotile before ejaculation. Understanding the physiology of cockerel reproduction is crucial for comprehending male fertility. Both internal and external factors can impact semen production in male birds. The reproductive functions of males are primarily controlled by endocrine factors involving the pituitary gland, testes, and to some extent, external influences. External factors affecting reproductive efficiency in cockerels can be categorized into two groups. firstly, those directly related to nutrition, management practices, and normal physiological processes governing spermatogenesis, and secondly, factors influencing how males respond to the massage technique during semen collection. The volume and sperm concentration of poultry semen largely depend on the relative contributions of various reproductive glands, the number of spermatozoa obtainable from a particular breed or strain, and the extent to which genetic potentials are utilized. Furthermore, factors such as breed, rooster age, and the timing of semen collection can also impact the quality of semen produced.

Poultry semen evaluation and processing

Representative samples of the ejaculates are quality tested using methods to assess selected qualitative and quantitative parameters before use in AI. Major evaluation methods include gross morphological examination, determination of sperm motility, sperm viability, sperm concentration, percentage of live and dead sperm. Advanced evaluation methods include Computer Assisted Semen Evaluation and Fluorescent staining techniques for assessing sperm morphology, viability and DNA integrity. After semen quality evaluation, selected samples are either pooled and immediately used for AI or can be processed by adding semen diluents. The efficacy of Artificial Insemination (AI) in poultry can be significantly enhanced through improvements in semen diluents and storage methods. Typically, collected semen undergoes pooling and dilution with a suitable extender prior to utilization. Diluting semen offers several advantages, including maximizing the utilization of limited high-quality semen, reducing the male-to-female ratio, and enabling the use of valuable sires with

low semen quantities for inseminating multiple females. Undiluted semen, due to its viscous nature, poses challenges in handling and expelling small volumes from tubes. However, diluents overcome this hurdle by facilitating the spread of semen over a larger number of hens. These diluents, typically buffered salt solutions, serve to extend semen, maintain sperm viability in vitro, and increase the number of hens that can be inseminated. Various components added to semen extenders help sustain sperm motility, fertilizing capacity, and preserve sperm membrane integrity. Popular poultry semen extenders include Beltsville Poultry Semen Extender, TRIS extender, and Al-Daraji diluent. Diluted semen should be stored in a cooler or refrigerator at temperatures ranging from 3 to 12°C to induce cooling. Liquid cold-stored semen can typically maintain sperm viability for approximately 6 to 12 hours. While poultry semen can be frozen, its reduced fertility restricts its usage to specialized breeding programmes.

Procedure of AI in poultry

The procedure for the artificial insemination in poultry involves training of healthy roosters, collection of semen, processing and quality assessment and subsequent insemination in healthy female birds. Both collection and insemination of semen are accomplished through artificial means. Typically, poultry insemination employs two methods: intra-peritoneal insemination and vaginal or intra-cloacal insemination. Intra-peritoneal insemination, although used periodically over the years, is deemed unreliable. This technique involves puncturing the abdominal wall with a sharp needle and inserting a cannula to deposit semen near the ovary.

The most dependable and successful routine for poultry insemination involves directly depositing semen into the mid-vaginal area using the intra-cloacal method. This technique requires applying pressure to the hen's abdomen to evert the vaginal orifice through the cloaca. The hen is restrained with the assistance of a handler, held upright by the legs with the left hand, and the tail is tucked back. The right-hand thumb is positioned against the upper lip of the vent, and with a gentle rounding motion, pressure is applied to the abdomen's left side to cause the cloaca to evert and the duct to protrude. Semen is then deposited 2–4 cm into the vaginal orifice simultaneously with the release of pressure on the hen's abdomen. Sterile straws, syringes, or plastic

tubes are commonly used for insemination, while large-scale commercial operations often utilize automated semen dispensers loaded with individual straws containing a pre-determined AI dose. Each female bird is inseminated with a volume of 0.3 ml of extended semen, and the concentration in diluted semen typically ranges from approximately 100 to 200 million sperm per AI.

Fig. A.I in backyard poultry birds

Conclusion and Prospects:

Artificial Insemination is a powerful tool that can provide poultry farmers and commercial farms the flexibility to improve farm productivity and profitability. The implementation of AI can notably enhance poultry production by facilitating the widespread utilization of genetically superior cockerels with exceptional productivity. Compared to natural mating, one of the key advantages of this technology is its efficient use of males. Only a small number of proven male birds need to be raised, reducing the overall requirement for male birds and consequently minimizing the costs associated with rearing. Moreover, the use of semen diluents in AI further reduces the need for a large number of males for breeding purposes, resulting in decreased feed costs and lower expenses related to space, maintenance, and operations. This technology can be adopted in place of natural mating to address the low fertility resulting from reduced libido and unsuccessful mating especially during adverse climatic stress conditions. Its success, however, majorly depends on semen collection, semen quality, proper semen storage and technique of insemination. With good management of roosters, proper semen handling and AI method, one can achieve satisfactory results in AI. Wider adoption of backyard farming along with improved rearing practices and techniques like AI can undoubtedly boost productivity and profitability in poultry farming particularly in the coastal region.

4 Design and construction of poultry houses in hot-humid regions

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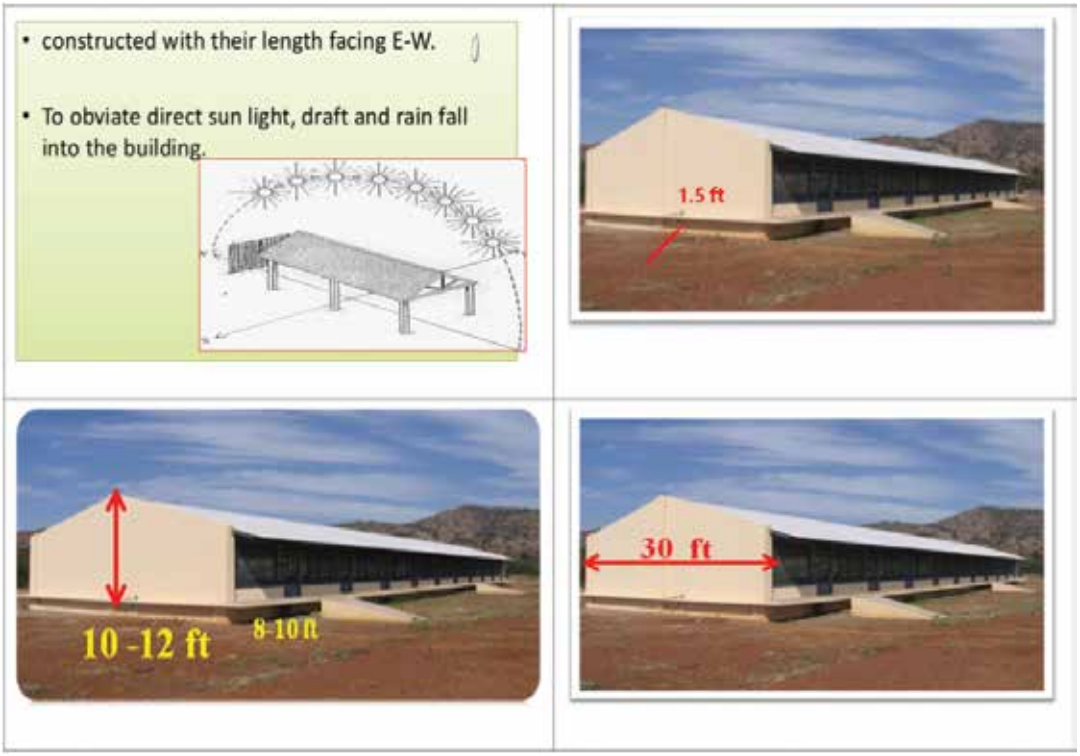
Worldwide poultry farming has been recognized as one of the potent tool to fight with social stigmas like hunger, malnutrition, poverty etc. In India also, it is now recognized as an organized and scientifically supported industry with tremendous capability of employment generation and as a potential tool to fight poverty and malnutrition. But ameliorating heat stress is the major challenging strategy in the poultry industry especially in tropical regions. In India costal area like Goa gets higher rainfall & temperature as well as humidity is also very high, so mitigating heat stress is big challenge. Among livestock, poultry is particularly sensitive to temperature associated environmental challenges especially heat stress because of absence of sweat gland & more feathers. High ambient temperature has deleterious effect on productive performance in poultry which could result in economic losses. The important intervention strategies to deal with stress conditions include different approaches like environmental management, housing management, nutritional manipulation. Among all these approaches we will discuss housing & environment management of poultry in this paper.

I. Intensive system for Commercial Poultry

A. Commercial layers

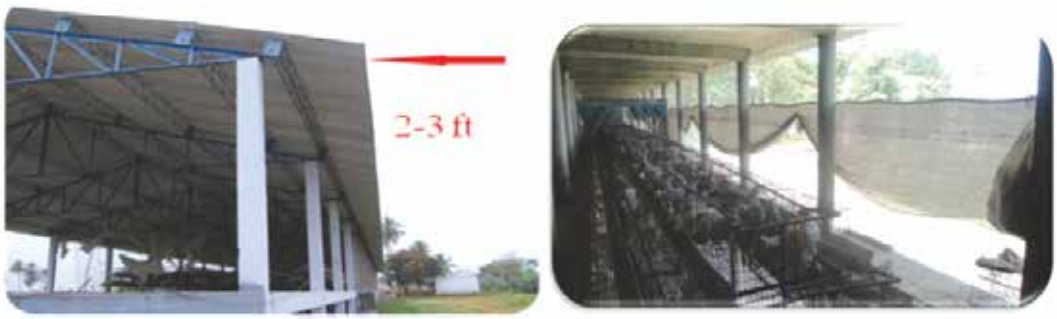
1. Orientation of Poultry Houses

In hotter parts of country, the long axis of the house should be east to west and the sides should face north south to prevent direct sun shine falling in the house. The distance between the houses of young and adult stock should be about 150-300 feet to help in disease prevention. The width of the open sided houses should be less than 30 to 32 feet to avoid ventilation problems during hot weather.



2. Sides and walls

The height of the house from foundation to roof line may be 8 to 10 feet. Usually half to two-thirds area will be kept open and fitted with wire mesh. In areas where the temperatures are high and continuous, more than two-third area will be left open for ventilation purposes. In chick houses, half the area and in grower and layer houses about two-thirds area is left open. In cage houses, the sides can be left open almost, for proper ventilation. If protection is needed during cold/rainy weather, curtains can be lowered from the overhang.



3. Roofs

The roof must be draft and moisture proof. Insulation of roof helps both in summer and rain. In order to reflect as much heat as possible, the roof should be painted with a reflecting type of paint such as aluminum paint or infra-red reflecting paints. Asbestos or cement board roofs do not radiate as much heat as metal roofing to birds in a poultry house and are therefore more desirable for poultry roofs. However, adding insulation and painting or covering with thatch also can improve them. An overhang of 3 feet will help to prevent the rainwater splashing inside the house and also helps in ventilation after the curtains are dropped.

4. Laying cages

Although the height of most laying cages is quite similar at 16 inches (40.6 cm) at the rear of the cage, the size of the floor area (width and depth) highly variable 10x16 to 24x18 inches (25x41cm to 61x46cm). The cages maybe single bird cages multiple bird cages (for 2-8 birds and colony cages (20-30 birds), to conserve space the cages can be kept in size deck, double deck, triple deck, four deck, five deck.

5. For heavy rain fall area:

In heavy rain fall areas to prevent the rain going into the poultry house, an overhang of 3' is necessary. The house should be located 9-12" above the surrounding

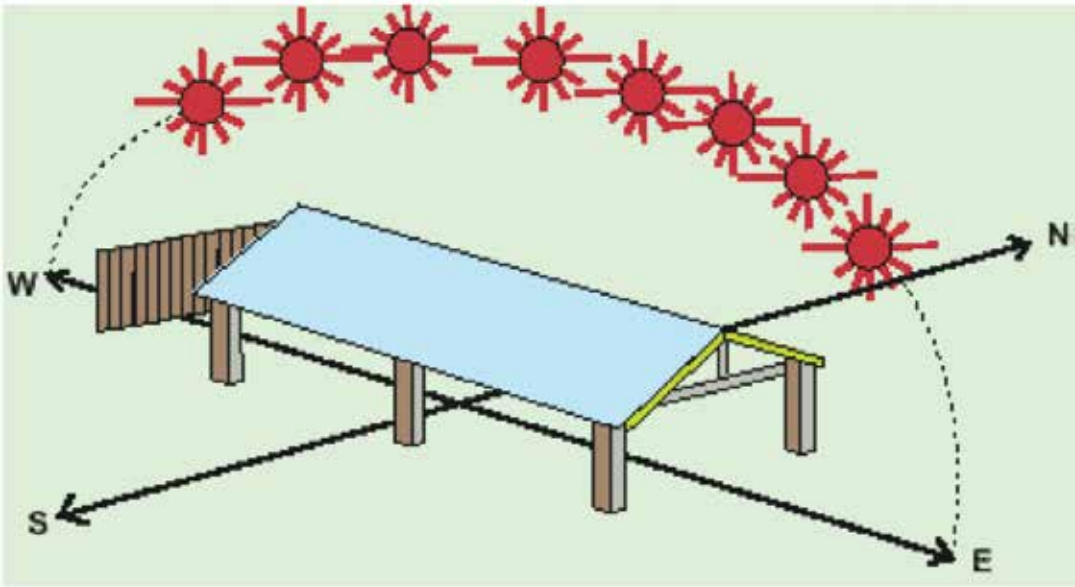
area. Good drainage also is required. If sub-soil water level is high, damp proofing of wall and floor is necessary. It can be done cheaply. By applying or painting a layer of coal tar or asphalt under the floor and at plinth area level, that is, before starting the brick walls. A layer of 2" cement concrete between foundation plinth and brick walls will prevent capillary suction of water from sub-soil and the life of wall will be lengthened.

6. For hot and humid area:

Where temperature readings are near the century mark, a highly intensive or a battery-cage unit will operate well, but more attention will be necessary – e.g., cooling devices such as sprinklers, insulated roofs, sheds nearly open at rear, or slatted sides-to avoid the possibility of high mortality and maintain good lay. The long axis and end walls should be in the directed of summer sun-line to prevent the sun shine directly falling into the house and to prevent the side walls being heated up. An overhang of about 3'6" is desirable to prevent the sun shining directly on the birds and to prevent the side walls being heated up. The roof material should be capable of reflecting heat. Paint the roof on top with white or aluminum paint and consider value of insulation under the roof. In dry and hot conditions, spraying of birds and the interior of the house is helpful. Foggers or mist sprayers if employed generate fine mist and lower the house temperature by 10 to 15 0F. Litter also can be sprayed lightly but the litter should not be made wet. If foggers are employed in deep litter house, ensure the prevention of drip water making the litter wet. Installation of Khas Khas screens on the sides from which hot winds prevail and sprinkling water on the screens reduces the inside house temperature. Installation of fans to increase the air circulation is helpful to reduce the temperature inside the poultry house.

B. Commercial Broilers

Open-sided poultry houses are very popular & economical in our country. In hotter parts of country, the long axis of the house should be east to west and the sides should face north south to prevent direct sun shine falling in the house. The distance between the houses of young and adult stock should be about 150-300 feet to help in disease prevention.



1. **Width** - Less than 30 to 32 feet.

2. **Height** - From foundation to roof line may be 8 to 10 feet. The higher height upto 12-14 feet helps to reduce the inside temperature in areas where the temperature is exceptionally high.

3. **Length** - The house may be of any length depending on the terrain of the land.

4. **Floor -** It must be moisture proof, free from cracks, easily cleaned, rat proof and durable. The different types of floor include all-litter floor, all-slat floor, slat and litter floor, wire and litter floor sloping wire floor etc.

5. **Sides:** Usually half to two-thirds area will be kept open and fitted with wire mesh.

6. **Roofs:** Should be painted with a reflecting type of paint such as aluminium paint or infra-red reflecting paints. For low-cost roofs made up of local materials such as bamboo, bamboo mat, polyphone sheet, scrap iron roof, galvanized steel roofing, woven plastic tarp that is held in place with wood strips or wire mesh can be used as effective as roofing materials for small scale commercial poultry farming. Asbestos or cement board roofs also can be used.

Open Sided House	Roof
	

II. Backyard Poultry

Brick and Asbestos Sheet Roof House

Size - 12 x 10 ft

Materials	Estimated cost
Asbestos Sheet	Rs 6,000 = 00
Brick Wall	Rs 6,000 = 00
Flooring	Rs 2,000 = 00
Iron angle	Rs 3,000 = 00
Other cost (Door, window etc.)	Rs 3,000 = 00
	Rs 20,000 = 00

Clay Tiled Mud House

Size - 12 x 10 ft

Materials	Estimated cost
Clay Tiles	Rs 3,000 = 00
Wooden beams	Rs 2,000 = 00
Wooden Planks	Rs 2,000 = 00
Mud walls	Rs 1,000 = 00
Flooring	Rs 3,000 = 00
Other cost (Door,window etc.)	Rs 3,000 = 00
	Rs 14,000 = 00

Wire Net and Hay Roof House

Size 10 ft diameter

Materials	Estimated cost
Hay roof	Rs 1,500 = 00
Wooden beams	Rs 2,000 = 00
Wooden Planks	Rs 2,000 = 00
Wire coup net	Rs 1,000 = 00
Brick wall	Rs 2,000 = 00
Flooring	Rs 3,000 = 00
Other cost (Door, window etc.)	Rs 3,000 = 00
	Rs 14,500 = 00

Bamboo and Plastic Sheet Roof House

Size 12 X 10 ft

Materials	Estimated cost
Plastic Sheet	Rs 2,000 = 00
Wooden beams	Rs 2,000 = 00
Wooden Planks	Rs 2,000 = 00
Bamboo wall	Rs 2,000 = 00
Brick wall	Rs 2,000 = 00
Wire coup net	Rs 1,000 = 00
Flooring	Rs 3,000 = 00
Other cost (Door, window etc.)	Rs 3,000 = 00
	Rs 17,000 = 00

A. Heat stress management in backyard poultry

Preventing heat stress is much easier than treating it. Provide Electral Energy (1-2 gm/liter) in water during hot hours/ Addition of 0.25% of salt to drinking water increases water consumption can be done. Incorporation of anti-stress vitamins like vitamin C in water should be advised in summer.

1) In moderate hot weather

Ascorbic acid....62.5 mg/litre
+ Acetylsalicylic acid 62.5 mg/litre
+ Sodium bi carbonate75 mg/litre
+ Potassium chloride (KCl) 125 mg/Litre

2) In heat stress

Vit C 400 mg/ L
+ Electrolytes
+ Acetyl salicylic acid (Disprin 1 tablet/5 L)
+ Sodium bicarbonate 1gr/Litre.....may be used

B) Nutritional manipulation

Chickens are omnivores. They eat grains, fruits, and vegetables as well as insects. Chickens should be fed with a balanced diet consisting of vitamins, minerals and proteins. A healthy laying hen diet should also contain cereal sources, protein sources, trace minerals, vitamins, crushed oyster shell for egg production and grit for digestion. They can also be fed with fruits and vegetable scraps from the kitchen and garden. During summer months, the birds consume less quantity of feed than the usual consumption which leads to less consumption of nutrients intake and thereby resulting in poor weight gain, drop in egg production and egg size. Hence it is suggested to increase the density of the nutrients in the ration which are given in evening as supplementary feed. The energy level should be reduced and protein, calcium, phosphorus and all other important vitamin levels in the ration should be increased if you are making own feed in extreme hot seasons. It is advisable to encourage the birds for consuming their maximum quantity of feed during the cooler parts of the day. Fowling are main point that to be considered if you are using commercial feed.

- Increase nutrient density of feed to compensate for depressed feed intake.
- Energy of feed should be reduced. Crude protein content should not be increased because heat generated by one gram of fat is 16.5% or one gram of fat is 22.5%.
- Similarly 20-30% extra vitamins and trace minerals should be added to feed.
- Available phosphorus content of feed should be increased.
- Vitamin C is necessary to maintain integrity of blood vessels. Supplementation of vitamin C is beneficial.
- Add soda-bicarbonate @ 0.1% for improvement of shell quality.
- Since hot humid climate favors growth of moulds/fungi in feed, so constant use of anti-fungal is recommended.
- The diet should be balanced with limiting amino-acids, methionine and lysine which will give better results.
- Increase the calcium level from 3-3.5% in layer diet.
- Inclusion of Growvit-A and Grow E-Sel 250mg /kg diet for better performance and combat heat stress.
- In vegetarian feed, inclusion of Sodabicarb at 0.4% (4 kg/ton) + Sodium chloride0.25%(2.5kg/ton) would properly balance sodium and chloride levels in feed.
- Betain (0.5 to 1 gr/ton) helps in maintaining water balance in the body cells against extra cellular osmotic gradient.
- Virginiamycin 15 to 20 ppm in feed apart from being growth promoter, reduces metabolic heat production, alleviates heat stress and stimulates immune responses.
- Anticoccidials, Nicarbazine and Monensin are contraindicated in summer. The former decreases tolerance to heat and the latter depresses water intake.
- Biotin supplementation at 150 micrograms /Kg feed is recommended.
- Vit K supplementation is recommended particularly at time of debeaking or if there is threat of coccidiosis because in heat stress blood clotting time is prolonged.

- Toxin binders: In wet summer, there is rapid growth and toxin formation in feed. Good quality toxin binders at higher dose should be used in feed.
- Phytobiotics like Dried neem fruit, Amla, Lemon, Aloe vera can be used.

III. Conclusion

Compare to commercial poultry birds the backyard varieties are more adaptable to hot and humid summer. But now people started backyard farming with commercial goals and with large scale. Coastal area like Goa will always face challenge of heat stress leading to production loss in commercial as well as backyard farming. So to avoid these losses and immunosuppresion in heat the housing, feeding and management manipulation must be adopted.

5

Economic feeding of poultry

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Introduction

Major constraint faced by poultry growers in Goa id high feed cost. Feed is the single largest item of expenditure compounding 60-70% of total cost in poultry production Feed cost is escalating at a disproportionate rate, compared to the market cost of eggs and broilers; resulting in losses. Several feed ingredients are mixed together to provide well-balanced nutrients in the diet at levels required by the birds at a reasonable price. Some feed ingredients are employed for providing only a particular nutrient, while others provide more than one nutrient. For example: Limestone is employed only to provide calcium in the diet, while cereal grains are employed mainly to provide energy as well as protein, minerals and vitamins No feed ingredient is compulsory to meet the nutrient requirement of birds. Hence Economic feeding is essential, to reduce the feed cost, without affecting their performance.

Feed Ingredients

Commonly available feed resources are classified as energy supplements, protein supplements, mineral and vitamin supplements. Energy supplements constitute 60-70% of poultry feed, provides bulk and satiety. They may further be divided into high energy like maize, wheat, sorghum, broken rice, fats /oils and low energy stuffs like pearl millet/other millets, rice polish/bran, molasses/tapioca flour.

Table: Feed resources used as ingredients in poultry feed

Ingredient	Broiler and layer chicks	Growers and layers	Remarks
Energy supplements	Inclusion Level		
Bajra	30	70	May increase fat content in the body
Barley	10	20	Add non-starch hydrolyzing enzymes (beta-glucanase)
Fats /oils	5	5	Unsaturated fats are advantageous in minimizing ill effects of aflatoxin
Jower	30	50	Sorghum. Tannin may increase protein requirement of the diet
Maize	60	60	Broken grain susceptible for mycotoxin, high moisture during harvesting period
Mango kernel	3	5	High in tannin
Molases	2	5	Good in low density feeds
Dried Poultry manure	0	10	Drying is expensive pathogen problem also in summer.
Ragi	10	30	Finger millet, increase lean meat content
Rice bran	10	25	Add anti-oxidants during storage and in feed having high proportion of bran
Rice broken	10	20	Quality is not constant, may increase fat deposition
Sal seed	3	6	High in tannin
Tapioca	10	20	Peeling is essential, add molasses to reduce dustiness
Wheat	10	30	Add xylanase to increase arabino-xylans
Wheat bran	0	10	Add bulk to feed
Protein Sources			
Vegetable protein sources			
Ambadi cake	10	20	High fibre
Coconut cake	5	5	Oxidation and mycotoxin contamination
Cotton seed cake	10	10	Fibre and gossypol limit utility. Iron salts may blind gossypol
Groundnut meal	20	30	Mycotoxin is a potential threat, deficient in lysine and methionine

Guar meal	3	5	Roasting is essential
Karanj cake	5	10	Solvent extraction is essential to remove karanjin
Kokum meal	5	10	
Linseed cake	3	5	Linatin, linamirase and mucilage limits utility
Maize gluten meal	20	20	Mycotoxin is threat
Niger cake	5	10	More fibre
Rape seed cake	10	5	Mustard cake, erucic, tannin, glucosinalates and argimone contamination threats
Rubber seed cake	0	5	Contains HCL
Safflower	5	10	Very high fibre
Soybean meal	40	30	Deficient in methionine
Sunflower meal	20	30	Can be added as sole protein source when energy and limiting amino acids are balanced
Till cake	15	20	Sesame. High in phytase and oxalates. Good combination with soybean meal
Animal protein sources			
Fish/fish meal	10	10	Pathogens, rancidity (oil fish), salt and high variability in protein content limit its utility
Feather meal	2	2	Poorly digestible protein
Hatchery by product meal	2	3	Pathogens and rancidity
Meat and bone meal	5	3	Pathogens, variable protein quality
Meat meal	5	5	Pathogens, variable protein quality
Poultry by-product meal	5	5	Pathogens, low in methionine
Silkworm pupae meal	2	2	Low threonine, rancidity
Squilla meal	5	5	Deficit in lysine, methionine, threonine, tryptophan and arginine

Protein supplements includes both plant and animal protein sources. Plant protein mainly comprises cakes and meals of groundnut, soyabean, cotton seed, mustard, rape seed, sunflower, safflower, cluster bean and maize gluten meal.

Methods to reduce feed cost:

Precision poultry nutrition

- Means Accurate feeding of birds based on their exact nutritional requirements of mostly energy and protein which will improve the FCR and performance of the birds significantly, resulting in considerable reduction in the feed cost.
- Due to precision nutrition, broiler farmers are achieving an FCR of <1.60, with a body weight of >2.20 kg in <40days, with < 5% mortality.
- Similarly, backyard farmers are getting 180-210 eggs /hen/ annum, with an FCR of 2 /dozen eggs.
- Moreover, these standards are showing an annual improvement of 3-5%, due to precision nutrition

Least-cost feed formulation

- Formulate feeds based on their digestible nutrients, instead of gross nutrient levels
- All integrators and big farmers are using feed formulation software for least-cost precision feed formulation by linear programming, to reduce feed cost/Excel based
- Make feed poultry software by ICAR-CARI, Bareilly.
- Use good quality Toxin-free feedstuffs, with known nutritional composition

Large scale Poultry Operation

- Large Bigger farm needs more feed
- Buy feed ingredients & feed supplements in bulk, which will reduce the feed cost
- Hence have a layer farm, with >100,000 layers Broilers >20,000 /week
- Large size backyard farms with improved varieties of poultry.

Integration in poultry production

- An integrated layer or broiler operator will have several contract farms under his fold.
- The integrator will be having a breeding farm and several contract broiler /layer farms, having millions of birds.
- Hence their feed requirement is huge, more than the large poultry farms; resulting in lower cost of production of feed. They will also have credit facilities.

Use of alternate feedstuffs

- If conventional feedstuffs like maize, soya and fish are costly/ scarce/ poor quality, go for alternate feedstuffs like jowar, millets, rice polish, broken rice / wheat, cheaper oil cakes, guar meal, Black Soldier Fly (BSF) larvae meal, meat-cum-bone meal etc.
- Select alternate feedstuffs, based on their relative cost, quality and availability.
- Multiple energy and protein feedstuffs will not only reduce the feed cost, but also improve the feed quality and reduce the mycotoxin level; compared to maize and soya combination only.

Table: Relative Cost Factor (RCF) of feed ingredients

Energy supplements	RCF	Protein supplements	RCF
Maize	1.00	Soya bean meal- 45-48% CP	1.00
Jowar	0.94	Sunflower meal- 25-28% CP	0.55
Pearl millet (bajra)	1.00	Peanut oil meal- 40-44% CP	0.70
Wheat / triticale	0.92	Rapeseed meal- 35-38% CP	0.75
Broke Rice	0.90	Full-fat soya-extruded	1.40
Ragi- finger millet	0.84	Fish meal – 60% CP	1.33
Molasses	0.55	Fish meal-50% CP	1.18
Rice polish - >15% oil	1.10	Fish meal-45% CP	1.10
Rice bran- > 6% oil	0.86	Fish meal- 40% CP	1.00
Deoiled rice bran-DORB	0.58	Meat meal -50-58% CP	1.05
Barley	0. 86	Meat-cum-bone meal (MBM)	0.90
Tapioca tuber / flour	0.75	Sesame oil cake- 37-40% CP	0.88
Animal fat	2.00	Coconut / palm cake-22% CP	0.45
Vegetable oil	2.15	Prawn head/ M. shrimp meal	0.54
Tamarind kernel meal	1.15	Corn gluten meal- 45% CP	0.80

Oats /	0.84	Corn gluten meal- 60% CP	1.10
Distillers / brewers dried grain	0.65	Silkworm pupae meal (SE)-60%	0.80
Wheat bran	0.50	Guar meal -42 % CP	0.70
Alfalfa / meal	0. 60	Prawn head/ M. shrimp meal	0.54
Vegetable oil	2.15	Corn gluten meal- 45% CP	0.80
Tamarind kernel meal	1.15	Corn gluten meal- 60% CP	1.10
Oats /	0.84	Silkworm pupae meal (SE)-60%	0.80
Distillers / brewers dried grain	0.65	Guar meal -42 % CP	0.70
Wheat bran	0.50	Cotton seed meal-38% CP	0. 70
Alfalfa / meal	0. 60	Cotton seed meal-38% CP	0. 70

Least cost feed preparation

- Avoid storage of feedstuffs with high moisture
- Make the warehouse rat proof, seepage proof and leak proof, to prevent spoilage of feedstuffs
- Minimize spillage, wastage and dustiness during feed preparation, transport & feeding of birds.
- Service the feed mill periodically, by changing the hammers (beaters), sieve & blades of the mixer.
- Avoiding over filling of feeders and providing sufficient feeder space

Feeding management

- Precision feeding like Split feeding, pellet /crumble feeding, restricted feeding, controlled feeding, phase feeding etc.
- Force-moult the hens during low egg price period, as well as for 2nd year of lay
- Automatic flat chain feeders & tubular feeders used in large farms will supply small quantity continues feed to the birds, with almost **NIL** wastage.

Restricted feeding

- Restricted feeding during growing period, not only reduce the feed cost but also improve the egg production & livability during laying period.
- This is followed in breeders & can be followed in commercial layers also with high degree of success
- The extent of feed restriction during growing period will be 20-25% of total feed intake. i. e. the birds are fed 75-80% of total feed.

- Even during laying period, the broiler breeders will be fed about 90 % of the total feed intake, to avoid excess fat deposition.

Controlled feeding

- It is a type of mild feed restriction; where the birds are fed with a recommended quantity of feed daily.
- It is mainly followed in broiler breeders; where there is a tendency for over eating.
- It is also carried out in automatic feeding system; where the feed flow is restricted according to the age of the broilers and level of egg production in layers and breeders.
- The feed supply will be stopped after the daily recommended feed is consumed by the birds.

Phase feeding

- The nutrient requirements of all groups of birds are not the same.
- Hence, they are fed according to their age, growth rate and level of egg production
- As the age advances, the protein requirement will decrease and the calcium requirement will increase; so that the feed cost can be reduced in older hens.
- Commercial broilers are fed 3 or 4-phase feeding; whereas layers and breeders are fed 2or 3-phase feeding.

Split feeding

- Fast-growing broiler hybrids and high laying hybrid layers need relatively lesser quantity of feed per unit growth rate or per dozen eggs
- Give better FCR and greater feed economy.
- Hence always select the best hybrid birds, most suitable for the local agro-climatic conditions.
- Know their exact nutrient requirements and formulate the feed accordingly, for optimal feed efficiency and economy.

Flock Health and general management

- A healthy flock will always give better growth rate, egg production, FCR & lower feed cost per unit production

- The feed consumed by a dead broiler or grower is totally a waste.
- Similarly, the feed consumed by a sick bird cannot be utilized properly for growth and egg production.
- Therefore, maximum attention must be paid for flock health by giving a toxin-free balanced feed, sanitized drinking water & do regular vaccination and medication
- For best results and greater feed economy, better farm management is more essential.
- Provide comfortable housing to protect birds from extremes of weather & predators
- Avoid overcrowding & insufficient feeder and water spaces.
- Provide adequate ventilation
- Provide sufficient floor, feeder & waterer spaces
- Avoid feed wastage of all kinds.

Table: Feed formula for dual purpose birds

Ingredient composition (%)									
Maize	65.16	66.56	68.95	53	55.15	56.95	41.3	43.55	45.55
sbm	22.89	17.25	12	20.25	14.9	9.5	17.75	12.3	7
FM	4	4	4	4	4	4	4	4	4
DORB	4.9	9.24	12.1	19.8	23	26.6	34	37	40.5
LPS	1.1	1.1	1.1	1.1	101	1.1	1.1	1.1	1.1
DCP	1	1	1	1	1	1	1	1	1
SALT	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
TMP	0.15	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
VPM	0.15	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cholin	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
toxin	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lysine	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Methionine	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total	100	100	100	100	100	100	100	100	100
cp	20.0134	18.0138	16.0615	19.983	18.0135	16.0515	19.952	18.0095	15.9995
ME	2903.865	2890.705	2893.625	2700.025	2698.575	2691.375	2502.425	2503.175	2498.425
calcium	0.980005	0.977555	0.972775	1.004675	1.000375	0.996775	1.028075	1.023575	1.019575
ap	0.476714	0.487094	0.490655	0.54725	0.552335	0.559355	0.61442	0.618695	0.624995
lysine	1.114736	0.986496	0.86287	1.0986	0.97359	0.84867	1.08.338	0.96023	0.83243
Methionine	0.570435	0.547879	0.52597	0.567715	0.54556	0.52342	0.564985	0.54316	0.52051
Threonine	0.806807	0.729783	0.654555	0.805695	0.729805	0.654205	0.804535	0.729685	0.652235

6 Phytogenic/ Herbal Feed Additives for Poultry

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Feed additives are defined as "products that are used in animal nutrition for purposes of improving the quality of feed and the quality of food from animal origin, or to improve the animals' performance and health. Phytogenic feed additives comprise a wide range of plants, like herbs and spices and plant-derived products like essential oils and oleoresins (Windisch *et al*., 2008). Addition of phytogenic feed additives have gained prime importance in poultry nutrition following ban of antibiotic growth promoters in feed. These natural feed additives are generally considered safe and improve poultry production performances. Feeding of these herbs either alone or in combination had numerous antioxidants, antimicrobial, anti-inflammatory, gut stimulating, immunomodulatory effect on poultry.

Natural adaptogens such as herbs, medicinal plants and their extracts act as feed additive during stressful periods as birds demand increase while feed intake decrease during that period. These natural, antibiotic alternatives as feed supplements can be rhizome based such as turmeric (*Curcuma Longa), ginger (Zingiber officinale*), alpinea (Alpinea galanga) or leave based viz Tulsi (*Ocimum sanctum*), drumstick tree (*Moringa oleifera*), Chekurmanis (*Sauropus androgynus*) or kalmegh/king of bitters (*Andrographis paniculata*) either given alone or in combination.

Fig. Turmeric powder

Turmeric (*Curcuma longa*) is used as colouring agent, preservative and to give special aroma as food additive. It is a potent antioxidant, hypolipidemic, anti-inflammatory and antimicrobial due to presence of phenolic compounds like curcumin. Mondal et al. (2015) found that

inclusion of 0.5% turmeric powder in feed of broiler have significant effect on weight gain, feed efficiency, lowered abdominal fat pad and dressing percentage except on feed intake and livability.

Zinger (*Zingiber officinale*) is a widely used aromatic and medicinal herb in ancient Indian medicine due to its antiemetic, gastrostimulant, antioxidant, hypocholestomic properties. The rhizome of ginger contains active compounds like gingerol, gingerdiol and gingerdione which are strong antioxidants. Feeding of ginger root powder at 0.5% and 0.75% in diet of laying hens have reduced the egg cholesterol without any adverse effect on egg weight and feed conversion ratio. Nawaz *et al*. (2021) also explained the beneficial roles of plant additives in heat stressed poultry at physiological, pharmacological and molecular level.

Fig. Zinger powder

Alpinea (*Alpinea galanga*) is endemic to Southeast Asia and has played an important role in many Asian traditions. Galangal is traditionally used as a flavouring spice in Thai, Indonesian, Malaysian, and Chinese cuisines. It is a plant from the ginger family with a long history of medicinal and culinary applications. The entire plant has various beneficial characteristics. However, the rhizome, or root mass, is the most used part. It contains several phenolic components, including flavonoids and phenolic acids (Khairullah et al., 2020). Galangal is said to be rich in essential oils such as cineole, methyl cinnamate, myrecene, and methyl eugneol, as well as numerous flavones such as galangin, alpinin, kampferide, and 3-dioxy4-methoxy flavone. The galangal rhizome is effectively used as a therapeutic treatment for various diseases, because it contains anti-bacterial, antifungal, anti-inflammatory, antihepatotoxic, antioxidants.

Fig. Alpinea plant

Tulsi (Ocimum tenuiflorum) is very beneficial for use as expectorant, analgesic, anticancer, anti-asthmatic, anti-emetic, anti-diabetic, anti-fertility and antistress agent. The main chemical constituents of Tulsi are oleanolic acid, eugenol ursolic acid, rosmarinic acid, eugenol, carvacrol, linalool, and β-caryophyllene.

Fig. Tulsi leaves

Moringa has lot of minerals that are essential for growth and development among which, calcium is considered as one of the important minerals for human growth. Moringa powder can be used as a substitute for iron tablets, hence as a treatment for anaemia. Unsaturated fatty acids (UFAs) are these poly unsaturated fatty acids (PUFAs) that can control cholesterol.

Fig. Moringa leaves

Chekurmanis (*Sauropus androgynus*) is a Euphorbiaceae perennial shrub that grows wild in Southeast Asia. Chekurmanis leaves are extremely nutritious, containing a high concentration of micronutrients, vitamins, and protein. It is powerhouse of multivitamins in packed leafy vegetables. Leaves are high in protein (6-8%) (more than methi and palak), vitamin A (more than mangoes and papayas), and vitamins B, C, nicotinic acid, mineral matters, phosphorous, and iron (Asfi et al. 2022).

Fig. Chekurmanis leaves

Andrographis paniculata (Burm. f.) Nees (Acanthaceae) is an herbaceous plant called as Kalmegh used in traditional medicines for the treatment of various ailments. Diterpene lactones are the main phytoconstituents responsible for the plant's bitter taste and therapeutic activity. Pure andrographolide (AD) and crude extracts have all been shown to be accountable for various pharmacological activities,

including anticancer, anti-inflammatory, hepatoprotective, immunomodulatory, neuroprotective, antidiabetic and antibacterial agents (Mehta et al., 2021).

Fig. Kalmegh plant

Quantitative and qualitative evaluation of the bioactive compounds in local varieties of these herbal additives is necessary for feed formulation during early chick nutrition. Early feeding after post hatch has a great effect in triggering the right momentum of growth in chicks. As per Jin et al., (1998) body weight is increased three to four-fold during the first week and considerable changes in gut, muscle weight and morphology are observed. Nutritional manipulation must occur during the first days after hatch to achieve long-term effects. The GIT which is sterile at the time of birth undergoes exposure to different antigens through the passage of feed. Early access to feed and/or feed additives results in more rapid gastro-intestinal and muscular development in the immediate post hatch period, investment in the chick's immune system and faster utilization of yolk sac (Noy *et al.*,1996). The earlier the food passes through the tract, sooner the proliferating stem cells will meet an environmental antigen, which helps to create a wider antibody repertoire too.

The efficacy of various phytogenic feed additives in early nutrition phase on growth and production performances of gramapriya and CARI-Debendra is studied. Highly significant differences($P \leq 0.01$)was observed in growth rate of Gramapriya layer chicks only at 6^{th} week with heighest growth in 2% leave based herbal supplementation followed by 1% and then control. Rhizome based feed additives such as turmeric (Curcuma Longa) and ginger (Zingiber officinale) with 5.5% curcumin and 25% gingerol added at 1% level upon superimposition in diet of CARI-Debendra variety in the institute experiments. The herbal supplementation group showed significant increase in body weight than control at 6wk. No significant effect of herbal supplementation on feed conversion ratio and carcass characteristics were observed throughout the experimental period. Feeding of phytogenic feed additives in early post hatch period had positively influence the bodyweight, immune response and haematological parameters with overall welfare and productivity.

7 Impact of Climate on Poultry Production

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Poultry industry plays a critical role in supplying inexpensive protein and supporting livelihoods of millions of people throughout the world. However, this industry is very vulnerable to the effects of climate change, which presents considerable challenges in sustaining and increasing poultry productivity. As the climate continues to change, with rising temperatures, shifting precipitation patterns, and more frequent extreme weather events, the poultry industry faces a complex set of challenges that must be addressed to ensure its long-term viability and resilience. One of the most immediate consequences of climate change on poultry production is rising ambient temperatures. Poultry, particularly hens, are extremely heat sensitive. Optimal temperature ranges are critical for the health and production of these birds. When temperatures rise above the comfort zone, which is normally between 18°C and 24°C, chickens undergo heat stress. This can result in decreased feed intake, slower growth rates, reduced egg production, and, in extreme situations, higher mortality. Heat stress also has an impact on the quality of poultry products, resulting in reduced meat quality and egg hatchability rates. These physiological stressors not only affect the economic efficiency of poultry farms, but also have animal welfare implications. In addition to heat stress, variations in humidity levels caused by climate change can further exacerbate the issues that poultry growers face. High humidity, especially when combined with high temperatures, can create a conducive environment for the spread of diseases and parasites. Pathogens like avian influenza and Newcastle disease thrive in warm, humid environments, increasing the frequency of outbreaks that may destroy poultry populations and cause considerable economic losses. Furthermore, climate change might alter the geographical distribution of these diseases, potentially bringing them to new places that are unable to deal with such risks.

Climate change has far-reaching consequences on poultry production that go beyond the physiological effects on the birds. Climate-induced disturbances in feed supply systems is another key concern. Weather patterns, such as prolonged droughts or extreme rainfall, can have an impact on the production of critical feed ingredients like maize and soybeans. These interruptions can result in higher feed prices and decreased availability, making it more difficult and costly for poultry producers to provide appropriate nutrition to their flocks. This can lead to inferior growth performance and lower production yields, further compromising the economic sustainability of poultry industry. Climate change also has an impact on water availability, which impacts poultry production. Adequate and clean water is critical for the health and production of poultry. Droughts caused by climate change can deplete water resources, while flooding can contaminate water supplies with pathogens and pollutants. Both scenarios represent serious threats to poultry health and production efficiency. Furthermore, water shortage can increase competition for this crucial resource among agricultural and other industries, complicating poultry farmers' water management strategies.

The economic consequences of climate change on poultry production are significant. Increased expenditures for managing heat stress, disease outbreaks, and feed and water scarcity can diminish margins for poultry farmers. This is especially difficult for smallholder farmers in developing countries, who may lack the funds to deploy adaptation measures like better housing, cooling systems, or alternate feed sources. As a result, climate change can worsen existing inequalities in the poultry industry, making it more difficult for vulnerable populations to sustain their livelihoods. Addressing the influence of climate on poultry production necessitates a multifaceted strategy. Adaptation strategies like developing heat-tolerant poultry breeds, improving housing designs to improve ventilation and cooling, and applying biosecurity measures to minimise disease outbreaks are all critical. Additionally, efforts to diversify feed sources and enhance water management methods can help to alleviate some of the problems caused by climate change. On a larger scale, regulations that encourage sustainable farming practices and fund research into climate-resilient poultry systems are critical for ensuring the sector's long-term sustainability.

Meteorological Data

Daily meteorological data including temperature, relative humidity, evaporation, wind speed and rainfall for a period of 20 years from 2004-2023 recorded at ICAR-Central Coastal Agricultural Research Institute, Old Goa was used to analyze the impact of climate on poultry production. The agro meteorological observatory is located at 15°29′22″ N, 73°55′10″ E and 67 m above mean sea level. The observatory has all the essential equipment like dry bulb, wet bulb thermometers, maximum and minimum thermometers, rain gauge, sunshine recorder, wind vane, anemometer, open pan evaporimeter, soil thermometers, etc. Temperature-humidity index (THI) was calculated by following formula (Moraes et al., 2008):

THI = 0.8Tdb + RH (Tdb – 14.3)/ 100 + 46.3

where Tdb = dry-bulb temperature and RH = mean relative humidity (%). THI > 80 indicate severe discomforts, where THI < 76 points to slight discomfort for birds.

The Mann-Kendall Trend Test

The rank-based nonparametric Mann-Kendall (Mann, 1945; Kendall, 1975) method was applied to the long-term data in this study to detect statistically significant trends. In this test, the null hypothesis (H_0) was that there has been no trend in weather parameters over time; the alternate hypothesis (H_1) was that there has been a trend (increasing or decreasing) over time. The mathematical equations for calculating Mann-Kendall Statistics *S* are as follows:

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} sign\left(X_j - X_i\right)$$

$$sign\left(X_j - X_i\right) = \begin{cases} +1 \; if\left(X_j - X_i\right) > 0 \\ 0 \; if\left(X_j - X_i\right) = 0 \\ -1 \; if\left(X_j - X_i\right) < 0 \end{cases}$$

For n ≥ 8, the statistic S is approximately normally distributed with mean μ=0 and variance is

$$V(S) = \frac{1}{18}\left[n(n-1)(2n+5) - \sum_{p=1}^{q} t_p(t_p-1)(2t_p+5)\right]$$

The standardized test statistic Z is computed by

$$Z = \begin{cases} \frac{S-1}{\sqrt{V(S)}} & when\ S > 0 \\ 0 \quad when\ S = 0 \\ \frac{S+1}{\sqrt{V(S)}} & when\ S < 0 \end{cases}$$

In these equations, X_i and X_j are the time series observations in chronological order, n is the length of time series, t_p is the number of ties for pth value, and q is the number of tied values. Positive Z values indicate an upward trend in the hydrologic time series; negative Z values indicate a negative trend. If $|Z| > Z_{1-\alpha/2}$, (H_0) is rejected and a statistically significant trend exists in the hydrologic time series.

Sen's Slope Estimator

Sen's nonparametric method (Sen, 1968) was used to estimate the magnitude of trends in the time series data. The slope (T_i) of all data pairs is computed as

$$T_i = \frac{X_j - X_k}{j - k}$$

In this equation, x_j and x_k represent data values at time j and k (j>k), respectively. The median of these N values of T_i is represented as Sen's slope estimator which is given as

$$Q_i = \begin{cases} T_{(N+1)/2} & N\ is\ odd \\ \frac{1}{2}\left(T_{\frac{N}{2}} + T_{\frac{N+1}{2}}\right) & N\ is\ even \end{cases}$$

A positive Q_i value represents an increasing trend; a negative Q_i value represents a decreasing trend over time.

Variations in weather parameters

The mean monthly minimum temperature starts increasing from January and reaches its peak during April-May with a clear secondary peak during October-November (Fig. 1). Similar pattern was observed for mean monthly maximum temperature. The mean monthly maximum temperature recorded at Old Goa varied between 28.51 °C (July) and 37.95 °C (May) with a mean value of 33.26 °C while mean monthly minimum temperature varied from 15.98 (January) to 26.69 °C (May) with mean value of 22.47 °C . The monthly distribution of morning relative humidity (RH Mor) revealed bimodal distribution while evening relative humidity (RH Eve) showed unimodal distribution with maximum RH Eve recorded in the month of July. RH Mor starts increasing from January and reaches local maxima in the month of March then it starts decreasing with local minima in the month of May. It again starts increasing reaching maximum in the month of September and decreased thereon. Mean monthly rainfall in Goa showed a unimodal distribution mainly due to southwest monsoon. The monthly rainfall starts increasing from May reaching its maximum in July and then it starts decreasing. Except December, January and February months, all other months were having THI > 77 indicating moderate discomfort to the poultry birds. In the month of April and May, it was higher than 80 indicating severe discomforts. So, this necessitates redefining the package of practices for poultry husbandry on the west coast of India, particularly in Goa to reduce the stress on poultry.

Trends in Meteorological Parameters

The results of trend analysis for various weather parameters impacting the poultry production are presented in Fig. 2. The Mann-Kendall analysis of annual mean maximum temperature has shown a negative trend ($Z = -0.487$, Sen slope = −0.016 °C /year) whereas, annual mean minimum temperature was found increasing ($Z = 0.552$, Sen slope = 0.015 °C /year). This increase in minimum temperature may be due to global warming and increased greenhouse effect (Fig. 1). Relative humidity records for Goa between 2004 and 2023 showed non-significant trend both for RH morning and evening. Sen's slope for morning relative humidity indicated a positive trend (0.073%/year) while it was negative for afternoon relative humidity

(−0.006%/year). Statistical record of rainfall in Goa region showed a steady and constant trend over the years without showing wide variations. Sen's slope for yearly rainfall showed a slightly increasing trend (12.01 mm/year). The THI in Goa region has shown an increasing trend though not significant over the years (Z = 1.265) with Sen's slope of 0.019 thereby putting the poultry birds under moderate to severe discomforts.

Conclusion

The influence of climate change on poultry production is a complex and requires immediate attention. The combination of rising temperatures, humidity levels, disturbed feed supply, and water scarcity presents considerable difficulties to poultry health, productivity, and economic sustainability. Understanding these consequences and employing adaptive strategies will help the poultry industry manage the challenges of a changing climate and continue to supply essential protein sources and economic opportunities for communities.

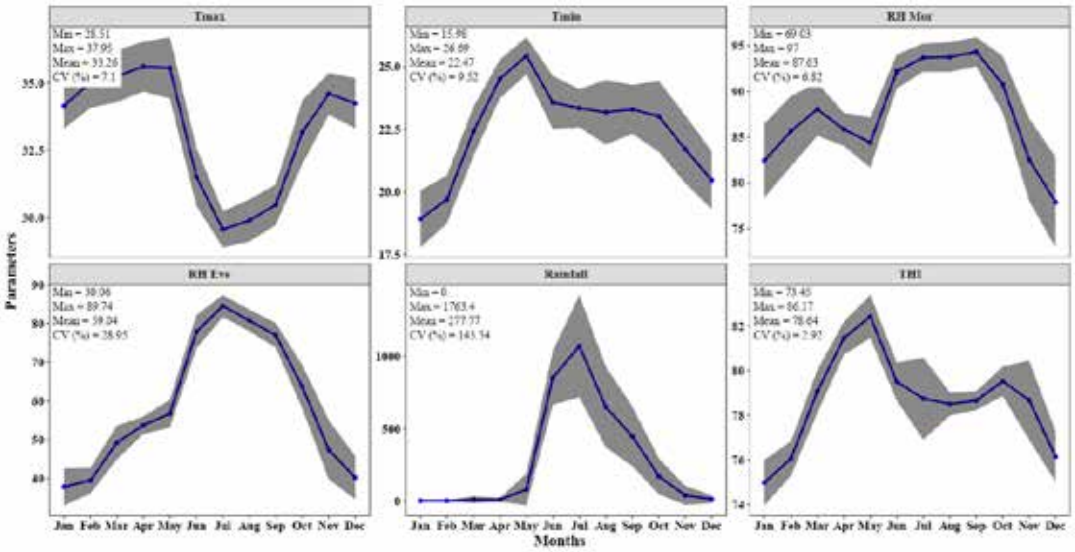

Fig. Mean monthly maximum temperature (Tmax, °C), minimum temperature (Tmin, °C), morning relative humidity (RH Mor, %), evening relative humidity (RH Eve, %), rainfall (mm) and their standard deviations for Goa

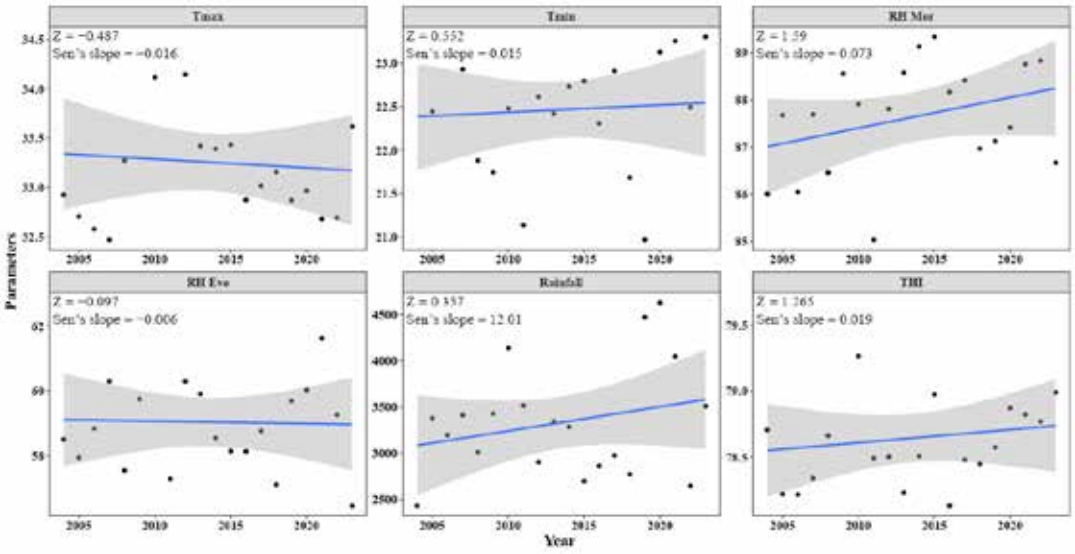

Fig. Trend analysis of mean annual maximum temperature (Tmax, °C), minimum temperature (Tmin, °C), morning relative humidity (RH Mor, %), evening relative humidity (RH Eve, %), rainfall (mm) and their standard deviations for Goa

8 Seasonal Management of Poultry

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Introduction

Climatic variability has imposed great concern in productivity and health of poultry. The Intergovernmental Panel on Climate Change sixth Assessment Report (IPCC, 2021) predicted crossing of earth surface temperature by 1.5ºC by early 2030s, which is about 10 yrs. earlier than the mid-point range (2030-2052) due to increased CO_2 emissions and anthropogenic activity. The effect of increased heat stress is a potential challenge in tropics which hampers poultry production, reduced reproductive competence, compromised immune status and increased cost for alleviation of heat stress (Rajkumar *et al*., 2011). It alters the neurohormonal pathways which affects immune systems reducing their health status. The tolerance to heat stress is breed dependant so genetic and epigenetic strategies can be utilised to improve the threshold level in thermotolerance (Mack *et al*., 2013). Moreover, poultry are more prone to thermal-stress owing to feathered body, lack of sweat glands and high body temperature. The improved varieties of poultry are reared by masses in backyard under scavenging system of rearing which predisposes them to long term heat exposure. Managing and improving their thermotolerance through suitable approaches in tropical climatic condition like our country is a major concern. In such changing climatic scenario and effect of various seasons in poultry, we have discussed the techniques for management of poultry.

Summer season management in poultry

The major problem in poultry during summer is heat stress. Rapid growth, lack of sweat gland and feathered body accentuates this problem in commercial poultry than backyard poultry. So following are the points to consider to mitigate the heat stress:

Have a plan to help your birds stay cool during the peak of summer. Try to arrange ice blocks or frozen bottles in the housing area in the morning, and misters and fans

can be set up when temperatures begin to climb. With just a little help, backyard birds can make it through the high temperatures of summer unscathed. Chickens should have a place to get out of the sun when they begin to get too warm. This may be natural landscaping features such as trees or other vegetation, or shades constructed for this purpose. Tarps or shade cloths can be used over an existing structure for a "quick fix" to provide extra shaded areas for birds. Consider the movement of the sun throughout the day and its effect on the location of the shade within a coop or run. For example, if your shade feature is located on the eastern side of your run, the late afternoon sun may cause the shadow to be entirely outside the area your birds can access. Positioning shade in the middle or west end of the chicken run ensures that chickens will have access to shade during the hottest times of day: midday to afternoon. In summer months water sprinkling also can be done. Before constructing the poultry house, short-growing plants and trees like subabul, agathi, neem trees, etc, should be planted around the sides of the houses. Wet gunny bags should be screened on the sides of the poultry houses. This will reduce the heat considerably. Litter preferably fresh litter of 2 inches thickness with racking or stirring of litter 2-3 times a day during cool hours is recommended.

- As temperature rises beyond 30◦c, the feed intake declines at an increasing rate. Hence provide feed at cooler parts of day i.e early morning and late evening.
- Provide adequate ventilation suitably in humid climates as birds cannot sweat. Cleaning of nets in sidewalls and air inlets for proper air flow in poultry house.
- Reduce stocking densities or provide more floor space/bird.
- Occasional rains may wet the litter hence litter treatment with wood ash: fertilizer grade superphosphate @4:1 may be sprinkled I.e 5kg for 10sq mt area is recommended.

- Catching and transport of birds should be timed at coolest part of day.
- Deworming of birds should be done at 8 weeks and 18 weeks of age. In floor rearing, preferably once in a month and once in two months for cage reared birds.
- Vaccinate early in morning to avoid heat stress as per vaccination schedule of poultry birds.
- Clean, cool and wholesome water should be provided, usage of water sanitizers is also advisable.

Other points:

- 10% extra floor space should be provided in summer.
- Overcrowding of birds should be avoided.
- Shifting, transportation and de-beaking should be done during night or cool hours of the day.
- Birds severely heat-stressed may be dipped in cold water for 2-3 minutes keeping their neck and head above water level.
- Provide proper cross ventilation.
- Fans (pedestal, ceiling or exhaust) may be fitted in sheds.
- Use foggers in the shed which could reduce the shed temperature up to 5-10oC depending upon quality.
- Use of paint, white lime etc. practically reduces the shed temperature up to 2oC
- Use side curtain in the shed which should be sprinkled with water.
- Provide 3 exhaust fans on one side and pad cooling on other side (200ft) which completely seals the shed sides and brings down temperature below 8oC.
- Use sprinklers on the top or inside shed.
- Surround the house with tall trees.
- Thatched roof is suitable for hot areas.
- House should be situated away from other buildings to facilitate free movement of air.
- High altitude of roof is ordinarily 2.6 to 3.3 m from foundation to the roof line to provide maximum ventilation.
- Provide one meter overhang to cut the direct sun and rain into the house.

Chickens should always have access to fresh, clean, cool water, especially in the summer heat. Provide multiple water sources located in shady, cool areas to encourage hens to drink and wade. Add ice cubes, ice blocks, or frozen water bottles to keep water cool. Electrolyte mixes can be used. It's best to provide the mix in the chicken's water supply for only a few hours, then remove it and replace with fresh, plain water. Low sided dishes or pans will allow hot chickens to wade in and

cool their feet, or high traffic areas can be temporarily flooded (provided the area will dry out fairly quickly). It is important to change open water daily to prevent coccidiosis from spreading. It is not uncommon to see extremely watery droppings during periods of high heat due to increased water consumption. This method, termed excretory heat loss, is one-way chickens are able to increase their capacity to cool themselves. Increase number of waterers by 25% and also frequency of watering. Provide electral energy (1-2 gm/liter) in water during hot hours/ Addition of 0.25% of salt to drinking water increases water consumption can be done. Incorporation of anti-stress vitamins like vitamin C in water should be advised in summer.

Rainy season management in poultry

House preparation:

- The repair of poultry house in pre-monsoon and proper functional drainage system should be ready. The doors should be closed and curtains be hanged to avoid entering of rain to shed causing wet of birds/litter or other associated problems.
- Proper ventilation and good litter practices should be provided to avoid accumulation of ammonia and other gases
- In heavy rainfall area like Goa, the floor should be raised with a generous roof overhang (4-5 feet), particularly over the entrance.
- For poultry houses of low-lying regions, measures should be taken to avoid water logging near houses, to keep the litter dry or remove the wet litter, preventive care against diseases particularly coccidiosis. Preferably, the birds should be transferred to a suitable place in covered vehicle if the situation demands.

Feeding management:

- Prevent the feed ingredients from getting wet, and the amount of feed should not be too much. The compound feed in the house should be placed on the platform above the ground to prevent the feed from regaining moisture. Energy rich sources like oil/fat should be added to the diet or level of other nutrients may be adjusted keeping the energy at same level.

- Contamination with mycotoxin is a crucial problem in high rainfall areas. Regular checking of feed storage area and feeders to avoid fungus contamination. Discard the fungus infested feed to avoid health issues.
- Purchase feed for an average of 15 days in small scale poultry feeding to prevent mycotoxin contamination. Fungal inhibitors and toxin absorbents can be premixed in feed with proper consultation with experts.

Water management:

- Provide your birds with warm water periodically during this rainy season to encourage consumption and help them keep warm without using up energy reserved in the process. Supplementary feeding should be given to the scavenging birds in backyard.
- Water sanitation can be done with 2gm of bleaching powder for 1000lt of drinking water for treating water. Avoid giving this with antibiotics and vaccines.
- De-wormers administered after every three months help in management of worms but the product withdrawal period should be followed.

Litter management:

- Litter may get wet due to leakage/seepage of water/diarrhoea or excess salt consumption so proper recking and coarse material should be used.Wet litter condition should be prevented as it may lead to burnt/swell hock condition, E.coli infection, coccidiosis etc. Hence proper housing space or stocking density along with proper ventilation should be ensured.
- Wet litter can be prevented by frequent stirring of the litter. Super phosphate 7 kg per 100 sq.ft. floor space may be added into litter by stirring. Very little ammonia will be released when litter is kept below a pH of 7.0, but is rapid at a pH of 8.0 or above. Phosphoric acid (1.9l/10.5ft^2) and super phosphate (1.09kg/10.5ft^2) are effective in controlling ammonia fumes of the litter.
- Insect proofing of the house may be required if litter is not taken care of properly.

Egg production:

- Less sunshine hours in rainy seasons reduced egg production, hence fluorescent lights may be given to make up the photoperiod upto 16 hr/day to sustain egg production.
- Immuno-modulators can be added in feed to boost the immunity and productivity

Health management:

- With rain comes many diseases also. So proper management, preventive care and deworming should be followed in time.
- Strict biosecurity measures like cleaning and disinfection of farm equipments and farm area with any standard disinfectant like bleaching powder/potassium permanganate, foot bath, separate clothing for working persons, rodent control and restricted entry for outsiders, vaccination and proper medication should be followed.

Poultry management during winter

1. Reduced hours of natural night causes reduced egg production in layers. Hence provision of artificial light in the laying shed to increase the total light period upto 16 hours is required.
2. In cold and hilly areas, provide side curtains without restricting proper ventilation (from sunset to sunrise in the next day) as birds naturally produce lot of moisture in breath and droppings.
3. The thickness of litter material in the deep litter poultry houses should be increased to six inches to provide warmth and insulation.
4. Balanced feed as per the feeding standard and ad lib fresh water should be given.
5. Increase the number of feeders or slightly increase the energy and protein content in the feed may be done for commercial broilers as it stimulates growth in winter. But care should be taken to avoid feed wastage.
6. Brooder room should be pre-heated a day before arrival of day-old chicks. Maintain the temp of the brooder house to 95ºF/35ºC during 1st wk of their life. Lower the temp each week by 5ºF/3ºC till it reaches 70ºF. Observe the chicks in brooding, avoid hurdling by providing required warmth by bulbs/brooders.
7. Provide warm water to chicks during cool hours if necessary.

9 Important diseases in backyard poultry and their management

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Backyard poultry rearing is an age-old practice in India that is characterized by small flock size and is maintained without much capital investment which provides small-scale farmers with additional income and a source of nutrition to the family. The birds are reared by utilization of kitchen leftovers and agricultural by-products. Commonly local indigenous birds are maintained all over the country and rarely improved breeds for better egg and meat production. In general, indigenous birds are resistant to most of the diseases but many disease outbreaks have been reported in backyard poultry. Diseases can cause severe economic loss in poultry farming due to mortality, reduction in egg production, and lack of weight gain. Disease prevalence in backyard poultry acts as a important source of infection for commercial poultry as well as wild birds (Pollock et al., 2012). Also, they are an important source of infection for zoonotic pathogens like *Salmonella, Mycobacterium Campylobacter, Chlamydia psittaci,* and Avian Influenza virus to humans. Better healthcare in terms of vaccination against important diseases, deworming, application of anti-coccidial agents, etc. can protect the birds from diseases and can help to increase productivity. A good understanding of common diseases of backyard poultry flocks is important for the farmers to take precautionary measures against these diseases. Based on the causative agent/factor, the common diseases are grouped into viral, bacterial, parasitic diseases and deficiency diseases.

Viral diseases:

Among the infectious diseases of poultry, viral diseases form a serious threat to backyard poultry. Poultry disease outbreaks caused by different viral pathogens have been reported in backyard poultry farming in different parts of the country. The common viral diseases reported in India are Newcastle disease, Avian Influenza,

Fowl Pox, Marek's disease, and Infectious Bronchitis. The occurrence and economic loss due to these viral diseases can be reduced to some extent by following proper biosecurity measures and vaccination.

New Castle Disease (Ranikhet Disease/RD) is a very common and highly contagious viral disease of poultry, characterized by increased mortality, and severe respiratory signs like gasping, coughing, sneezing, and rales. The disease has been reported in poultry, turkeys, geese, ducks, pheasants, partridges, guinea fowl and other wild birds (Kaleta and Baldauf, 1988). Often this disease is associated with signs of nervous system disorders like tremors, paralyzed wings, and legs, twisted necks, circling and digestive disorders like greenish diarrhea. The disease results in the complete cessation of egg production. ND is highly prevalent in Indian poultry even though vaccination is practiced widely (Gowda, and Eswaran, 1992) and the disease has been well-reported in backyard poultry in different states of the country (Ravishankar et al., 2022; Puro et al., 2022; Joshi et al., 2021; Sahoo 2022; Deka 2022).

Infectious bronchitis is a highly contagious viral respiratory disease, seen mainly in young birds. Infectious bronchitis virus is mainly a respiratory pathogen but it can also affect other organs such as the kidney, gonads, and gastrointestinal tract and affected birds show respiratory signs, nephritis, reduced egg production, eggshell abnormalities, and decreased internal egg quality (Raja et al., 2020). High morbidity is reported in chicken of all ages and a mortality of 10%-30% occurs in birds of less than 6 weeks of age (Surendar et al., 2017).

Marek's disease (MD) is a neoplastic viral disease caused by an alpha Herpesvirus called Marek's Disease Virus. the disease is seen in both commercial and backyard poultry. The disease is characterized by the occurrence of T cell lymphoma and infiltration of T lymphocytes in the nerves and visceral organs. The important lesions seen in affected birds are tumors of the viscera, muscle, skin, and peripheral nerves. The disease is manifested in different forms like neurological form which occur due to infiltration of the central nervous system and peripheral nervous system causing paralysis of the legs and wings. Visceral form is characterised by tumours in the liver, spleen, heart, ovaries, testis etc and in the cutaneous form tumours of feather follicles are seen. (OIE, 2018). As the virus is released into the environment from

the follicle, the disease can spread easily among chickens. Avian leucosis is also a neoplastic viral disease with lesions of tumours and the disease is usually seen in birds of more than 6 months old.

Fig. Liver showing enlargement and multiple tumors in MD-affected bird

Fowl Pox is another viral disease of chickens and turkeys. It is a slow-spreading disease. Viral infection leads to the formation of wart-like proliferative skin lesions on the featherless area on combs, wattles, and eyelids. In the diphtheritic form of the disease, moist, necrotic lesions on the mucous membranes of the mouth and upper respiratory tract are seen. Death rate is usually less in the case of the cutaneous form, and affected birds are more likely to recover than those with the diphtheritic form. Mortality mainly occurs in the diphtheritic form because of asphyxia and lack of feed intake due to proliferative lesions in the nasal passages, tongue, larynx, trachea, etc. Transmission of the virus is generally associated with contamination of open wounds and from biting insects such as mosquitos and mites (Roy et al., 2013).

Avian Influenza is a notifiable disease caused by viruses the Genus Influenza virus A. Many species of birds are susceptible to this viral infection and aquatic birds can act as a major reservoir for this virus. Most of the Influenza Virus A strains are of low pathogenicity (low virulence) in poultry. Clinical signs may vary depending on species, age, type of bird, and the virus strain. Varying clinical signs are seen depending the strain of the infecting virus. Clinical signs include ocular and nasal discharges, cough and dyspnea, swelling of the sinuses and/or head, reduction in feed and water intake, a marked drop in egg production, cyanosis of the featherless areas of skin, wattles and comb, incoordination and nervous signs and diarrhea. Low pathogenicity avian influenza (LPAI) virus infection normally causes only mild or no clinical disease (OIE, 2018). Suspected cases may be informed immediately to the State Animal Husbandry Department for prevention, control and containment of the disease.

Table: Vaccination schedule for poultry

Age	Disease	Vaccine	Route
1 day	Marek's	HVT vaccine	Inj. Subcutaneous (SC)
5-7 days	RD	Lasota/F	Occulonasal
10-14 days	IBD	IBD Live	Drinking water
24-28 days	IBD	IBD Live	Drinking water
8th week	RD	R2B/RDVK	Inj. S/C or Intramuscular (I/M)
10-12 week	Fowl Pox	Modified live	Inj. Wing web prick
16-18 week	RD	Inactivated	Inj. I/M in Thigh/ breast muscle

Bacterial diseases:

Bacterial diseases are another important cause of poultry mortality. It contributes to nearly 50% of the first-week mortality in broiler chicks (Thofner and Christensen, 2021). Bacterial pathogens of various Genus and species are involved in poultry diseases. In general, bacterial diseases can be controlled by appropriate use of antibiotics.

One of the common bacterial diseases is Infectious Coryza caused by *Avibacterium paragallinarum*. It is a highly contagious acute disease of the upper respiratory tract of chickens. Affected birds show signs like nasal discharge, sneezing, rales, and swelling of the face under the eyes. Infected flocks can act as a permanent threat to healthy flocks. Transmission occurs by direct contact, airborne droplets, or through contaminated drinking water. In mild outbreaks, birds show listlessness, serous nasal discharge, and occasionally slight facial swelling. In severe cases extensive swelling of one or both infraorbital sinuses with edema of the surrounding tissues can occur and it can extend to the intermandibular space and wattles. In the absence of secondary infection occurs the swelling will subside in 2 weeks.

Pullorum disease caused by *Salmonella enterica pullorum* is a fatal septicaemic disease causing very high mortality in young chickens and turkeys during 2-3 weeks of age. Affected birds show clinical signs like huddling, anorexia, weakness, depression, and the presence of white fecal material on the vent area. Birds may show respiratory disease, blindness, and swollen joints. Disease spread by either direct or indirect contact with infected birds or through respiratory or enteric routes from contaminated feed, water, or litter, etc. The bacteria can also be transmitted

vertically via egg or hatchery contamination. Infected survivors are asymptomatic carriers. Young birds show lesions like presence of yolk sacs and the occurrence of gray nodules in the visceral organs like liver, spleen, lungs, heart, gizzard, and intestine. Presence hard cheesy material in the ceca and raised plaques in the intestinal mucosa are also seen. Adult birds may have nodular pericarditis, fibrinous peritonitis, or hemorrhagic, atrophic, regressing ovarian follicles. Fowl typhoid is also a disease seen in poultry caused by *S. gallinarum*. This bacterium causes a severe septicemic disease primarily affecting adult birds. Clinical signs are similar to pullorum disease like depression, somnolence, anorexia, huddling, together, droopy wings, dehydration, labored breathing, diarrhea, ruffled feathers, weakness, and adherence of feces to the vent (Berhanu and Fulasa, 2020).

Fowl cholera caused by *Pasteurella multocida* is seen in poultry either as acute septicaemic form with a high morbidity and mortality or as a chronic local form. In acute fowl cholera death is the first sign with lesions in visceral organs. In less acute disease, the common signs are anorexia, ruffled feathers, oral and nasal mucus discharge, cyanosis and white or greenish watery mucoid diarrhoea. In chronic form, affected bird show various lesions in the respiratory tract, the conjunctiva, and adjacent tissues of the head. Also caseous arthritis and peritonitis and salpingitis with increased amount of fluid are seen. Lesions include generalized congestion of the carcass, enlargement of the liver and spleen, and haemorrhage in the epicardium. The presence of disseminated multiple, small, necrotic foci in the liver and spleen may be seen in chronic cases. Chronically infected birds and asymptomatic carriers can act as a major source of infection to young birds. Wild birds and farm animals also carry this bacterium.

Colibacillosis. It is an acute fatal septicemia caused by Avian pathogenic *Escherichia coli* (APEC). It is one of the most prevalent infectious diseases in poultry of all ages and most commonly affects young chicks up to three weeks old (Singh et al., 2018). Clinical signs vary depending on the age of the affected birds and presence of concurrent infections. Commonly respiratory, reproductive, and gastro intestinal systems are affected. Young birds with acute septicemia show few lesions like enlarged, hyperaemic liver and spleen with increased fluid in body cavities. Subacute cases show fibrinopurulent airsacculitis, pericarditis, perihepatitis, and depletion of

lymphocytes in the bursa and thymus. Proper follow of biosecurity practices will help in preventing the disease manifestation.

Chronic respiratory disease is a condition caused by *Mycoplasma gallisepticum* characterized by respiratory signs like gasping, nasal discharge and lesions like thickening of air sac, tracheal congestion, and deposition of mucous or caseous material over the tracheal mucosa and air sacs. Uncomplicated CRD is mostly sub-clinical. When symptoms are present they are normally mild in nature and include coughing, sneezing, and a nasal discharge. Clinical signs and lesions are more pronounced when other factors including secondary bacterial infections, complicate the CRD infection. *M. gallisepticum* is transmitted vertically through eggs and also get transmitted horizontally through contaminated aerosols, feed, water, environment and fomites. The organism persists in the infected flock for prolonged period mainly in multiple-aged flocks. Hence it is necessary to maintain good management and biosecurity practices to prevent entry of mycoplasma in the flock. Adverse environment conditions like peak summer or cold weather, poor air quality or crowding, concurrent infections etc. result in high mortality.

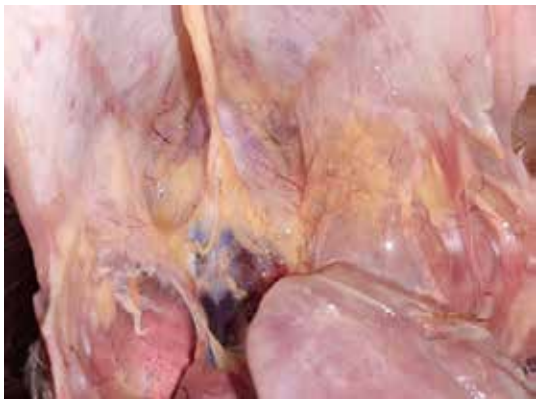

Fig. Air sacculitis in CRD

Fig. Bumble foot in chicken

Bumblefoot (ulcerative pododermatitis) is clinical condition with swollen foot pad occurring due to bacterial infections of the foot mainly after injuries caused by rough perches, splinters, wire floors, poor litter or bedding. Most common associated bacteria is *Staphylococcus aureus.* The affected bird shows signs like lameness, swollen foot pad which could be either hard or pus-filled abscess. The condition can be treated by wound dressing and topical antibiotic application.

Fungal Diseases:

Aspergillosis commonly known as brooder's pneumonia is a fungal disease caused by the fungus of Genus *Aspergillus*. The disease is caused by inhalation of fungal spores (conidia) and entry of spores into the lungs and air sacs where they establish infection. The disease mainly affect respiratory system with occurrence of yellow cheesy plaques and hard nodular masses in the lungs and air sacs. Rarely other organs are also involved. Chicks and poults show high mortality if large quantity of spores are inhaled during hatch or reared in bedding contaminated with mold spores. Older birds develops the disease due to inhalation of spore-laden dust from contaminated litter, feed, or dusty range areas. This is a disease is of high economic importance as it can cause high morbidity and mortality in young chicks (Arne et al., 2011). All age groups are susceptible to this disease and it is reported in poultry, duck, quails as well as in wild birds (Leishangthem et al., 2015). The acute aspergillosis develops with in a week of infection and is seen in young birds showing clinical signs like dyspnoea, anorexia, polydypsia, cyanosis, diarrhea and emaciation. The birds may die suddenly without showing any clinical signs in per acute cases. The signs of chronic diseases include inappetence, emaciation, dyspnea, gasping, increased thirst, fever and diarrhea (Jensen et al., 1997). Predisposing factors are stress, unhygienic farm conditions, overcrowding, malnutrition, vitamin A deficiency, over use of corticosteroids, and use of disinfectant fumes and aerosol sprays etc. The treatment is expensive and difficult with poor prognosis and hence preventive measures must be followed. Preventive measures must address predisposing factors like malnutrition, stress, hygiene and other factors. Avoiding wet litter, moldy litter and feed, provision of good ventilation in shed and regular cleaning and disinfection of feeders, waterers, and incubators will help in preventing the disease.

Favus or white comb is a chronic inflammatory skin condition in poultry caused dermatophytes group of fungus mainly *Microsporum gallinae*. The condition is reported worldwide. The disease is reported in the chicken, turkey, duck, quail, and wild birds. The disease is contagious and zoonotic. The disease occurs sporadically and due to entry of fungal spores into skin. Lesions are commonly seen on feather less areas like comb, wattles and shank. Lesions appear as white spots on skin as the disease progresses the spots disappear and skin form thickened wrinkled crusts

and feather loss also occur in the area. The infection spreads by direct contact or through contaminated fomites. Poor immunity, overcrowding and damp surroundings are predisposing factors. This condition can be prevented by applying adequate hygienic measures in poultry sheds and premises including maintenance of dry floor and litter, proper ventilation and exposure to sunlight etc. Immediate treatment and isolation of affected birds prevent spread of the disease in large flocks.

Fig. White spots and crust in the comb of Favus affected bird

Parasitic diseases:

Due to their scavenging nature, the backyard poultry also carry a wide range of internal parasites from microscopic protozoa to large helminth worms. They inhabit the gastrointestinal tract, feed blood and drain the nutrients from the birds which affect the growth and productivity. The most important protozoan parasitic infection is coccidiosis caused by different species of Eimeria. The disease is commonly seen in chicks and grower birds. It is characterized by haemorrhagic enteritis and mortality. Oocysts are passed in feces of affected birds which can act as source of infection. The condition can be diagnosed by detection of oocysts microscopically. The disease can be controlled by use of anticoccidial drugs like Sulfa antibiotics and Amprolium. Control also requires change of litter and application of calcium oxide (lime) in the litter.

Fig. Haemorrhagic enteritis in Coccidiosis-affected bird

Helminth parasites include different species of Nematodes, Cestodes and trematodes. The Nematodes or round worms range from large Ascarids, to minute *Capillaria sp.* and *Heterakis gallinarum. Syngamus trachea* or gape worm inhabits the trachea and bronchi of birds and it is a serious problem in birds kept outdoors in endemic regions. The common cestodes or tape worms in chicken are *Railletina*

spp., *Davainea* spp and *Choanotaenia*. The cestodes have an indirect lifecycle, involving intermediate host like ants, beetles, houseflies, slugs, snails, earthworms, and termites. Houseflies are source of infection for caged birds. For birds in deep litter, termites and beetles can act as intermediate hosts for this parasite. Snails and earthworms can serve as intermediate hosts of parasite in case of free-range birds. As it is difficult to cure the infection with anthelminthics it is important to control of the intermediate hosts in preventing initial infections and reducing the risk of re-infection. A severe infestation with parasites can cause reduction in the nutrient absorption, intestinal blockage, and death. Prosthogonimus or oviduct fluke a trematode parasite is a serious threat to outdoor chicken. The worms are easily transmitted by contamination of premises with oocysts in the feces. Regular deworming is essential to reduce the parasite infection to ensure better growth and productivity of the flock. As the continuous use of same anthelminthic may result in development of resistance in parasite change in the anthelminthic drug is also required to effectively control the parasite infection.

Fig. Intestine showing nematode worm *Ascaridia* sp.

Poultry can carry a large variety of external parasites on the skin including large, blood sucking ticks to the microscopic mites. The common mite is the red poultry mite (*Dermanyssus gallinae*). Other commonly encountered external parasites are the stickfast flea on the comb, chicken body louse (*Menacanthus stramineus*) and shaft louse (*Menapon gallinae*). External parasites generally cause mild clinical signs such as feather damage, anaemia and irritation. Infection with these parasites can be controlled by regular examination and treatment using insecticides like deltamethrin, Cypermetrin or herbal veterinary insectisides in the form of dusts, wettable powders, liquid sprays etc.

Nutritional deficiency:

As the back yard poultry is mainly fed on kitchen wastes and agricultural by-products nutritional demands of growing birds or layers are not generally met from this feed. Deficiency diseases reported in birds include calcium deficiency resulting in poor bone growth and rickets, energy deficiency characterised by poor growth, weight loss, poor egg production, and vitamin A deficiency affecting skin and feathering. In case of deficiency disorders the diet may be supplemented with vitamin and mineral source supplements to form a balanced feed.

Heat stress:

When the air temperature and humidity increase during the summers the body core temperature increases and hence birds undergo heat stress. The signs exhibited during heat stress are panting, increased water intake, and sudden death. Access to cool, fresh water, providing more water space, providing good ventilation, cooling of poultry house by sprinklers and adjusted feed schedules can help provide relief to birds. Heat stress causes increased loss of minerals from the body hence providing electrolytes in drinking water will help to cope with heat stress. Inclusion of Sodium bicarbonate in the feed is useful for laying hens.

10 Setting up a Poultry Farm in Goa: Enhancing Rural Livelihoods and Economic Growth

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Introduction

Poultry farming plays a vital role in improving livelihoods and boosting India's economy by providing significant income and employment opportunities for millions of people, mostly in rural areas. It raises chickens, turkeys, ducks, and geese for meat and eggs and contributes 1.2% of the country's total GDP to the agricultural sector (Ministry of Agriculture, 2023). With a market value of approximately Rs. 80,000 crore and an annual growth rate of 8-10%, the industry is rapidly expanding due to rising population, urbanization, and changing dietary preferences (Poultry Federation of India, 2022). Poultry farming not only directly employs about 3 million people, but also supports related industries, such as feed production, equipment manufacturing, and veterinary services. It offers quick return on investment, making it an attractive option for small and marginal farmers seeking to diversify their income sources. Moreover, the government's supportive policies, including credit assistance and training programs, further enhance the sector's potential to uplift the socioeconomic status of rural communities (Government of India, 2023).

The Government of Goa initiative to raise farmers' incomes has pushed for the growth of allied agricultural activities, and poultry farming is now a highly profitable option. The increased demand for poultry products, along with government policies and credit support, makes poultry farming a promising business with quick returns on investment. To ensure success, farmers should undergo training, invest in proper infrastructure, implement biosecurity measures, and provide quality nutrition to birds. Developing effective marketing strategies and maintaining accurate records will contribute to the success of poultry farming, providing farmers with a sustainable

and diversified income source (Government of Goa, 2023). The high demand for eggs and meat in Goa, which cannot be met by the state's 800-900 poultry farms (Goa Livestock Census, 2022), presents a significant opportunity for expansion of the poultry industry. By investing in this sector, the local economy can experience substantial growth while providing farmers with a stable income source (Directorate of Animal Husbandry, 2023).

Benefits of the Poultry Farming Business

Poultry farming is expanding swiftly due to the rising demand for poultry products. The key benefits of this business are as follows:

- **High Yield**: Poultry farming is a high-yielding business that offers significant returns in terms of both meat and eggs. This high productivity is a major factor driving its rapid growth (Poultry Federation of India, 2022).
- **Low Capital Requirement**: Starting a poultry farm does not require substantial capital investments. Compared to other agricultural ventures, the initial setup costs are relatively low, making it accessible to small and marginal farmers (Government of India 2023).
- **Minimal Space Requirement**: Poultry farming does not require large tracts of land. Efficient and intensive farming practices allow for high output, even in limited spaces, which is advantageous for farmers with restricted land resources (FAO, 2022).
- **Quick Return on Investment**: The high demand for poultry products often leads to a quick return on investment. Poultry birds, especially broilers, have a short growth cycle, leading to quicker market readiness and cash flows (Ministry of Agriculture, 2023).
- **Ease of Licensing**: Obtaining necessary licenses for poultry farming is relatively straightforward. The regulatory framework is supportive, with streamlined processes for farm registration and compliance (Government of Goa 2023).
- **Accessible Credit**: Securing credit from financial institutions for poultry farming is not difficult. Various government schemes and financial products are tailored to support poultry farmers, ensuring that they have access to the required capital (NABARD 2023).

- **Employment Generation**: Poultry farming generates significant employment opportunities, especially in rural areas. The industry does not require highly skilled labour, provides jobs to a wide range of workers, and contributes to rural development (Ministry of Rural Development, 2023).
- **Low Maintenance**: Poultry farms require relatively low maintenance. Modern farming techniques and automated systems reduce the labour and time required for daily operations, making it easier to manage and sustain business (FAO, 2022).

How do we start a Poultry Farm?

After deciding to start a poultry farm, it is crucial to consider the key factors before launching the business.

- **Total Meat Production**: Evaluate the potential production capacity of meat, considering market demand, number of birds, and their growth rates.
- **Total Egg Production**: Assess expected egg production, factoring in the breed of chickens, their laying cycles, and overall health.
- **Type of Housing**: Determine the appropriate type of housing for birds, ensuring that it provides adequate space, ventilation, and protection from predators and weather.
- **Availability of high-quality chicks**: Secure a reliable source of high-quality chicks from reputable hatcheries to ensure healthy stock and optimal growth.
- **Availability of Cost-Effective Poultry Feed**: Identify sources for cost-effective, nutritious poultry feed to ensure the health and productivity of birds.

- **Egg and Meat Processing**: Plan for the processing of eggs and meat, including necessary equipment and facilities to maintain hygiene and quality standards.
- **Chicken Hatching**: Consider the requirements for hatching chicks, including incubators and brooders, to ensure a steady supply of new birds.
- **Packaging and Marketing of Eggs and Meat**: Develop strategies for the efficient packaging and marketing of your products to maximize sales and effectively reach the target market.

Steps and Considerations for Starting a Poultry Farm

Entrepreneurs have the flexibility to choose multiple sectors based on their interests and feasibility when starting a business. Some general steps and considerations for starting poultry farming are as follows:

1. **Research and Planning**: Understanding the regulations and requirements of poultry farming in Goa. Contact local Animal Husbandry departments, Krishi Vigyan Kendra (KVKs), and other authorities for specific guidelines.
2. **Choose the Type of Poultry Farm**: Decide whether to focus on meat production (broilers) or egg production (layers).
3. **Infrastructure Requirement**: Appropriate housing with proper ventilation, temperature control, and lighting must be set up. Sufficient space per bird must be ensured according to the recommended guidelines. Install proper feeding and watering systems.
4. **Type of Birds**: Choose poultry breeds well suited for specific purposes (meat or egg production) and adaptable to local conditions. Initially, we selected a limited range of broiler and layer chickens, or dual-purpose improved breeds, for meat and egg production. As a business grows, you consider adding more varieties based on demand and profitability.
5. **Poultry Farm Location**: Choose a location not too far from the consumer base to avoid logistical challenges and increased transportation costs. Finalize the site in advance to ensure convenient operation.
6. **Feed and Nutrition**: Development of a balanced and nutritious feeding program for poultry. Work with local feed suppliers to ensure a consistent supply of high-quality feed.
7. **Health Care**: Implementation of a health management program to prevent and control disease. Establishing a relationship with a veterinarian for regular check-ups and vaccinations. Take advice from experts in the KVK or the Animal Husbandry Department.
8. **Waste Management**: Develop a waste management system to handle poultry waste responsibly.
9. **Registration of Poultry Farm**: Name and register your poultry farm according to the state laws. Consider creating a logo and website for online marketing and

distribution to distant locations.

10. **Financial Capitals**: Although the poultry business is not capital-intensive, it requires initial funds for land, equipment, staff, birds, raw materials, cash flow management, and salaries. Apply for loans from banks and financial institutions, including government schemes such as MUDRA, and Start-ups, to arrange funds.
11. **Marketing**: Develop a marketing strategy to reach the target audience. Various communication channels and social media platforms are used to create awareness and buzz regarding a product.
12. **Consumers**: Establish connections with local markets, restaurants, and retailers to sell poultry products. Direct producers to consumer marketing channels are more profitable, creating a win-win situation for both producers and consumers.
13. **Compliance and Regulations**: Ensure compliance with local regulations regarding poultry farming, including environmental and health standards.

How much funds are required to start poultry farm business?

Starting a poultry farm business requires a significant amount of capital. Depending on the scale and scope of the operation, you may need around Rs. 1.5 lakh to get started. These funds are required for various purposes, including

- Birds Cost
- Construction Cost
- Equipment Cost
- Staff Costs
- Poultry Feed and Other Raw Materials
- Marketing, Transportation, and Miscellaneous Costs

Recognizing entrepreneurs' needs, financial institutions offer credit facilities at competitive rates. Entrepreneurs can also apply for loans under government schemes, such as MUDRA, to start the poultry farming business.

What License Would I Need?

You will need various licenses to operate the poultry farming business. These include:

- No Objection Certificate (NOC) from the local village panchayat or municipality.
- NOC from the Pollution Control Board.
- Permission for Farm Expansion if your farm grows beyond a certain size.
- License from the Groundwater Department.

The Government of Goa encourages small businesses; therefore, obtaining these licenses should be a seamless process.

Documents Required to Apply for a Loan

To avail of a loan from financial institutions to start a poultry business, you will need the following documents:

- Business plan
- Application form
- Identity proof: Aadhar card, PAN card, Driving license, Passport
- Address proof: Voter ID, PAN card, Passport
- Photographs: 2 passport sizes
- Trade license and permits
- Rent agreement or land documents

How to Apply for a Loan for Starting the Poultry Business

Follow these simple steps to apply for a loan.

- ***Check Eligibility Criteria***: Ensure that you meet the eligibility criteria of the bank from which you intend to avail the loan.
- ***Fill the Application Form***: Provide basic details in the application form.
- ***Submit the Application***: Submit the loan application along with the documents required for the KYC.
- ***Approval and Verification***: Once the application is approved and documents are verified, the loan amount is transferred to the account.

Schemes for Setting up a Poultry Farm in Goa

A. State Government Schemes

Objective: Promote the idea of poultry farming to farmers to raise poultry meat and egg production in the state, thereby achieving self-reliance.

1. Gram Shakti Scheme

Under this scheme, grown birds and feed are provided to eligible farmers free of cost, amounting to Rs. 1,000/- through the Government Poultry Farm once a year.

Eligibility:

- Individual rural farmers with space to rear birds in their backyards.
- Farmers with hired/rented houses with backyards.

Pattern of Assistance:

- A unit of grown L.I.T. birds (nine females and one male), along with feed, will be provided.
- Birds and feed must be collected from the Government Poultry Farm, Ela, Old Goa at the farmer's own cost by submitting identity proof and acknowledging receipt.

2. Financial Assistance for Infrastructure of Poultry Farm

This scheme offers financial assistance and subsidies to new poultry sheds and equipment. *Eligibility*:

- The farm must operate for a minimum of ten years.
- The individual should have experience in poultry keeping and must undergo poultry training as a certificate is required.

Pattern of Assistance:

- This scheme provides 75% of the infrastructure costs.

Table: Details of financial assistance

Birds	No. of Birds	Poultry Shed Area (sq. ft)	Sheds Cost (In Lakhs)	Cost of Infrastructure (In Lakhs)	Financial assistance (Subsidy In Lakhs)
Broiler Farm	2000	2000	7.00	8.594	6.00
Layer Farm	4000	7000	26.25	28.705	21.00
L.I.T Birds Farm	2000	2000	7.00	8.594	6.00

Table: For broiler unit under deep litter system

Sr. No.	Particulars	Requirement	Permitted value Per Unit (Rs)	For 2000 Broilers (Rs)
1	Civil construction for poultry shed (2000 sq. ft.)	1 sq. ft/bird	350/-	700000/-
2	Store room	250 sq. ft.	350/-	
3	Chick feeders	1 per 75 birds	150/-	1200/-
4	Adult feeders	1 per 25 birds	300/-	18000/-
5	Chick waterers	1 per 75 birds	150/-	1200/-
6	Adult waterers	1 per 25 birds	250/-	18000/-
7	Electrification	-	15,000/-	25000/-
8	Water pump	-	25,000/-	25000/-
9	Water tank with stand	-	25,000/-	25000/-
10	Defeathering machine	-	30,000/-	40000/-
11	Metal brooders	1 per 300 birds	1,500/-	3000/-
12	Metal chick Guards	1 per 300 birds	1,500/-	3000/-
			Total	**859400/-**

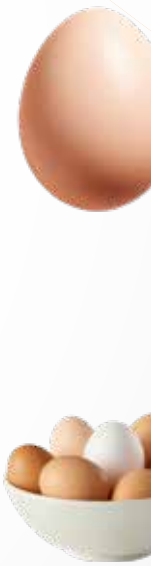

Table: For layer unit under deep litter system

Sr. No	Particulars	Requirement	Permitted value Per unit (Rs)	For 4000 Layers
1	Civil construction for poultry shed (7000 sq. ft.)	2 sq. ft/bird	350/-	2450000/-
2	Feed Store/ Egg room	500 sq. ft.	350/-	175000/-
3	Wooden Nest boxes	150	600/-	90000/-
4	Chick Feeders	1 per 75 birds	150/-	2250/-
5	Adult Feeders	1 per 25 birds	300/-	36000/-
6	Chick Waterers	1 per 75 birds	150/-	2250/-
7	Adult Waterers	1 per 25 birds	250/-	36000/-
8	Cost of Electrification	-	15000/-	25000/-
9	Water pump with shed	-	20000/-	20000/-
10	Water tank with stand	-	20000/-	20000/-
11	Debeaking machine	-	3000/-	3000/-
12	Metal brooders	1 per 300 birds	1500/-	4500/-
13	Metal chick Guards	1 per 300 birds	1500/-	4500/-
14	Vaccinators	-	1000/-	2000/-
			Total	**2870500/-**

1. Financial Assistance for Rearing Broilers, Layers, and Low Input Technology Birds

This scheme aims to support the economic viability of Goan farmers by providing subsidies for the transportation of ready poultry feed from outside the state.

Eligibility:

- Experience in poultry farming is required.
- Certificate for poultry farming training is mandatory.

Pattern of Assistance:

- Provides a subsidy to help with the transportation costs of ready poultry feed from outside the Goa.

B. Centrally Sponsored Schemes

1. Establishment of Backyard Poultry Unit

Under this scheme, grown birds and feed will be provided to farmers who belong to the Scheduled Tribe (ST) and Scheduled Caste (SC) communities free of cost twice a year.

Eligibility:

- Scheduled Tribe and Scheduled Caste families in the state of Goa.
- Only one beneficiary per family member.
- A Caste/Tribe Certificate must accompany the application form.

Pattern of Assistance:

- A unit of grown low input technology birds (nine females and one male) along with feed will be provided (worth Rs. 1, 000) in two instalments per year.
- No processing fees are charged.

Note:

- The subsidy will only be disbursed after the proposed poultry unit is completed, and the final utilization certificate is submitted by the Area Veterinary Doctor and Bank Manager.
- The bank then claims a subsidy from the Department by forwarding the following documents:
- Application submitted by the beneficiary
- Purchase statement
- Purchase receipts
- Utilization certificate
- Insurance documents

- The agreement bond, duly signed by the beneficiary and two witnesses, was signed in the presence of the Area Veterinary Doctor.

Role of Krishi Vigyan Kendra in promoting poultry enterprise in Goa

Krishi Vigyan Kendra (KVKs) in Goa play a crucial role in promoting poultry enterprises by providing training, demonstrations, advisory services, and market linkages. This section provides an overview of their contributions to technological backstopping and development.

Capacity Building: KVKs in Goa regularly organize workshops and training sessions to educate farmers on various aspects of poultry farming. These programs include breed selection, feed management, disease control, and housing systems, thereby equipping farmers with essential knowledge and skills.

Skill Development: Special focus is placed on practical skill development. For instance, the KVK North Goa conducted a series of training programs on backyard poultry farming to help small-scale farmers enhance their incomes through scientific poultry farming practices (ICAR-CCARI, 2020).

Model Poultry Farms: KVKs establish model poultry farms to demonstrate best practices. These units serve as practical examples for farmers to learn and replicate modern poultry-farming techniques.

On-Farm Trials/Demonstrations: KVKs conduct on-farm trials to assess the suitability of new breeds or practices at the district level and demonstrate the benefits of improved poultry breeds and innovative management practices, encouraging farmers to adopt these methods (Naik et al. 2019).

Advisory Services: KVKs provide personalized advisory services to poultry farmers by offering solutions for disease management, nutrition, and housing improvements. Extension workers from KVKs also conduct field visits to provide onsite advice and diagnostic services (Sawant et al. 2021).

Field Visits and Diagnostic Services: These services help farmers address challenges promptly and effectively, ensuring the health and productivity of their poultry.

Promotion of Improved Breeds: KVKs facilitate the distribution of improved poultry breeds that are more productive and disease resistant. These efforts have

helped to enhance the productivity of poultry enterprises in Goa (Kumar et al. 2020).

Market Access: KVKs assist farmers in establishing market linkages, ensuring that they receive fair prices for their poultry products and access broader markets.

Value Addition: Training on value addition, including processing, packaging, and branding of poultry products, helps farmers increase their market value and income from their poultry enterprises (Desai et al. 2018).

Awareness Programs: KVKs conduct awareness campaigns and workshops to educate farmers about the economic benefits of poultry farming, biosecurity measures, and hygiene practices. These programs aimed to improve the overall health and productivity of poultry farms (Patil et al. 2017).

Conclusions

Poultry farming presents a promising opportunity for farmers in Goa to increase their income and contribute to the state agricultural outputs and economy. The high demand for poultry products in Goa, coupled with its relatively low capital investment and rapid returns, makes poultry farming a viable and profitable venture. Implementing best practices for infrastructure, bird selection, feed management, and healthcare ensures the sustainability and profitability of poultry farms. Furthermore, effective waste management and strategic marketing can contribute to business success. As the poultry industry continues to expand, it not only provides direct employment opportunities, but also supports allied sectors, contributing to rural development and economic growth. The multifaceted support provided by KVKs significantly contributes to the development and sustainability of poultry enterprises in Goa, empowering farmers with the knowledge, skills, and resources required to thrive in the poultry industry. With comprehensive planning and adherence to regulatory standards, poultry farming can become a key component of agricultural diversification and prosperity in the Goa.

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