ISBN : 978-81-997322-6-1

Package of Practices for Livestock and Fish Farming in Eastern India

Shanker Dayal, Kamal Sarma, Pradeep Kumar Ray,
Jyoti Kumar and Anup Das

ICAR Research Complex for Eastern Region
ICAR Parisar, P.O. B. V. College
Patna-800 014, Bihar

Package of Practices for Livestock and Fish Farming in Eastern India

Editors

Shanker Dayal

Kamal Sarma

Pradeep Kumar Ray

Jyoti Kumar

Anup Das

ICAR Research Complex for Eastern Region, Patna Bihar - 800014

Ph.: +91 - 0612-2223962, Fax - +91-0612-2223956

E-mail: director.icar-rcer@icar.org.in Web.: www.icarrcer.org.in

ISBN No. : 978-81-997322-6-1

Package of Practices for Livestock and Fish Farming in Eastern India

Citation :

Dayal, S., Sarma, K., Ray, P. K., Kumar, J. and Das, A. (2026). Package of Practices for Livestock and Fish Farming in Eastern India, ICAR Research Complex for Eastern Region, Patna.
Pp 134

Printed : 2026

Published by :
The Director
ICAR Research Complex for Eastern Region, Patna
Bihar - 800014
Ph. : +91 - 0612-2223962, Fax - +91-0612-2223956
E-mail : director.icar-rcer@icar.org.in
Web. : www.icarrcer.org.in

Print at : Virtue Enterprises, Patna-800001
Mob. : 9304410331, 9162040001

ICAR

डा. राघवेंद्र भट्टा
उप महानिदेशक (पशु विज्ञान)
Dr. Raghavendra Bhatta
Deputy Director General (Animal Science)
M. V. Sc. Ph.D., Postdoctorate (Japan, USA)

भारतीय कृषि अनुसंधान परिषद
कृषि भवन, डॉ0 राजेन्द्र प्रसाद रोड, नई दिल्ली-110001
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
Krishi Bhawan, Dr. Rajendra Prasad Road, New Delhi-110001
Phone : 011-23381119, E-mail : ddgas.icar@nic.in

No. AS/PS/DDG(AS)/Message/2026/6
Dated 9th February, 2026

FOREWORD

The livestock and fisheries sectors constitute vital pillars of agricultural development in Eastern India, contributing significantly to food and nutritional security, employment generation, and the socio-economic upliftment of rural communities.

Eastern India is endowed with abundant natural resources and diverse agro-climatic conditions that are highly conducive to livestock and fish farming. However, despite this immense potential, productivity and profitability in these sectors often remain below their achievable levels. This gap can largely be attributed to inadequate dissemination of scientific technologies, limited adoption of improved management practices, and various resource constraints faced by farmers.

In this context, the present publication assumes great significance. The book systematically compiles scientifically validated, farmer-friendly packages of practices aimed at promoting sustainable and profitable livestock and fish farming, particularly among small and marginal farmers. Its emphasis on low-input technologies, improved farming approaches, animal health care, balanced nutrition, and environmental sustainability makes it a valuable resource for farmers, extension personnel, students, and researchers alike. The integration of livestock and fisheries systems highlighted in this book reflects a holistic and forward-looking approach to rural development and income enhancement.

I sincerely appreciate the efforts of the authors in effectively translating research findings into practical, field-oriented guidelines that can be readily adopted by farming communities. This book will serve not only as an important reference for academic institutions but also as a practical handbook for capacity building and technology transfer initiatives across the region.

I am confident that this publication "**Package of Practices for Livestock and Fish Farming in Eastern India**" will make a meaningful contribution to strengthening the livestock and fisheries sectors in Eastern India and will support the vision of sustainable agricultural development in alignment with the mission of **Viksit Bharat @ 2047**. I congratulate the authors on this commendable effort and wish the book wide acceptance and success.

(Raghavendra Bhatta)

Preface

Livestock farming and freshwater aquaculture play a transformative role in strengthening rural livelihoods, ensuring nutritional security, and accelerating inclusive economic growth. In India, where small and marginal farmers form the backbone of the agricultural economy, these sectors are not merely supplementary activities but critical engines of resilience, income diversification, and employment generation. Recognizing this immense potential, the present publication on *"Package of Practices (PoP) for Livestock and Fish Farming in Eastern India"* has been prepared as a practical and policy-oriented guide for farmers and decision-makers alike. This book is designed to bridge the gap between scientific knowledge and field-level implementation. While research institutions, veterinary universities, and extension agencies continuously generate improved technologies and management strategies, their effective adoption depends on accessible, well-structured, and locally relevant guidance. The Package of Practices compiled here translates proven scientific recommendations into actionable steps covering breed selection, housing, feeding, health care, biosecurity, reproduction management, disease prevention, water quality management in aquaculture, and overall farm economics. For farmers, this publication serves as a ready reference manual to improve productivity, reduce avoidable losses, enhance resource-use efficiency, and ensure sustainable income. Emphasis has been placed on low-cost technologies, regionally adaptable practices, climate-resilient systems, and integrated farming approaches that maximize returns while conserving natural resources. Special attention has been given to preventive health care, vaccination schedules, nutritional balance, housing standards, and management practices that directly influence profitability and long-term sustainability. For policymakers and planners, this book provides a grounded understanding of field realities along with technically sound benchmarks.

The practices outlined herein may support the formulation of development schemes, subsidy structures, capacity-building programs, disease control campaigns, and infrastructure investments. Strengthening livestock and aquaculture sectors requires coordinated efforts—improved input delivery systems, accessible veterinary services, quality seed and feed supply chains, cold chain infrastructure, market linkages, and institutional credit. By presenting standardized and scalable practices, this volume contributes to evidence-based policy formulation and implementation. The integration of livestock and aquaculture within diversified farming systems is increasingly essential in the face of climate variability, shrinking landholdings, and growing demand for animal protein. Scientific management not only enhances productivity but also safeguards animal welfare, environmental sustainability, and public health. This book therefore underscores the importance of biosecurity, responsible antibiotic use, disease surveillance, and ecosystem-friendly production systems aligned with national development goals.

It is hoped that this publication will serve as a practical handbook for progressive farmers, an operational guide for extension personnel, and a reference framework for policymakers working toward strengthening the livestock and fisheries sectors. By combining scientific rigor with field applicability, the book aspires to contribute meaningfully to enhanced farm incomes, improved nutritional outcomes, and sustainable rural development. The success of livestock farming and aquaculture ultimately depends on informed decision-making at both farm and policy levels. May this work support that shared endeavour toward prosperity, resilience, and food security.

Editors

Content

01
CHAPTER

Eastern India : Challenges and Strategy

P. K. Ray, Shanker Dayal, Tarkeshwar Kumar and Kamal Sarma

Livestock farming and fisheries are integral components of rural livelihoods and agricultural systems across Eastern India, especially for small and medium farmers. In this region, animal husbandry and freshwater aquaculture contribute significantly to food security, nutritional support, income generation, and employment diversification for rural households. Unlike high-input commercial operations, the majority of livestock farming here is low-input and small-scale, often conducted alongside crop cultivation to enhance farm sustainability and economic resilience whereas owing to the vast and varied aquatic resource base, the eastern region plays a pivotal role in the country's fisheries sector.

The animal husbandry sector in Eastern India is resource-rich and structurally strong but operationally constrained. While the region has strong strengths in terms of livestock population, smallholder participation and ecological suitability, these are offset by weaknesses in nutrition, health services and market integration. The eastern region has around 84.54 million cattle, contributing around 43.9% of the Indian population as per 20th Livestock Census. Similarly, around 20.44 million (18.61%) buffalo, 4.04 million (5.5%) sheep, 148.9 million (39.5%) goat, 5.05 million (55.80%) pig and 216.43 million (25.4%) poultry. In Eastern India livestock rearing serves as a critical buffer against crop failure, provides milk, meat, eggs, draft power and manure, and integrates with crop systems to recycle nutrients and maintain soil fertility. The small and medium livestock farmers in this region typically own mixed herds of cattle, buffalo, goats, sheep, poultry and ducks. These farmers depend on livestock for regular cash flows through sale of milk, eggs, and meat, while also using animals for draft and organic manure to support crop production. The livestock sector thus enhances rural livelihoods and nutritional security and supports women's participation in farm income generation.

Freshwater aquaculture is a vital pillar of the rural economy, nutritional security, and livelihood generation across Eastern India, with Bihar emerging as a key contributor to the region's inland fish production. Eastern India, comprising states such as Bihar, West Bengal, Odisha, Jharkhand, and Assam, is endowed with extensive freshwater resources. These resources support millions of small and marginal farmers, fishers, and women-led households engaged in aquaculture and capture fisheries. These eastern states are endowed with abundant and diverse aquatic resources, for fisheries and aquaculture development. The region possesses approximately 0.55 lakh km of

rivers and canals, accounting for about 25.24% of the total river and canal, reservoirs cover around 5.2 lakh hectares, (nearly 21.6% of nation), ponds and tanks extend over 8.16 lakh hectares (about 8.87% of the national), beels and oxbow lakes, which are ecologically significant floodplain wetlands, cover nearly 3.9 lakh hectares, (81% of of nation). As per estimates, the eastern states contributed approximately 32% of India's total fish production (2021-22) and accounted for nearly 70% of the total freshwater fish seed production, underscoring the region's strategic importance in ensuring national fish supply, seed availability, and livelihood support for millions dependent on fisheries and aquaculture.

Livestock farming and freshwater aquaculture in Eastern India is a foundation of rural resilience, livelihood security, and agricultural diversification for small and medium farmers. These are central to the socio-economic fabric of rural Eastern India, particularly for small and medium farmers. Realizing their full potential will require coordinated improvements in breeding, nutrition, veterinary support, market access, infrastructure and policies that support smallholder engagement and sustainability. With a significant livestock population and a deep integration of livestock within mixed farming systems, the sector offers significant potential for improving rural incomes and nutrition. Yet realizing this potential will require focused policies and extension support to enhance productivity, services, market access, and climate resilience. Addressing nutrition, housing and disease management weaknesses through targeted interventions can unlock significant productivity gains. A well-designed 'Package of Practices' for Livestock Farming and aquaculture can catalyze such transformation, empowering smallholders to sustainably improve livelihoods and contribute to a robust regional livestock and fisheries-based economy. Strategic interventions focusing on scientific packages of practices and service delivery strengthening can transform weaknesses in this sector into opportunities, making livestock and fish farming a resilient and profitable livelihood option for small and medium farmers. By bridging the gap between potential and performance, the eastern region can not only achieve self-sufficiency in livestock and fish production but also emerge as a model of sustainable livestock and aquaculture development in Eastern India.

Current Status and Future Challenges of Livestock Farming and Aquaculture in Eastern India

A. Livestock Farming

Current Status

1. Predominance of Small-scale, Low-input Systems

Most livestock in Eastern India is reared under traditional, low-input systems, with limited use of modern feeding, housing, and health care practices. Productivity metrics such as milk yield, egg production, and growth rates remain comparatively low due to breed quality and nutrition limitations.

2. Role in Livelihood and Crop Systems

Livestock owns a complementary role with crop agriculture. Farmers integrate manure into fields for soil fertility and, in many cases, manage livestock to recycle resources efficiently. The region often performs well for specific products - for example, Eastern India contributes a high share of duck egg production due to agro-ecological suitability.

3. Limited Access to Adequate Services

Small and medium farmers often face restricted access to veterinary care, breeding services, inputs (like quality feed and vaccines), extension support, and markets. In many villages, veterinary outreach is sporadic, leading to disease burdens that reduce productivity and increase costs.

4. Underdeveloped Market and Value Chains

Markets for livestock products especially meat and non-dairy products are often informal and poorly structured, with farmers frequently selling at volatile or sub-optimal prices due to intermediaries and lack of grading or infrastructure.

Future Challenges

Despite its importance, livestock farming in Eastern India faces several persistent and emerging challenges that need to be addressed in any forward looking package of practices:

1. Low Productivity and Genetic Potential

Livestock productivity in the region continues to trail national and global benchmarks due to limited genetic improvement, low adoption of improved breeds, and inadequate breeding programs. Boosting productivity will require focused breeding, artificial insemination services, and support for crossbreeding adapted to local environments.

2. Feed and Fodder Scarcity

A major constraint across Eastern India is the scarcity of quality feed and fodder, especially during lean seasons. Green fodder deficits, inadequate dry fodder availability, and minimal land allocation for feed crops constrict nutritional inputs, lowering animal growth and output.

3. Inadequate Health Care and Veterinary Support

Frequent outbreaks of livestock diseases (e.g., FMD, lumpy skin disease, poultry ailments) compounded by gaps in veterinary services, vaccination coverage, and animal health infrastructure restrict production and increase mortality risk. Strengthening veterinary networks, disease surveillance, and farmer awareness is critical.

4. Market Access, Value Chains and Infrastructure

Small and medium producers face fragmented markets, weak cold chains, and limited processing systems. Coupled with under-developed slaughterhouses and grading mechanisms, this limits the region's potential to scale value addition and improve farm incomes.

5. Climate Change and Resource Pressures

Climate variability - including temperature extremes, droughts, and altered rainfall patterns - impacts water availability, feed production and disease patterns, posing adaptive challenges for vulnerable smallholders. Sustainable climate-resilient practices and water / fodder management strategies will be essential.

6. Financial Constraints and Credit Access

Small and medium farmers often lack access to affordable credit, insurance and risk buffering mechanisms (e.g., livestock insurance), which makes investment in improved housing, feed, and health services risky. Policies enhancing access to finance and risk mitigation services will be important.

B. Freshwater aquaculture

Current Status

1. **Large and potential open-water resources with low productivity:** Eastern states are also blessed with rich aquatic resources. Total river and channels are around 0.55 lakh km, reservoir 5.2 lakh ha, ponds and tanks 8.16 lakh ha, beel and oxbow lake 3.9 lakh ha. Similarly, Bihar is particularly rich in inland water resources, with about 3,200 km of rivers, 9,000 hectares of oxbow lakes, 26,303 hectares of reservoirs, and 93,296 hectares of ponds and tanks, making it one of the most resource-endowed states in terms of inland fisheries. However, despite this vast potential, current production from open water bodies remains very low and is well below the national average.

2. **Low productivity and predominance of small-scale traditional farming systems:**

   Most fish culture practices in Eastern India are based on traditional, low-input systems with limited adoption of modern feeding, pond management, and health care practices. As a result, productivity remains relatively low compared to many other states. The majority of fish farming is carried out in small ponds (<1 ha) using extensive or semi-intensive methods, with limited use of quality seed, balanced feed, aeration and other essential requirements. Continued reliance on natural productivity and traditional practices has become a major bottleneck to achieving higher yields.

3. **Inadequate supply of quality fish seed and feed:** The availability of quality fish seed and feed remains a major constraint to aquaculture development in the Eastern states. Farmers frequently face problems related to limited access to reliable seed and feed. In Bihar, despite having more than 200 hatcheries in Bihar, a large share of fish seed is still imported from neighboring states due to the non-functioning or suboptimal performance of many local hatcheries.

4. **Integration of agriculture and livelihoods in fish culture:** Aquaculture is often integrated with crop and livestock systems (e.g., rice-fish, pig-fish integration, poultry-fish integration etc.), which enhances resource use efficiency and farm income. Fish farming also provides seasonal employment, supports women's participation in value chains, and contributes to improved household nutrition.

5. **Gaps in input supply and extension services:** Aquatic animal health inputs, including medicines and diagnostics, are either not readily available when required or are prohibitively expensive. Extension services are limited in coverage and effectiveness, restricting farmers' access to timely technical guidance and best management practices.

6. **Underdeveloped value chains and markets:** Fish markets remain largely informal and unorganized, with weak cold-chain infrastructure, limited processing facilities, and poor price transparency. Post-harvest losses are significant, and farmers often receive low prices due to dependence on intermediaries and inadequate market infrastructure.

Future Challenges

Sustainable growth of freshwater aquaculture in Eastern Region requires addressing the following key challenges:

1. **Low productivity and limited species diversity: T**he region experiences a significant yield gap due to poor-quality seed, inbreeding, limited technical knowledge of fish culture, low adoption of improved breeds, reluctance toward species diversification, etc. Enhancing productivity will require the establishment of certified hatcheries, selective breeding programmes, quality broodstock development systems, input supply chain, and efficient seed multiplication networks. Fish culture in Eastern India is largely restricted to Indian Major Carps (Catla, Rohu, and Mrigal). Despite the availability of well-developed technologies for several commercially important species such as minor carps, murrels, and catfishes, diversification in the region remains very limited.

2. **Feed scarcity and high cost:** Quality fish feed is expensive and inconsistently available. Many small and marginal farmers either do not provide adequate feeding or rely on farm-made feeds, which limits stocking density and growth rates. The number of feed manufacturing plants is limited, and existing facilities often operate far below their installed capacity.

3. **Disease and health management:** Disease outbreaks such as Epizootic Ulcerative Syndrome (EUS), Columnaris, and parasitic infestations are common due to poor water quality, lack of diagnostic facilities, limited skilled technical manpower, extension support, easy & readily available required medicine at reasonable price etc. Preventive health care, biosecurity measures, and disease surveillance systems remain weak.

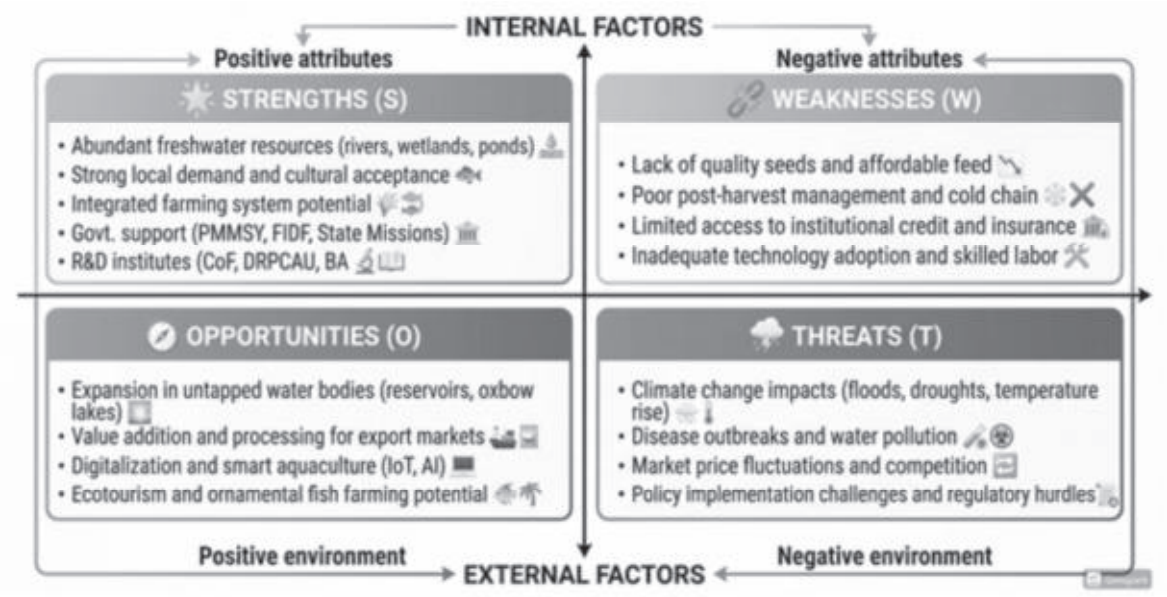
4. **Infrastructure and market linkages:** Inadequate hatchery infrastructure, cold storage facilities, ice plants, cold chain transportation networks, restrict value addition and market access are challenges for the development of aquaculture in this region. Weak farmer producer organizations (FPOs) and cooperatives further reduce farmers' bargaining power and limit their integration into organized value chains.

5. **Climate vulnerability:** Frequent floods, droughts, extreme high and low temperature and very high temperature fluctuations adversely affect water availability, fish health, and overall productivity. The adoption of climate resilient aquaculture practices and adaptive management strategies is has to be developed.

6. **Financial and institutional barriers:** Small and marginal farmers have limited access to credit, insurance, and government support schemes. High initial investment requirements and perceived risks discourage the adoption of improved aquaculture practices and technologies.

SWOT Analysis of the Animal Husbandry and Fishery Sector in Eastern India

SWOT Matrix: Animal Husbandry Sector in Eastern India



SWOT Matrix: Fishery Sector in Eastern India

Factors to be considered by small holders for profitable livestock and Fish farming

A. Livestock

For smallholders, livestock becomes profitable not by scale, but by smart decisions, low-cost practices, and risk management. Here are the key factors that really matter on the ground

1. Choice of Species and Breed

- Select locally adapted breeds (indigenous or improved local strains)
- Prefer animals with:
    - Lower feed requirement
    - Disease tolerance
    - Ability to thrive under low-input systems
    - Match species with resources:
    - Cattle/buffalo → fodder availability
    - Goat/sheep → grazing + crop residues
    - Poultry → backyard feed resources

✓ *Breed–environment mismatch is a major cause of losses.*

2. Feed and Fodder Management (Biggest Cost Factor)

- Feed cost = 60–70% of total expenditure
- Ensure:
    - Year-round fodder planning (green + dry + concentrate)
    - Use of crop residues (paddy straw, maize stover, wheat bhusa)
    - Promote: Azolla, fodder trees, kitchen waste (for pigs/poultry)

✓ *Even small improvements in feeding give big gains in milk/meat output.*

3. Housing and Management

- Low-cost, well-ventilated housing using local materials
- Protection from:
  - Heat stress
  - Rain and dampness
  - Predators (especially for goats & poultry)
- Clean floor, proper drainage → less disease

4. Animal Health Care

- Follow preventive health practices:
  - Timely vaccination, Regular deworming and Ectoparasite control
- Early disease detection reduces mortality and treatment cost
- Maintain basic health records

✓ *Ignoring vaccination is often more expensive than vaccinating.*

5. Reproductive Efficiency

- Timely heat detection and breeding
- Avoid long calving/kidding intervals
- Use quality AI services or proven breeding males
- Proper care during pregnancy and after parturition

✓ Poor reproduction = fewer animals + lower lifetime returns

6. Labour Availability and Skill

- Family labour is an advantage for smallholders
- Training in:
  - Feeding
  - Milking hygiene
  - Disease signs
  - Basic record keeping

7. Market Access and Price Realization

- Know:
  - Nearest milk collection center / traders
  - Seasonal price fluctuations
- Explore:
  - Cooperatives, SHGs, FPOs
  - Direct sale (milk, eggs, kids)
- Value addition (curd, ghee, manure) increases income

8. Financial Planning and Credit

- Start with manageable herd/flock size
- Use institutional credit (banks, NABARD-supported schemes)
- Insure animals wherever possible
- Maintain cost–benefit awareness

✓ Profit = controlled costs + assured income, not herd size

9. Risk Management

- Diversification reduces risk:
  - Dairy + poultry
  - Goat + crop farming
- Insurance, fodder reserves, vaccination buffer shocks
- Avoid over-dependence on one species

10. Record Keeping and Decision Making

- Simple records of:
  - Feed cost
  - Milk/egg production
  - Health expenses
- Helps identify:
  - Non-performing animals
  - Profitable practices

✓ *"What gets recorded gets improved."*

Bottom Line

✓ For smallholders, profitability comes from efficiency, not expansion

✓ Right breed + low-cost feeding + disease prevention + assured market = sustainable income.

B. Aquaculture

For small and marginal farmers, profitability depends on efficient resource use, risk management, and market linkage.

1. Selection of Species and Stocking

✓ Choose fast-growing and locally adapted species (Rohu, Catla, Mrigal, Pangasius)

✓ Use certified quality seed from reliable hatcheries

✓ Avoid overstocking and understocking with uniform size of species

✓ Adopt polyculture systems to optimize pond productivity

2. Pond Preparation and Water Management

✓ Ensure proper pond deepening, liming, and fertilization

✓ Maintain optimal water quality (pH 7–8.5, dissolved oxygen >5 mg/L etc.)

✓ Implement aeration and water exchange in intensive systems

3. Feed Management

✓ Provide balanced nutrition using quality pellets or farm-made feed

✓ Avoid under and over feeding

✓ Adopt scheduled and regular feeding to reduce waste and pollution

✓ Integrate with poultry, duck farming or with other livestock to reduce feed cost

4. Health and Disease Prevention

- ✓ Practice regular water quality monitoring
- ✓ Implement biosecurity measures and preventive health care
- ✓ Ensure timely disease diagnosis and treatment

5. Harvest and Post-Harvest Handling

- ✓ Harvest at optimal market size
- ✓ Use proper handling, icing, and storage to minimize losses
- ✓ Explore local processing (smoking, drying) for value addition

6. Market Linkages and Price Realization

- ✓ Link with FPOs, cooperatives, or contract farming arrangements
- ✓ Explore direct sales to hotels, retailers, or local markets
- ✓ Understand seasonal price trends to plan harvests

7. Financial and Risk Management

- ✓ Start with small, manageable units
- ✓ Access subsidies, credit, and insurance schemes (KCC, PMMSY)
- ✓ Maintain simple records of inputs, production, and sales

8. Training and Knowledge Upgradation

- ✓ Participate in farmer training programs and demonstrations
- ✓ Adopt climate-resilient practices (cage culture, recirculating systems)
- ✓ Use mobile-based advisories for weather, market, and health alerts

9. Sustainability and Compliance

- ✓ Follow environmental guidelines to prevent pollution
- ✓ Adopt responsible stocking and harvesting practices
- ✓ Ensure legal compliance (leasing, licensing, size regulations)

10. Record Keeping and Decision Support

- ➢ Maintain logs of:
  - ✓ Stocking details
  - ✓ Water quality parameters
  - ✓ Harvest and sales data
  - ✓ Feed consumption and cost
  - ✓ Health treatments
- ➢ Use records to **improve efficiency and profitability**

Bottom Line

- ✓ For smallholders, success comes from management efficiency and resource mobilization.
- ✓ Quality seed + balanced feed + good water quality & health management + market access = sustainable and profitable aquaculture.

PART A: LIVESTOCK FARMING

02
CHAPTER

Cattle

P. K. Ray, Jyoti Kumar, Shanker Dayal, Rajni Kumari, Rakesh Kumar & Manoj Kumar Tripathi

Cattle farming plays a vital role in Indian agriculture by providing milk, regular income, employment, manure, and nutritional security. Adoption of scientific management practices in breeding, feeding, housing, calf care, health care, reproductive health management, and economics ensures higher productivity and profitability. Scientific cattle farming following the package of practices given below is economically viable, sustainable, and suitable for small to commercial farmers, ensuring steady income and livelihood security.

I. Breeds of Cattle in India and Selection of Breeds

1. Introduction

India possesses one of the richest cattle genetic resources in the world, adapted to diverse agro-climatic zones. Indigenous breeds are known for heat tolerance, disease resistance, longevity and ability to thrive under low input systems, while exotic and crossbred cattle contribute to higher milk productivity under improved management.

2. Classification of Cattle Breeds in India

A. Indigenous (Desi/Zebu) Cattle (Bos indicus)

(i) Milch Breeds

Breed	Home Tract	Average Milk Yield (kg/lactation)	Salient Features
Sahiwal	Punjab, Haryana, UP	1800–2500	Best indigenous milch breed, heat tolerant
Gir	Gujarat	1600–2500	Long ears, curved horns, good fat %
Red Sindhi	Sindh (India–Pakistan)	1500–2200	Good adaptability, reddish coat
Rathi	Rajasthan	1500–2000	Dual adaptability to arid regions

(ii) Dual-purpose Breeds

Breed	Home Tract	Milk Yield (kg)	Draught Utility
Hariana	Haryana, Western UP	1200–1800	Good for light draught
Kankrej	Gujarat, Rajasthan	1400–1800	Strong draught power
Ongole	Andhra Pradesh	1000–1500	Excellent draught ability
Deoni	Maharashtra, Telangana	1200–1600	Moderate milk and draught

(iii) Draught Breeds

Breed	Home Tract	Salient Feature
Hallikar	Karnataka	Excellent draught, endurance
Amritmahal	Karnataka	Fast trotting, army use earlier
Khillari	Maharashtra	Strong limbs, drought tolerant
Kangayam	Tamil Nadu	Best draught breed of South India

B. Exotic Cattle Breeds (Bos taurus)

Breed	Origin	Average Milk Yield (kg)	Remarks
Holstein Friesian	Netherlands	6000–8000	Highest milk yield, needs intensive care
Jersey	UK	4000–5000	High fat %, suitable for tropics
Brown Swiss	Switzerland	4500–6000	Strong body, good milk solids

C. Crossbred Cattle

Crossbreds are developed by crossing indigenous cattle with exotic breeds to combine adaptability and productivity.

Common Crossbreds in India:

- HF × Hariana / Sahiwal
- Jersey × Red Sindhi / Gir

Average Milk Yield: 3000–5000 kg/lactation (under good management)

3. Selection of Cattle Breeds in India

3.1 Criteria for Selection of Breeds

A. Agro-climatic Suitability

- Temperature and humidity tolerance
- Availability of fodder and water
- Resistance to local diseases and parasites

B. Purpose of Rearing

- **Milk production:** Prefer milch breeds (Sahiwal, Gir) or Jersey/HF crossbreds

- **Draught work:** Prefer indigenous draught breeds (Kangayam, Hallikar)
- **Dual purpose:** Hariana, Kankrej, Deoni

C. Production Potential

- Milk yield and fat percentage
- Persistency of lactation
- Age at first calving

D. Management Level

Management Level	Suitable Breeds
Low-input	Indigenous breeds
Medium-input	Dual-purpose breeds, Jersey crosses
High-input	HF, HF crossbreds

E. Farmer's Resources

- Capital availability
- Housing and feeding facilities
- Access to veterinary and AI services

3.2. Recommended Breed Selection by Production System

Production System	Recommended Breeds
Smallholder, rainfed	Gir, Sahiwal, Red Sindhi
Mixed crop–livestock	Hariana, Kankrej, Deoni
Peri-urban dairying	Jersey cross, HF cross
Commercial dairy farms	HF, HF cross (≥75% exotic inheritance)

3.3 Source and Method of Selection

- Purchase animals from registered breeders or government farms
- Prefer animals with known pedigree and performance records
- Select healthy, disease free animals with good body condition (BCS 3–3.5)
- Avoid animals with physical defects, chronic mastitis or reproductive disorders

3.4 Conservation-Oriented Selection

- Prefer indigenous breeds in their native tracts
- Avoid indiscriminate crossbreeding
- Promote selective breeding and progeny testing of native cattle

4. Conclusion

Selection of an appropriate cattle breed is a critical decision influencing productivity, profitability and sustainability of dairy farming in India. Adoption of recommended package of practices emphasizing agro-climatic suitability, production objective and resource availability ensures optimal utilization of India's rich cattle genetic resources.

II. CATTLE FEEDING

1. Objectives

- To provide balanced nutrition for maintenance, growth, reproduction, and milk production
- To improve milk yield, feed efficiency, and reproductive performance
- To prevent nutritional and metabolic disorders
- To reduce feeding cost through efficient use of local feed resources

2. General Principles of Cattle Feeding

Feeding should be based on body weight, age, milk yield, and physiological status

- Maintain Roughage: Concentrate ratio of 60:40 on dry matter basis
- Ensure continuous supply of clean drinking water
- Supplement mineral mixture and common salt daily
- Avoid sudden changes in diet

3. Feed and Fodder Resources in India

3.1 Roughages

(A) Green Fodders

- Kharif: Maize, Sorghum, Bajra, Cowpea
- Rabi: Berseem, Lucerne, Oats
- Perennial: Hybrid Napier, Guinea grass

(B) Dry Fodders

- Paddy straw/Wheat straw
- Maize and sorghum stover

Roughages should supply not less than 60% of total dry matter intake (DMI)

3.2 Concentrate Feeds

- Energy sources: Maize, barley, broken rice
- Protein sources: Groundnut cake, soybean meal, mustard cake, Linseed cake
- Agro-industrial by-products: Rice bran, wheat bran

Standard Concentrate Mixture

- Maize: 35%
- Wheat bran: 30%
- Mustard Oil cake: 32%
- Mineral mixture: 2%
- Common salt: 1%

4. Nutrient Requirements of Cattle

4.1 Daily Dry Matter Intake (DMI)

- Adult cattle: 2.0–3.5% of body weight
- Lactating cows: Up to 3.5% of body weight

4.2 Nutrient Requirements (General Guidelines)

Class of Cattle	DM (% BW)	Crude Protein (%)	TDN (%)
Calves (0–6 mo)	2.5–3.0	16–18	65–70
Growing heifers	2.0–2.5	14–16	60–65
Lactating cows	3.0–3.5	16–18	65–70
Dry cows	2.0–2.5	12–14	55–60

5. Feeding Practices for Different Classes of Cattle

5.1 Calves

- Colostrum within 1 hour of birth
- Quantity: 10% of body weight/day for first 3 days
- Introduce calf starter at 7–10 days
- Green fodder from 2 weeks of age
- Weaning at 3 months

5.2 Growing Heifers

- Green fodder: 10–15 kg/day
- Dry fodder: 2–3 kg/day
- Concentrate: 1–1.5 kg/day
- Avoid underfeeding (delayed puberty) and overfeeding (fatty udder)

5.3 Lactating Cows

- Green fodder: 15–20 kg/day
- Dry fodder: 4–5 kg/day
- Concentrate feeding:
    - 1 kg concentrate for every 2.5–3 litres of milk produced
- Feed concentrates in 2–3 equal meals

5.4 Dry and Pregnant Cows

- Dry fodder: 6–8 kg/day
- Green fodder: 8–10 kg/day
- Concentrate: 1–1.5 kg/day
- Follow steaming-up during last 2 months of pregnancy

6. Mineral and Salt Supplementation

- Mineral Mixture 50–60 g/cow/day
- Essential minerals: Ca, P, Mg, Cu, Zn, Co, I, Se
- Common Salt-30–50 g/day or salt lick blocks

7. Feed Technologies Recommended for day to-day practices

- Urea-treated straw (4% urea)
- Urea–Molasses–Mineral Blocks (UMMB)
- Bypass protein and bypass fat for high-yielding cows
- Total Mixed Ration (TMR)

8. Prevention of Nutritional Disorders

Disorder	Preventive Feeding Practice
Milk fever	Balanced Ca & Mg; avoid excess Ca pre-calving
Ketosis	Adequate energy during early lactation
Acidosis	Adequate fiber and roughage
Bloat	Avoid excess lush legumes
Repeat breeding	Balanced minerals and vitamins

III. CATTLE HOUSING

1. Objectives of Proper Cattle Housing

- To provide comfort, protection, and welfare to cattle
- To reduce stress and incidence of diseases
- To improve milk production, growth, and reproductive efficiency
- To facilitate easy management, sanitation, and labour efficiency

2. Principles of Ideal Cattle Housing (ICAR Guidelines)

- Housing should be simple, economical, durable, and well ventilated
- Protect animals from extreme heat, cold, rain, and wind
- Provide adequate floor space, light, drainage, and cleanliness
- Ensure easy access to feed, water, and movement
- Housing should suit local climatic conditions

3. Types of Cattle Housing Systems in India

3.1 Loose Housing System (Recommended)

- Animals move freely in open paddock with covered shed
- Lower construction cost and better animal comfort
- Suitable for tropical Indian conditions

3.2 Conventional (Tie-stall) Housing

- Animals tied individually
- Higher labour requirement
- Suitable for small herds and cold climates

4. Site Selection for Cattle Shed

- Elevated, well-drained land
- Away from residential areas
- Availability of clean water and electricity
- East–West orientation preferred
- Good road access

5. Orientation and Layout

- Long axis of shed should be East–West (hot climates)
- Proper ventilation through ridge vents and side openings
- Separate areas for calves, heifers, lactating cows, dry cows, and sick animals

6. Floor Space Requirement

Table: Covered and Open Space Requirement per Animal

Class of Cattle	Covered Area (sqm)	Open Paddock (sqm)
Calf (0–6 months)	1.0–1.5	2.0–3.0
Calf (6–12 months)	1.5–2.0	3.0–4.0
Growing heifer	2.5–3.0	6.0–8.0
Adult cow (indigenous)	3.5–4.0	8.0–10.0
Adult cow (crossbred)	4.0–4.5	10.0–12.0
Breeding bull	12.0–16.0	20.0–30.0

7. Floor, Drainage and Roofing

Flooring

- Non-slippery, impervious, and easy to clean
- Cement concrete floor with rough finish preferred
- Floor slope: 1 in 60 towards drain

Drainage

- Open drains with proper slope
- Efficient disposal of urine and wash water

Roofing

- Materials: Thatched, asbestos sheets, GI sheets, tiles
- Roof height: 3–3.5 m at eaves, 4.5–5 m at ridge

8. Ventilation and Lighting

- Adequate natural ventilation through side walls and ridge vents
- Open sides with adjustable curtains
- Natural lighting preferred; artificial lighting for night management

9. Feeding and Watering Arrangements

Mangers

- Cement or brick-lined mangers
- Width: 60–75 cm, Depth: 25–30 cm

Water Troughs

- Continuous access to clean water
- One trough for 20–25 animals

10. Calf Housing Practices

- Individual calf pens for first 2–3 months
- Dry, well ventilated, draft free sheds
- Raised floors or bedding material recommended

11. Sanitation and Hygiene

- Daily removal of dung and urine
- Regular washing and disinfection of floors
- Proper manure pit located away from shed
- Fly and rodent control measures

12. Housing for Special Categories

Sick and Isolation Shed

- Separate shed for diseased animals
- Located downwind from main shed

Calving Pen

- Size: 12–15 sqm
- Clean, dry, and well-bedded

13. Climate-Specific Housing Modifications

Hot and Humid Regions

- Maximum ventilation
- White-painted roof
- Foggers, fans, and sprinklers

Cold Regions

- Closed housing with protection from wind
- Adequate bedding

14. Advantages of Proper Housing

- Reduced disease incidence
- Improved milk yield and fertility
- Lower stress and better animal welfare
- Efficient labour utilization

15. Extension Message

"Comfortable housing with adequate floor space, ventilation, and sanitation is essential for sustainable dairy production."

IV. CATTLE CALF CARE AND MANAGEMENT

1. Before Calving (Prenatal Care)

Key Practices:

- **Drying Period:** Dry the pregnant cow 6–8 weeks before the due date of parturition to let its body recover and prepare for colostrum production.
- **Nutrition:** Feed balanced rations with sufficient energy, protein, minerals (Ca, P) and vitamins (A, D, E). This improves calf birth weight and immunity.
- **Clean Housing:** Provide clean, well-ventilated, dry calving area to reduce infection risk.
- **Monitor Body Condition:** Avoid underfeeding (weak calves) and overfeeding (dystocia).
- **Veterinary monitoring:** Deworm and vaccinate the dam as per schedule before calving.
- Prenatal care ensures a healthy dam and improve calf vitality.

Calving and First Hours Care

- **Clear respiratory airways:** Remove mucus from nose and mouth to stimulate breathing.
- **Dry & Warm:** If the dam doesn't lick the calf (or climate is cold), dry the calf with clean cloth/bedding to stimulate circulation.
- **Umbilical Care:** Tie the umbilical cord about 3–5 cm from the body, cut 1 cm below ligature, and apply tincture iodine/antiseptic to prevent infection (navel ill).
- Dip entire stump in 7% tincture iodine or chlorhexidine solution.
- Repeat dipping once daily for 3 days.
- **Record Birth Weight & Time:** Important for monitoring growth.
- **Hypothermia Prevention**
    - Dry calf thoroughly.
    - Provide dry bedding.
    - In winter: calf jackets or gunny bags may be used.

3. Colostrum Feeding (First Immunity Boost)

- Colostrum provides antibodies (immune globulins) essential to protect the calf from diseases.

Feeding Protocol:

- **Within 1–2 hrs:** Feed colostrum, feed about 5–8 % of body weight (e.g., 1.5–2.5 L for 50 kg calf).
- **Repeat doses:** Another feed around 10–12 hrs later improves protection.
- **Quality:** Use warm (37–38 °C) clean colostrum. If maternal is limited, use pooled or commercially available colostrum substitutes carefully.

4. Feeding Young Calves

Milk and Forage Feeding:

- Feed milk or whole milk replacer twice daily, warm and clean. Provide milk at ~10 % of body weight daily (max ~5–6 L/day) for 6–10 weeks.
- Avoid overfeeding to prevent calf scours (diarrhea).
- Introduce calf starter concentrate from ~3–4 weeks of age.
- Provide clean fresh water ad libitum from the first week.
- After ~8–10 weeks, offer good quality hay/green fodder to stimulate rumen development.

5. Health Management & Preventive Care

Routine Checks:

- Daily observation for appetite, activity, fever, coughing, diarrhoea, dehydration, etc.
- Isolate sick calves to prevent spread.

Healthy Calf Indicators

- Bright eyes, Smooth coat, Active behaviour, Firm dung, Good appetite

Warning Signs

- Sunken eyes, Dull coat, Reluctance to stand, Fever or hypothermia

5.1 Prevention of Calf Scours (Diarrhoea)

Major causes:

- Overfeeding milk
- Dirty utensils
- Sudden diet changes
- *E. coli,* Rotavirus, Coronavirus, Cryptosporidium

Preventive practices:

- Feed milk at fixed time daily
- Maintain milk temperature at 37°C
- Clean feeding utensils with hot water daily
- Avoid dilution or sudden change in milk source

5.2. Management of Diarrhoea

- Do not stop milk completely and provide oral rehydration solution (ORS)

Example of electrolyte solutions:

- Commercial: *Electral®, Vet ORS etc*
- Homemade (Farmers level):
    - Clean water – 1 litre
    - Sugar/glucose – 40 g
    - Common salt – 3.5 g
    - Sodium bicarbonate – 2.5 g
- Feed ORS 2–3 times/day
    - Call veterinarian if there is blood in dung, fever or severe dehydration

5.3. Parasite Control, Deworming & vaccination:

- Deworm at 3–6 weeks and repeat after every 3 months till age of 1 year.
- Keep calf housing clean and dry to minimize parasite load.
- Follow vet-prescribed schedule for regional diseases (e.g., FMD, HS, BQ, etc.) — often starting from 6–8 weeks.

6. Housing and Environment

- Calf pens should be Clean, dry, well-ventilated, with protection from heat/cold/rain.
- Individual pens reduce spread of diseases, allow better monitoring.
- Use clean straw/sawdust; change regularly to reduce pathogen load.
- Regularly clean feeding utensils and bedding areas.
- Disinfect navel and pen surfaces with safe antiseptics.

7. Weaning and Transition (6–10 Weeks)

Weaning Criteria:

- Calf eating sufficient starter feed (approx. e"1 kg/day).
- Healthy weight gains ~0.6–1.0 kg/day are good targets
- Gradual Weaning: Reduce milk gradually over 1 week to reduce stress.
- Continue good quality starter and forages post-weaning.

8. Record Keeping

Maintain records for each calf:

- Birth date, weight, dam ID, colostrum timing
- Feeding quantities & growth rates
- Vaccinations, deworming, illness/treatments

These help monitor performance and health trends.

9. Involving Veterinary Support

Engage a local veterinarian for:

- Health checkups
- Development of vaccination and deworming schedules
- Treatment guidance for sickness (e.g., pneumonia, navel ill, scours)

Key Message

Good calf healthcare is preventive, not curative. Early colostrum, hygiene, nutrition, and observation can reduce calf mortality by more than 50%.

V. CATTLE HEALTH MANAGEMENT

1. Objective

To maintain optimum health of cattle through preventive healthcare, systematic vaccination, regular deworming, biosecurity, and timely disease management, resulting in improved productivity, fertility, and longevity.

2. General Health Management Practices

2.1 Daily Health Monitoring

- Observe animals daily for:
  - Appetite, rumination, gait, posture, discharge, wounds.
  - Milk yield changes: Sudden drop in milk yield triggers immediate evaluation.
- Note any signs of discomfort and udder swelling,
  - Nasal discharge, diarrhoea, lameness
- Record abnormalities and report early to a veterinarian.
- Normal body temperature: 100.5–102.5 °F

2.2 Biosecurity Measures

- Restrict entry of visitors and vehicles.
- All visitors and workers must disinfect hands/feet before entry.
- Maintain footbaths at shed entrances. Replace regularly and keep solution fresh.
- Quarantine newly purchased animals for 14–21 days in a separate area.
- Use separate equipment for sick animals (feed buckets, needles).
- Dispose carcasses and biomedical waste as per local regulations.

2.3 Housing & Hygiene

- Provide clean, dry, well-ventilated housing.
- Avoid overcrowding.
- Ensure proper drainage and fly control.
- Clean feeding and watering troughs daily.

3. Vaccination Practices for Cattle

3.1 General Guidelines

- Vaccinate only healthy animals.
- Deworm animals 2–3 weeks before vaccination.
- Maintain cold chain at 2–8°C.
- Use sterile needles and syringes.
- Follow government disease-control programmes.
- Maintain individual vaccination records.
- Avoid vaccination during: Late pregnancy (unless advised) and in Severe stress or illness.

3.2 Vaccination Schedule

Disease	Age at First Vaccination	Booster / Frequency	Remarks
Foot and Mouth Disease (FMD)	4 months	Every 6 months	Mandatory under FMD-CP
Haemorrhagic Septicaemia (HS)	6 months	Once yearly (pre-monsoon)	Oil adjuvant vaccine preferred
Black Quarter (BQ)	6 months	Once yearly (pre-monsoon)	Important in endemic areas
Brucellosis (S19)	4–8 months (female calves only)	Single dose (lifetime)	Do not vaccinate adults
Anthrax	6 months	Annual (endemic areas)	Avoid during outbreak
Theileriosis	>3 months	Single dose	Mainly crossbred/exotic cattle
Lumpy Skin Disease (LSD)	>4 months	As per govt. advisory	Follow latest DAHD guidelines

4. Deworming Practices

4.1 Objective

To control internal and external parasites, enhance nutrient utilization, improve growth, milk production, immunity, and reproductive performance.

4.2 Deworming Schedule

Category	Age / Stage	Frequency
Calves	1–12 months	Every 2–3 months
Heifers	12–24 months	Every 3–4 months
Adult cattle	>24 months	Every 6 months
Pregnant cows	Mid-gestation	Once (under veterinary advice)

4.3 Common Anthelmintics (Administration to animals strictly on Veterinary prescription only)

- Albendazole, Fenbendazole
- Levamisole
- Ivermectin, Closantel (also control ectoparasites)

Note: Rotate drugs periodically in consultation with Veterinarian to prevent anthelmintic resistance.

4.4 General guidelines for Deworming

- Estimate body weight accurately.
- Administer correct dose orally or subcutaneously.
- Avoid deworming during severe illness or late pregnancy.
- Prefer deworming during low-stress periods.
- Maintain deworming records.

5. Annual Vaccination & Deworming Calendar (Indicative)

Month	Vaccination	Deworming
January	—	Adult cattle
February	—	Calves
March	FMD	—
April	HS + BQ	Heifers
May	—	Calves
June	—	Adult cattle
July	—	Calves
August	—	Heifers
September	FMD	—
October	—	Adult cattle
November	—	Calves
December	—	Heifers

Special Notes:

- Brucellosis: Female calves (8-9 months) – once in lifetime
- Anthrax / LSD: As per endemicity and official advisories

6. Sick Animal Management

- Immediately isolate sick animals.
- Seek veterinary diagnosis and treatment.
- Follow prescribed drug, dose, and withdrawal period.
- Disinfect housing and equipment after recovery.
- Monitor recovery; restrict return to herd until fully recovered.

7. Record Keeping

Maintain individual animal health records including:

- Animal identification
- Vaccination details (date, batch, expiry)
- Deworming details (drug, dose, date)
- Treatments and outcomes

8. Expected Benefits

- Reduced disease incidence and mortality
- Improved milk yield and growth rate
- Better reproductive efficiency
- Lower treatment and economic losses

VI. REPRODUCTIVE HEALTH MANAGEMENT & BREEDING OF CATTLE

1. Objective

To achieve optimum reproductive efficiency in cattle through scientific reproductive health management, balanced nutrition, timely breeding, disease prevention, and adoption of appropriate reproductive technologies, leading to improved conception rate, reduced calving interval, and enhanced lifetime productivity.

2. Reproductive Performance Targets

Parameter	Recommended Target
Age at first service	15–18 months (crossbred); 18–24 months (indigenous)
Age at first calving	24–30 months
Calving interval	12–14 months
Conception rate	≥40%
Services per conception	≤2
Post partum oestrus	Within 60 days

5. Heifer Management and Puberty

5.1 Breeding Readiness

- Breed heifers at 60–65% of adult body weight.
- Ensure good skeletal growth and Body Condition Score (BCS) ≥ 2.75.
- Avoid breeding underweight or stunted heifers.

5.2 Nutritional Management

- Balanced ration with adequate energy and protein.
- Mineral mixture containing Ca, P, Cu, Zn, Mn.
- Vitamins A, D, and E supplementation.
- Target growth rate: 600–700 g/day.

6. Oestrus Detection and Heat Management

6.1 Oestrus Detection

- Observe animals three times daily (early morning, afternoon, late evening).
- Key signs: standing heat, clear vulval discharge, restlessness, bellowing, reduced feed intake.Tail painting or chalk marking
- Heat mount detectors / activity monitors (where available)

6.2 Heat Stress Management

- Provide shade, fans, foggers or sprinklers.
- Avoid breeding during peak heat stress
- Supply electrolytes (Such as common salt, sodium bicarbonate, Magnesium sulphate) and antioxidants during summer months.
- Common antioxidants required are Vitamin E, Selenium, Vitamin C, Beta carotene, Zinc and copper (as part of antioxidant enzyme systems)
- Supplement Vitamin E + Selenium during:
    - Late pregnancy
    - Early lactation
    - Heat stress periods
- Avoid excess selenium; use under veterinary guidance.

7. Breeding Practices

7.1 Artificial Insemination (Preferred)

- Use certified frozen semen from approved breeding bulls.
- Maintain semen cold chain strictly.
- Follow AM–PM rule for insemination.
- AI to be performed by trained technicians only.

7.2 Natural Service (Where Practised)

- Use healthy, disease free bulls.
- Bull: cow ratio: 1:25–30.
- Screen bulls for brucellosis, campylobacteriosis, and trichomoniasis.

8. Pregnancy Diagnosis and Management

- Pregnancy diagnosis by per rectal examination, by pregnancy detection kit or ultrasonography at 30–60 days post AI depending on availability of method.
- Early identification of non pregnant animals for rebreeding.
- Provide balanced nutrition during pregnancy, especially in the last trimester.

9. Post partum Reproductive Health Management

9.1 Immediate Post calving Care and Uterine Involution

- Monitor for retained foetal membranes, uterine prolapse, metritis, milk fever.

- Provide clean and hygienic calving environment. Normal uterine involution completed within 30–45 days.
- Animals not showing oestrus by 60 days post partum should be examined.

10. Nutrition–Reproduction Interface

- Prevent negative energy balance during early lactation.
- Supplement bypass fat and high quality protein.
- Maintain Ca: P ratio at 1.5–2:1.
- Supplement minerals and vitamins regularly.

11. Infertility Management Programme

- Early diagnosis of anoestrus, repeat breeding, silent heat, ovarian cysts, endometritis.
- Correct nutritional deficiencies and parasitic burden.
- Hormonal therapy only under veterinary supervision.
- Avoid indiscriminate hormone use.

12. Disease Control for Reproductive Health

- Vaccination against brucellosis (female calves only), FMD, HS, BQ.
- Periodic screening for brucellosis and tuberculosis.
- Immediate isolation of aborting animals.
- Proper disposal of aborted foetuses and uterine discharges.

13. Record Keeping

Maintain individual reproductive records including:

- Estrus and breeding dates
- AI / bull details
- Pregnancy diagnosis results
- Calving dates
- Reproductive disorders and treatment

14. Expected Benefits

- Improved conception rate
- Reduced calving interval
- Lower infertility and repeat breeding incidence
- Improved lifetime milk yield
- Enhanced farm profitability

VII. Economics of Dairy Cattle Farming

1. Importance

Dairy farming is an important subsidiary enterprise in Indian agriculture, providing regular income, employment, nutritional security, and manure. Economic success depends on breed selection, feeding efficiency, health care, and marketing.

2. Breed and Production Potential

Type of cattle	Average milk yield (L/day)
Indigenous milch cows	6–10
Crossbred cows	10–18
HF/Jersey cows	18–25

3. Capital Investment (Fixed Cost)

a) Cost of Animals

Category	Cost (₹ /animal)
Indigenous cow	50,000–80,000
Crossbred cow	60,000–1,00,000
HF/Jersey cow	90,000–1,40,000

b) Housing and Equipment

Item	Approx. cost (₹)
Pucca shed	30,000–35,000/cow
Feeding & watering equipment	1,000–2,000
Milking equipment	2,000–4,000
Fodder storage	12,000–15,000

Depreciation period:

- Animals: 6–8 years
- Buildings & equipment: 8–10 years

4. Recurring Expenditure (Variable Cost)

a) Feed and Fodder (Major Cost: 60–70%)

Feed component	Quantity/day	Cost (₹)
Green fodder	20–25 kg	50–62
Dry fodder	5–7 kg	28–38
Concentrate	4–6 kg	88–132
Total feed cost	—	**166–222**

b) Other Costs

Item	Cost/day (₹)
Labour	50–80
Veterinary care & medicines	10–15
Electricity & water	10–15
Insurance	5–8
Miscellaneous	5–10

Total recurring cost: ₹ 246–350/cow/day

5. Returns from Dairy Farming

a) Milk Income

- Average milk price: ₹ 35–55 per litre
- Example (Crossbred cow):
    - Milk yield: 12 L/day
    - Milk price: ₹ 45/L
    - **Gross income:** ₹ 540/day

b) Additional Income

Source	Approx. income
Sale of dung/biogas slurry	₹ 1,000–1,500/year
Sale of calves	₹ 5,000–10,000

6. Profitability (Per Cow Basis)

- **Gross income:** ₹ 540–660/day
- **Recurring cost:** ₹ 246–350/day
- **Net profit:** ₹ 294–310/day
- **Annual profit:** ₹ 82,000–1,00,000 (well-managed cow)

7. Break-even Analysis

- Break-even milk yield: 7–8 L/day
- Break-even period: 2–3 lactations
- Productive life: 6–7 lactations

8. Economics by Herd Size

Herd size	Economic status
2–3 cows	Supplementary income
5–10 cows	Viable family enterprise
>20 cows	Commercial dairy unit

✓ Cost per litre of milk decreases with increase in herd size

9. Factors Affecting Economic Efficiency

- Breed and genetic potential
- Balanced ration and fodder planning
- Short calving interval (<13 months)
- Disease prevention and timely vaccination
- Efficient marketing and milk pricing

10. Recommendations

- Select high-yielding, disease-free animals
- Adopt scientific feeding and breeding practices
- Maintain proper records (milk yield, health, expenses)
- Ensure regular vaccination and deworming
- Promote value addition for higher profitability

11. Conclusion

Scientific dairy cattle farming is economically sustainable and profitable when integrated with proper feeding, health management, and market linkage, making it suitable for small, medium, and commercial farmers.

❐

03
CHAPTER

Buffalo

Rakesh Kumar, Chandran P.C., Reena Kamal and Kamal Sarma

Introduction

Buffalo farming is a major livelihood activity for small and marginal farmers of Bihar and eastern India. Productivity of buffalo largely depends on scientific management of breed selection, feeding, housing, breeding and health care. Traditional practices, imbalanced feeding, poor housing and irregular vaccination lead to low milk yield, repeat breeding and frequent diseases. This Package of Practices provides practical and low-cost recommendations suited to the agro-climatic conditions of the eastern region. The document covers selection of suitable buffalo breeds, balanced feeding using local fodder resources, scientific housing, breeding management, disease prevention, vaccination and clean milk production. Adoption of these practices can increase milk yield by 20–30 percent, reduce disease incidence, improve calf survival and enhance farm income while ensuring safe milk for consumers.

Utilization of crop residues through urea treatment, cultivation of fodder on field bunds, and use of community grazing resources can reduce feeding costs in Bihar conditions. The eastern region faces specific challenges like summer fodder scarcity, waterlogging, high humidity and prevalence of diseases such as Foot and Mouth Disease and Hemorrhagic Septicemia. At the same time, expanding urban markets, dairy cooperatives and milk collection centres provide a good opportunity for regular income from buffalo milk, which has higher fat and a better price compared to cow milk. This Package of Practices for Scientific Buffalo Farming has been prepared keeping the real needs of farmers of Bihar and eastern India in mind. The recommendations are practical, low-cost and based on scientific principles that can be followed by smallholders. Adoption of these practices will help farmers to obtain more milk, healthy calves, better fertility and higher profit while ensuring clean and safe milk for the family and consumers.

Selection of Buffalo Breed and Its Importance for Farmers

Buffalo farming plays a vital role in the livelihood security of Indian farmers by providing milk, manure, draft power and regular income. However, the productivity and profitability of buffalo depend largely on the choice of breed. Different buffalo breeds vary considerably in milk yield, fat percentage, adaptability to climate, feed efficiency and disease resistance. Therefore, farmers must select a breed according to local agro-climatic conditions, availability of fodder resources, market demand and management capacity rather than only on physical appearance. The genetic potential of the animal determines its response to feeding and health care. High yielding breeds perform better under intensive management, whereas indigenous breeds are more suitable for low-input systems. The comparative details of major buffalo breeds of India with farmer-oriented traits are presented in Table 1.

Importance of Breed Selection

- **Ensures Higher Milk Production:**

  High-yielding breeds like Murrah and Nili Ravi provide greater daily milk output, increasing household income.

- **Better Fat Percentage and Milk Price:**

  Breeds such as Bhadawari and Surti produce milk with a high fat content, suitable for ghee and traditional dairy products, and fetch a premium price.

- **Adaptability to Local Climate:**

  Indigenous breeds like Pandharpuri, Marathwadi, and Banni tolerate heat, drought, and saline conditions better than exotic types.

- **Efficient Feed Utilization:**

  Local breeds can convert crop residues and poor-quality fodder into milk, reducing feeding costs for small farmers.

- **Improved Reproductive Performance:**

Suitable breeds show regular heat cycles, a higher conception rate, and a shorter calving interval.

- **Reduced Disease and Health Problems:**

  Adapted breeds have better resistance to local diseases and parasites, lowering veterinary expenses.

- **Suitability to Farming System:**
  - Intensive stall-fed: Murrah, Nili Ravi
  - Low-input backyard: Manda, Marathwadi
  - Wetland areas: Chilika, Luit
  - Desert/saline areas: Banni
- **Social and Gender Benefits:**

  Docile and small-sized breeds like Surti and Manda are easy to manage by women and elderly farmers.
- **Value Addition Opportunities:**

  High-fat milk supports the production of ghee, paneer, and khoa, improving profit margins.
- **Risk Reduction:**

  Locally suited breeds withstand climate stress and market fluctuations better.

Table 1. Buffalo Breeds of India with Production and Adaptability Traits

S.N.	Breed	Home Tract	Type	Avg. Milk yield (kg/lact.)	Fat %	Key Features	Pictorial view of breed
1.	Murrah	Haryana, Punjab, Delhi	Riverine	2000-3000	6.5-7.5	Best commercial breed, high milk price, high AI conception rate, suitable for stall feeding	
2.	Nili Ravi	Punjab	Riverine	1800-2500	6.5-7.0	Docile nature, large teats for easy milking, good for canal irrigated areas	
3.	Bhadaw-ari	Uttar Pradesh & MP	Riverine	800-1200	8-10	Highest fat, ideal for ghee making, thrives on poor fodder	

4.	Mehsana	Gujarat	Riverine	1500-2000	6.5-7.0	Dual purpose, heat tolerant, suitable for cooperatives	
5.	Surti	Gujarat	Riverine	1200-1600	7-8	Small size, low feed cost, good for small farmers	
6.	Jaffarabadi	Gujarat	Riverine	1800-2200	7.5-8.5	Heavy body, high milk & dung, profitable peri-urban	
7.	Nagpuri	Maharasthra	Riverine	1000-1200	7.0	Milk + draft, survives on dry fodder	
8.	Pandharpuri	Maharasthra	Riverine	900-1100	7.0	Drought tolerant, low disease	
9.	Marath wadi	Maharasthra	Riverine	700-900	7.5	Low input breed	
10.	Toda	Tamil Nadu	Riverine	500-600	7.0	Hill grazing type	
11.	Banni	Gujarat	Riverine	1500-1800	7.5	Salinity tolerant, long walking ability	
12.	Chilika	Odisha	Swamp	500-700	7.0	Feeds on aquatic weeds	

13.	Kalahandi	Odisha	Riverine	400-600	7.0	Good fertility in poor feed	
14.	Luit	Assam & Manipur	Swamp	300-500	7.5	Best for wet land ploughing	
15.	Bargur	Tamil Nadu	Riverine	400-600	7.2	Hill adapted	
16.	Chhattis-garhi	Chhattis-garhi	Riverine	600-800	7.0	Good immunity	
17.	Gojri	Punjab & HP	Riverine	700-900	7.0	Migratory system	
18.	Dharwadi	Karnataka	Riverine	800-1000	7.2	Good conception	
19.	Manda	Odisha	Riverine	350-500	7.0	Dwarf, women friendly	
20.	Purnathadi	Maharashtra	Riverine	700-900	7.0	Village, low maintenance	
21.	Manah	Assam	Mixed	500-700	7.3	Flood area adapted	
22.	Melghati	Maharashtra	Riverine	600-800	7.0	Forest tract, hardy	

Source : *Image adopted from publicaly available web sources, copyright remain with respective owners.*

Housing for Buffaloes

Housing plays a vital role in the health, comfort, productivity, and welfare of buffaloes. Proper housing protects animals from extreme climatic conditions, helps in efficient management, reduces disease incidence, and improves milk production and reproductive efficiency. Since buffaloes are more sensitive to heat stress than cattle, their housing needs special attention under tropical and subtropical conditions. Major objectives of housing buffaloes are:

- To provide protection against heat, cold, rain, and strong winds
- To ensure comfort and reduce stress, especially heat stress
- To facilitate easy feeding, watering, milking, and management
- To maintain hygiene and reduce disease occurrence
- To improve productivity, longevity, and reproductive performance

Site Selection and Orientation

The site for buffalo housing should be located on high, well-drained land to prevent water stagnation and dampness. Low-lying areas should be avoided as they promote the growth of pathogens and increase the risk of foot diseases.

The shed should preferably be oriented in an east–west direction. This orientation minimizes direct sunlight entering the shed during the day, helping to keep the housing area cool. Adequate space around the shed should be provided for future expansion.

Type of Housing Systems

1. Conventional (Closed) Housing System

In this system, buffaloes are kept in individual stalls or tied arrangements. While this system allows better individual care, it is costly, labor-intensive, and less suitable for buffaloes due to restricted movement and higher heat stress.

2. Loose Housing System

The loose housing system is the most suitable and widely recommended system for buffaloes in India. Animals are allowed to move freely in an open paddock with access to a covered resting area.

Advantages of Loose Housing:

- Reduces construction cost
- Allows free movement and exercise
- Better heat dissipation and comfort
- Easier detection of estrus
- Improves milk yield and overall health

Floor and Drainage

The floor of the buffalo shed should be strong, non-slippery, and easy to clean. Cement concrete floors are preferred. A slope of 1:60 should be maintained to facilitate quick drainage of urine and wash water.

Poor drainage leads to wet floors, which may cause mastitis, foot rot, and other infectious diseases. Grooves may be provided on floors to prevent slipping, especially in milking and feeding areas.

Roof, Walls, and Ventilation

The roof should be constructed using heat-resistant materials such as tiles, asbestos sheets, or thatch. The height of the roof should be 10–12 feet at the center and 8–9 feet at the sides to allow free air movement.

Walls, if provided, should not be too high; half walls are sufficient. Adequate ventilation is extremely important as it removes moisture, harmful gases, and excess heat. Proper ventilation helps in reducing respiratory problems and improves animal comfort.

Space Requirement

Adequate floor space is essential to avoid overcrowding and stress.

Recommended space for adult buffaloes:

Covered area: 4–5 m^2 per animal

Open paddock area: 10–12 m^2 per animal

Overcrowding leads to competition for feed, higher disease transmission, and reduced productivity.

Wallowing Facility

Buffaloes possess fewer sweat glands and depend mainly on wallowing for thermoregulation. Therefore, providing a wallowing tank or pond is highly beneficial.

Benefits of wallowing:

- Reduces body temperature
- Improves feed intake
- Increases milk yield
- Enhances comfort and reproductive efficiency

If wallowing tanks are not feasible, sprinklers or shower systems may be used as alternatives.

Feeding and Watering Arrangements

Mangers should be smooth, strong, and easy to clean to prevent feed wastage. The height of the manger should be comfortable for the animals.

Clean and fresh drinking water must be available round the clock, especially during hot weather. Water troughs should be cleaned regularly to prevent contamination.

Lighting and Electricity

Proper lighting inside the shed helps in effective management and observation of animals. Natural light should be utilized as much as possible, supplemented with artificial lighting when required, especially during early morning and evening hours.

Sanitation and Waste Management

Good sanitation is essential for disease prevention. The shed should be cleaned daily, and manure should be removed regularly. Proper disposal of dung and urine reduces fly breeding and foul odour. Periodic disinfection of sheds helps in controlling infectious diseases and maintaining a healthy environment.

Hence, Proper housing is a cornerstone of scientific buffalo management. A well-designed buffalo shed with adequate space, ventilation, drainage, and wallowing facilities ensures animal comfort, reduces stress, and enhances productivity. Adoption of loose housing systems under Indian conditions is highly economical and beneficial for sustainable buffalo farming.

Feeding management of buffaloes

Scientific feeding is the foundation of profitable buffalo farming. Milk yield, fat percentage, reproductive efficiency and disease resistance largely depend on the quality and quantity of feed offered to the animal. A balanced ration containing green fodder, dry fodder, concentrate mixture, mineral mixture and clean water helps in maintaining production at optimum level and reduces the cost per litre of milk. Feeding should always be done according to body weight, milk production and physiological stage of the animal. Sudden changes in ration must be avoided and hygienic management should be followed. Balanced feeding of buffaloes is highly essential for the following purposes:

- To increase milk yield and fat percentage
- To maintain good health and fertility
- To reduce feed cost per litre of milk
- To ensure proper growth of calves and heifers
- To prevent nutritional deficiency diseases

Principles of Balanced Feeding

- Feed should be provided according to body weight, milk yield and physiological stage.
- A combination of green fodder, dry fodder and concentrate must be given daily.
- Sudden change in feed should be avoided.
- Clean and fresh drinking water should be available at all times.
- Mineral mixture and salt must be included regularly.

For practical feeding of an adult buffalo, the daily requirement of fodder and concentrate may be followed as presented in Table 2.

Table 2. Standard Feeding Schedule for Buffalo (500-550 kg body weight)

Animal category	Green fodder (kg/day)	Dry fodder (kg/day)	Concentrate (kg/day)	Mineral mixture (g/day)	Salt (g/day)
Lactating: 6–8 L milk	20–22	5–6	2.0	50	30
Lactating: 9–10 L milk	22–24	5–6	3.0	50	30
Lactating:11–12 L milk	24–25	5–6	4.0	50	30
Pregnant (last 3 months)	20–22	5	2.0	50	30
Dry buffalo	8–10	4–5	1.0	30	25

As a Thumb Rule,

- Provide 1 kg concentrate for every 2.5 litres of milk
- Add 1 kg concentrate for body maintenance

The concentrate mixture should be prepared using locally available ingredients so that feeding remains economical. A standard formulation for preparing concentrate mixture is given in Table 3.

Table 3. Recommended Concentrate Mixture for Buffalo

Ingredient	Proportion (%)
Maize/Bajra	30
Mustard/Groundnut cake	25
Wheat bran	42
Mineral mixture	2
Common salt	1
Total	100

This concentrate mixture provides adequate energy, protein and minerals required for milk production and body maintenance.

Feeding According to Physiological Stage

For a Lactating Buffalo

- Provide 20–25 kg green fodder and 5–6 kg dry fodder daily.
- Concentrate should be given as per milk yield.
- Mineral mixture 50 g/day is essential to maintain fat percentage and fertility.

For a Pregnant Buffalo (Last 3 Months)

- Provide additional 1.5–2.0 kg concentrate daily.
- Good quality green fodder should be ensured.
- Avoid moldy or poor-quality feed to prevent abortion and weakness.

For a Buffalo Calved Newly

- Offer lukewarm water mixed with 100 g jaggery for 3–4 days.
- Increase concentrate gradually over one week.
- Provide easily digestible feed during initial days.

For a Dry Buffalo

- 8–10 kg green fodder, 4–5 kg dry fodder and 1 kg concentrate is sufficient.
- Mineral mixture 30 g/day should be given.

General guidelines for stage-wise feeding including calf management are summarized in Table 4.

Table 4. Stage-wise Feeding Guidelines & Calf Feeding

Stage	Feeding recommendation
Maintenance	1 kg concentrate/day
Milk production	1 kg concentrate per 2.5 L milk
Advance pregnancy	+1.5–2.0 kg concentrate
Newly calved	Gradual increase for 5–7 days
Calves 0–3 days	Colostrum 10% of body weight
Calves 4–30 days	Milk 1/10th body weight
From 2nd week	Start calf starter
From 1 month	Introduce green fodder

Calf Feeding Management

- Colostrum must be given within one hour of birth. Early feeding of colostrum improves immunity and protects the calf from infections.
- Milk should be fed at the rate of 10% of body weight. This ensures adequate nutrition for proper growth and healthy development.
- Calf starter should be introduced from the second week. Early introduction helps in rumen development and prepares the calf for solid feed.
- Green fodder can be offered from one month of age. Soft and tender fodder improves digestion and supports gradual feed transition.
- Clean water must be available to calves. Adequate water intake is essential for digestion, metabolism, and overall health.

Summer Feeding Management

- Provide water 3–4 times daily. Frequent water intake prevents dehydration and helps regulate body temperature.
- Offer fodder during morning and evening hours. Feeding during cooler hours improves intake and reduces heat stress.
- Add 50 g sodium bicarbonate to prevent acidosis. It helps maintain rumen pH and improves digestion during heat stress.
- Provide shade and wallowing facility. Shade and wallowing reduce body heat and improve animal comfort and productivity.

Winter Feeding Management

- Increase concentrate by 10–15 percent. Additional concentrate helps meet higher energy requirements during cold stress.
- Provide lukewarm drinking water. Lukewarm water encourages intake and prevents energy loss due to cold exposure.
- Include more oil cakes for additional energy. Oil cakes improve energy density of the ration and support body condition.

Urea Treated Straw

- Preparation ratio (Urea, water and straw). Mix 4 kg urea in 40 litres of water and sprinkle uniformly on 100 kg of straw. Ensure proper mixing so that all straw is evenly treated.
- Covering and treatment period. After treatment, heap the straw and cover it airtight using polythene or mud plaster. Keep it covered for 21 days before feeding to animals.
- Improvement in straw digestibility. Urea treatment breaks lignin–cellulose bonds, making straw softer and more digestible. Animals can extract more nutrients from the treated straw.
- Increase in feed intake. Treated straw becomes more palatable, encouraging higher voluntary intake. This helps animals meet their daily roughage requirement.
- Enhancement in milk yield. Better nutrient availability leads to improvement in milk production. Milk yield may increase by up to 10–20 percent.

Expected Benefits

- ***Increase in milk yield and fat percentage :***
  Improved nutrition supports higher milk output and better fat content. This directly increases overall milk value.
- ***Better reproductive performance :***
  Balanced energy intake improves heat expression and conception rate. It helps in maintaining regular breeding cycles.
- ***Lower disease incidence :***
  Improved feeding strengthens immunity and reduces nutritional disorders. Animals remain healthier with fewer disease occurrences.
- ***Reduction in feeding cost per litre of milk :***
  Efficient use of low-cost straw reduces dependence on costly concentrates. This lowers the overall cost of milk production.

Animal Health, Disease Management and Vaccination

Animal health management is the backbone of profitable buffalo farming. Diseases directly reduce milk yield, delay conception, increase veterinary expenses and sometimes cause death of valuable animals. Most infectious diseases can be prevented through timely vaccination, hygiene and balanced feeding. Early identification of illness and prompt treatment save both animal and income of the farmer. The major objectives of animal health and disease management include:

- To prevent major infectious diseases through vaccination
- To provide practical knowledge on common buffalo diseases
- To guide farmers on first aid and timely treatment
- To reduce calf mortality and reproductive problems
- To ensure clean and safe milk production
- To minimize economic loss in buffalo farming

Principles of Good Health Management

- Follow regular vaccination and deworming calendar. Timely vaccination and deworming protect animals from major infectious diseases.
- Observe animals daily for abnormal signs. Early detection of illness through daily observation helps in timely treatment.
- Keep shed clean, dry and well ventilated. Proper hygiene and ventilation reduce disease occurrence and stress in animals.
- Provide balanced nutrition to improve immunity. Adequate nutrients strengthen the immune system and enhance overall performance.
- Isolate sick animals immediately. Isolation prevents the spread of diseases to healthy animals in the herd.
- Seek veterinary help at early stage. Early veterinary intervention reduces severity of disease and economic losses.

The recommended vaccination programme for buffaloes is presented in Table 5.

Table 5. Vaccination Schedule for Buffalo

Disease	Age of first dose	Booster	Repeat
Foot & Mouth Disease (FMD)	4 months	After 1 month	Every 6 months
Hemorrhagic Septicemia (HS)	6 months	After 1 month	Yearly before monsoon
Black Quarter (BQ)	6 months	After 1 month	Yearly
Brucellosis (female calves)	4–8 months	Not required	Single life time
Anthrax*	6 months	–	Yearly in endemic area

Regular control of internal and external parasites should be followed as indicated in Table 7.

Table 7. Deworming Schedule for Buffalo Management

Category	Frequency
Calves	15 days, then every 3 months
Adult buffalo	Every 6 months
Pregnant	Before breeding & after calving
External parasites	Every 2–3 months

Major Diseases of Buffalo and Farmer Level Management:

1. Foot and Mouth Disease (FMD)

- Major symptoms of the disease include high fever, excessive salivation, and loss of appetite. Blisters appear in the mouth, tongue, gums, and between the hooves.
- Painful foot lesions cause lameness and difficulty in walking. There is a sudden drop in milk yield due to stress and reduced feed intake.
- Farmers have to isolate the affected animal at once to prevent spread of infection. Wash mouth with alum solution and provide only soft green fodder.
- Call a veterinarian at the earliest for proper treatment and medication. Do not allow movement of animals in or out of the shed or village.
- **Prevention and control measures:** Follow six-monthly FMD vaccination schedule for all susceptible animals. Maintain shed hygiene and regular disinfection to reduce virus spread.

2. Hemorrhagic Septicemia (HS)

- Major symptoms of the disease include high fever with dullness and loss of appetite. Swelling is commonly seen in the throat and brisket region.
- **Respiratory distress and severity:** Breathing becomes difficult due to swelling and lung involvement. In severe and untreated cases, sudden death may occur.

- **Immediate action by farmers:** Arrange immediate veterinary treatment without delay. Do not shift or stress the animal, as movement worsens the condition.
- **Control and preventive measures:** Vaccinate all animals regularly, preferably before the onset of monsoon. Maintain good hygiene and reduce stress to prevent outbreaks.

3. Black Quarter (BQ)

- Major symptoms of the disease are painful swelling appears on thigh, shoulder, or hip region of the animal.
- Characteristic signs are swollen muscles produce a crackling or crepitation sound on pressing. High fever and sudden lameness are commonly observed.
- The disease progresses rapidly and can cause sudden death if untreated.

  Early recognition is critical for saving the animal.
- **Prevention and control measures:** Follow annual vaccination schedule, especially before monsoon season. Avoid grazing animals in previously infected or marshy fields.

4. Mastitis

- Common symptoms of mastitis include udder becomes swollen, hard, hot, and painful on touch. Milk may contain clots, flakes, pus, or blood with sudden fall in yield.
- Immediate management practices. Wash and clean the udder thoroughly before and after milking. Ensure complete milking with no milk retention in the udder.
- Hygienic milking and treatment. Follow teat dipping after every milking to prevent infection spread. Seek immediate veterinary treatment to avoid permanent udder damage.
- Preventive measures at farm level. Maintain clean and dry floor with proper bedding material. Use separate clean towels for each buffalo during milking.
- Dry period management. Adopt dry cow therapy at the time of drying off. This helps prevent new infections during the dry period.

5. Parasitic Diseases

- Common symptoms in affected animals include rough and dull hair coat with poor body condition. Diarrhea, weakness, weight loss, and reduced milk yield are common signs.
- Parasitic infestation reduces nutrient absorption and feed efficiency. This leads to poor growth, low immunity, and economic losses.
- Follow a regular and strategic deworming schedule as advised by veterinarians. Proper dosing helps in effective control of internal parasites.
- Provide clean and safe drinking water at all times. Maintain cleanliness to reduce chances of reinfestation.
- Prevent accumulation of stagnant water around sheds and grazing areas. Control snails and other intermediate hosts to reduce parasitic load.

6. Common Reproductive Disorders

- Anestrus: Commonly caused due to poor nutrition and mineral deficiency. Provide 50 g mineral mixture daily along with deworming and better feeding.

- Repeat breeding problem: Often associated with uterine infections or improper heat detection. Ensure accurate heat detection and use services of a qualified inseminator.
- Retention of placenta: Failure to expel placenta within 12 hours requires immediate attention. Call a veterinarian and never pull the placenta by force.
- General preventive measures. Maintain balanced nutrition and proper body condition of animals. Timely veterinary check-ups help prevent reproductive complications.

7. Zoonotic Diseases

- Common zoonotic diseases in livestock include brucellosis, tuberculosis, and anthrax can spread from animals to humans. These infections pose serious health risks to farmers and handlers.
- Consumption of raw or unboiled milk can transmit zoonotic infections. Always boil milk properly before drinking or selling.
- During abortion and calving, use gloves and protective gear while handling aborted fetus or discharges. Wash hands thoroughly after handling animals or contaminated materials.
- Dead animals should be disposed of scientifically by deep burial or rendering. Proper disposal prevents disease spread to humans and other animals.
- Maintain personal hygiene and clean animal sheds regularly. Seek veterinary advice immediately if zoonotic disease is suspected.

Economics to start a Buffalo farm (10 female and one male)

Assumptions

- Breed: Murrah / upgraded local buffalo
- Age of females: In milk / early lactation
- Lactation length: 270 days
- Average milk yield: 8 litres/day/buffalo
- Milk price: ₹ 55 per litre
- Male buffalo kept for natural breeding
- Housing: Simple pucca shed
- Labour: Family labour (no hired labour considered)

Fixed Capital Investment

Particulars	Quantity	Rate (₹)	Amount (₹)
Female buffaloes	10	90,000	9,00,000
Male buffalo	1	60,000	60,000
Shed construction	–	–	2,00,000
Equipment (chaff cutter, buckets, etc.)	–	–	40,000
Total Fixed Cost			12,00,000

Recurring / Annual Expenditure

(a) Feed Cost

Green fodder: ₹ 80/day × 11 animals × 365 = ₹ 3,21,200

Dry fodder: ₹ 50/day × 11 × 365 = ₹ 2,00,750

Concentrate feed (5 kg/day for 10 females @ ₹ 25/kg):

= ₹ 125 × 10 × 270 days = ₹ 3,37,500

Total Feed Cost = ₹ 8,59,450

(b) Other Costs

Veterinary & medicines = ₹ 25,000

Breeding & miscellaneous = ₹ 15,000

Electricity & water = ₹ 12,000

Total Other Costs = ₹ 52,000

Total Annual Recurring Cost = ₹ 9,11,450

Returns

(a) Milk Income

Daily milk production = 10 × 8 = 80 litres

Annual milk production = 80 × 270 = 21,600 litres

ncome from milk = 21,600 × ₹ 55

= ₹ 11,88,000

(b) Sale of manure

Approx. ₹ 2,000/buffalo/year × 11

= ₹ 22,000

Total Gross Income = ₹ 12,10,000

Net Profit

Net Annual Income = Gross Income – Recurring Cost

= ₹ 12,10,000 – ₹ 9,11,450

= ₹ 2,98,550 per year

Buffalo farming with 10 female and 1 male buffalo under Indian conditions is economically viable, providing the Net profit of about ₹ 3.0 lakh per year. Regular daily income from milk and additional benefits through manure and calf production. Profitability can be further improved by: On-farm fodder cultivation, own feed manufacturing and value addition (curd, ghee, paneer).

04
CHAPTER

Goat

Shanker Dayal, Jyoti Kumar, P K Ray, Rajni Kumari, Rakesh Kumar and Kamal sharma

Goat is a multi-functional animal and plays a significant role in the economy and nutrition of landless, small, and marginal farmers in the country. Goat rearing is an enterprise which has been practiced by a large section of population in rural areas. Goats can efficiently survive on available shrubs and trees in adverse harsh environment in low fertility lands where no other crop can be grown. In pastoral and agricultural subsistence societies in India, goats are kept as a source of additional income and as an insurance against disaster. Goats are also used in ceremonial feastings and for the payment of social dues. In addition to this, goat has religious and ritualistic importance in many societies. The advantages of goat rearing are:

i) The initial investment needed for Goat farming is low,
ii) Due to small body size and docile nature, housing requirements and managemental problems with goats are less.
iii) Goats are friendly, animals and enjoy being with the people.
iv) Goats are prolific breeders and achieve sexual maturity at the age of 10-12 months gestation period in goats is short and at the age of 16-17 months it starts giving milk. Twinning is very common and triplets and quadruplets are rare.
v) In drought prone areas risk of goat farming is very much less as compared to other livestock species.
vi) Unlike large animals in commercial farm conditions both male and female goats have equal value.
vii) Goats are ideal for mixed species grazing. The animal can thrive well on wide variety of thorny bushes, weeds, crop residues, agricultural by products unsuitable for human consumption.
viii) Under proper management, goats can improve and maintain grazing land and reduce bush encroachment (biological control) without causing harm to the environment.
ix) No religious taboo against goat slaughter and meat consumption prevalent in the country.
x) Slaughter and dressing operation and meat disposal can be carried without much environmental problems.
xi) The goat meat is more lean (low cholesterol) and relatively good for people who prefer low energy diet especially in summer and sometimes goat meat (chevon) is preferred over mutton because of its "chewability"
xii) Goat milk is easy to digest than cow milk because of small fat globules and is naturally homogenized. Goat milk is said to play a role in improving appetite and digestive efficiency. Goat milk is non allergic as compared to cow milk and it has antifungal and antibacterial properties and can be used for treating urogenital diseases of fungal origin.

xiii) Goats are 2.5 times more economical than sheep on free range grazing under semi-arid conditions.

xiv) Goat creates employment to the rural poor besides effectively utilizing unpaid family labour. There is ample scope for establishing cottage industries based on goat meat and milk products and value addition to skin and fiber.

Strength and weakness of goat husbandry in Eastern India

Strength

1. Well adapted to hot and humid agro-climatic condition.
2. Well adapted to prevalent diseases, low quality feed and poor management
3. No religious taboo attached with goat farming or consumption of goat meat.
4. Comparatively low investment is required to start goat farming,
5. Can consume all kinds of plant which are generally rejected by the other animals and also can withstand more bitter taste.
6. They are naturally browsing in nature and can easily pluck feed from trees, bushes and shrubs.
7. Due to small fat globule present in goat milk, it is easily digested and medically recommended for infants and aged people

Weakness

1. Indiscriminate breeding
2. Lack of superior breeding buck
3. Lack of breeding policy
4. Lack of Breed Society
5. Poor awareness among farmers for improved managemental practices

Package of Common Management Practices Recommended for Goat rearing

Modern and well-established scientific principles, practices and skills should be used to obtain maximum economic benefits from goat rearing. Some of the recommended practices are given here under

Selection of Breed:

Goat is generally reared for meat purposes in Eastern India. Bihar, Bengal, Odisha and Jharkhand is predominantly inhabited by Black Bengal breed of goat. However, crosses with other breeds like Jamunapari, Barbari, Sirohi and Jakharna are also available. Rearing of Black Bengal goat has distinct advantage over the other breed in the region. They are known for their superior meat and hide quality. Black Bengal goat is highly prolific even triplet and quadruplet birth is very common. Average wt. of adult goat is 12-15 Kg. They reach market weight around 9-10 months. Male Bengal goat comes in puberty at the age of 8-9 months whereas the age of 1st kidding is on an average 14-15 months. Lactation length of this breed of goat at farmer's field has been recorded as 80-120 days and kidding interval at 250 days.

Breed descriptor of Black Bengal

Colour: Predominately black, white, brown, grey and their combinations with black

Ears: Mostly erect to horizontal

Orientation Directed upwards with inclination to back.

Size Small

Tail Curved upward, 5-15 cm long

Nose line slightly depressed

Hair coat is short and lustrous

Small-legged goat

Fig. 1 Black Bengal Buck

Fig. 1 Black Bengal Doe with kids

Scientific Managemental Practices

I. Housing management:

1. Construct shed on dry and properly raised ground.
2. Avoid water-logging, marshy areas.
3. In low lying and heavy rainfall areas the floors should be preferably elevated.
4. For a comfortable shed east-west orientation with generous provision for ventilation / air movement to dry the floor will be suitable.
5. The floors should be constructed in such a way, so that it should be easily cleaned.
6. Buck should be housed in individual pen.
7. Does can be housed in group's up to 60 per pen.
8. Provide proper shade and cool drinking water in summer.
9. Dispose the dung and urine properly.
10. Give adequate space for the animal.
11. Avoid over stocking or crowding




Fig.3 Housing of Goat

Floor space Requirement (BIS standard)

Types of animals	Minimum floor space per animal (Sq.m)
Buck in groups	1.8
Buck - individual	3.2
kids - in group	0.4
Weaner in groups	0.8
Doe in groups	1.0
Doe with Kid	1.5

II. Selection of breeding stock and it's management:

1. Animals in good health and having good physical features must be purchased in consultation with Veterinarian.
2. Purchase animals-which are ready to breed and in prime stage of production.
3. Identify the newly purchased animals by suitable identification mark.
4. Vaccinate the newly purchased animals against the diseases
5. Keep the newly purchased animals under observation for about 15 days and then mix with the general flock.

6. Unproductive animals should be culled promptly and should be replaced by the newly purchased animals or farm born one
7. Age of first breeding is 10-12 month when female weight is approximately 10-12 Kg.
8. Animals are to be bred at the interval of 8-9 months for maximum productivity.
9. Cull the old animals at the age of 6 years and above.
10. Avoid the kidding during peak periods of summer and winter.

Care to be taken before Selecting superior Buck

- True to Breed characteristics
- Body weight and height at different production stages s/b 25-30% higher than average
- Good libido, well developed, descended testis, equal in size
- Buck should be selected based on 9 months body weight and 90 days milk yield
- They should be utilized after attaining proper physical and physiological maturity
- Replaced after 18-24 months of use
- Sound health and should not carrier of any diseases

Care to be taken before Selecting superior Doe (female)

- True to breed characteristics
- Selected based on performance of pure-bred parent
- Selected based on 6- and 9-months body weight and 90 days milk yield
- Age of mating should be 8-9 month after attaining 9-10 Kg body weight
- Productive age is 5-6 Yrs depending on optimum feeding condition

III. Feeding management:

Feeding Components

Green Fodder: Berseem, Lucerne, Hybrid Napier, Cowpea etc.

Dry Fodder: Straw, hay

Concentrates (100–250 g/day):

- Crushed maize
- Oil cakes
- Bran

Mineral mixture & salt regularly

Clean drinking water always available

Salient point

1. Offer roughages adlib.
2. As a thumb rule 2/3rds of the energy requirements should be met through roughages. Half of the roughages should be leguminous green fodders and rest half should be grasses/ tender tree leaves.
3. In the absence of good quality green fodders, concentrates must be considered to replace them.
4. Tree leaved of Kathal, Kadamb, Pakar etc can be fed to the animal at lean season when green fodders are not available.
5. Kids should be fed colostrum up to 5 days of age. Kid should be fed milk up to one tenth of their body weight.
6. Green leguminous fodders should be offered adlib. to kids from 15 days onwards.
7. When sufficient milk is not available, kid should be fed milk replacer or cow milk diluted with water.
8. Provide salt and water to kids at all times.
9. Provide mineral mixture 5-10 gm to each goat, daily.
10. Additional 250 gm concentrates should be given to bucks and does during breeding season.
11. About 2 to 3 weeks before the onset of the breeding season, nutrition of does should be stepped up to promote their body weight. This practice will bring does into heat earlier in the season thereby giving early kids.
12. Care should be taken to meet the nutrient requirements as recommended

Feeding does at kidding time

- As kidding time approaches or immediately after kidding the concentrate should be reduced but good quality dry roughage is fed free choice.
- It is usually preferable to feed lightly on the day of parturition, but allow plenty of clean, cool water.
- Soon after kidding the doe must be given just enough of slightly warm water.
- After parturition the ration of the doe may be gradually increased so that she receives the full ration in divided doses six to seven times in a day.
- Bulky and laxative feedstuffs may be included in the ration during the first few days.

Feeding lactating doe

The following rations may be recommended

- 6-8 hours grazing + 8 kg green fodder/day
- 6-8 hours grazing + 400 g of concentrate mixture/day

IV. Breeding care:

1. It should be planned to obtain 3 kidding's in 2 years period by adopting optimal management conditions.
2. For every 25 does one buck should be provided in one breeding season.
3. Breed the animals 12 hours after the onset of the first symptoms of heat for maximum conception.
4. Unbreedable animals must be examined thoroughly as directed by veterinary doctor for prompt elimination of causes for anoestrum or cull them if necessary.
5. Male should be rotated or discarded after 2 yrs.

V. Care during pregnancy:

In advanced stage of pregnancy, the does must be transferred to either kidding pens or separately earmarked space for kidding within the main shed after thoroughly disinfecting it. After kidding, the does should be provided with warm bran mash for two days.

VI. Care of kids:

1. Take care of new born *kids* by providing guard rails.
2. Treat / disinfect the naval cord with tincture of iodine as soon as it is cut with a sharp knife.
3. Protect the kids from extreme weather conditions, particularly during the first two months.
4. Dehorn the kids during first two weeks of age
5. Male kids should be castrated for better quality meat production.
6. Vaccinate the kids as per the recommended schedule
7. Wean the kids at the age of 8 weeks
8. Proper selection of kids based on initial body weight and weaning weight should be initiated by maintaining appropriate records for replacing the culled adult stock as breeders.
9. Additional feed requirements of lactating does must be ensured for proper nursing of all the kids born.

VII. Protection against diseases:

1. Be on the alert for signs of illness such as reduced feed intake, fever, abnormal discharge or unusual behavior.
2. Consult the nearest veterinary aid center for help if illness is suspected.
3. Protect the animals against common diseases.
4. In case of outbreak of contagious diseases, immediately segregate the sick animals from healthy one and take necessary disease control measures.

5. Deworm the animals regularly.
6. Examine the feces of adult animals to detect eggs of internal parasites and treat the animals with suitable drugs.
7. Provide clean and uncontaminated feed and water for minimizing the health disorders.
8. Strictly follow the recommended vaccine schedule.

Important points for goat health management:

1) Housing & Hygiene

- Keep shed dry, clean, well-ventilated
- Avoid damp floors : prevents pneumonia & foot rot
- Provide proper drainage and sunlight
- Keep a practice of regular cleaning and disinfection
- Prevent overcrowding

2) Feeding & Nutrition

- Provide balanced diet: Including a mix of green fodder, dry fodder and concentrate.
- Always provide clean drinking water
- Provide mineral mixture and salt lick
- Extra nutrition for pregnant, lactating and kids

3) Vaccination (must follow schedule):

Common vaccines (depends on area):

- PPR
- ET (Enterotoxemia)
- FMD
- Goat pox
- HS (Hemorrhagic septicemia) **(where recommended)**

4) Deworming & Parasite Control

- Deworm regularly (every 3–4 months or as per expert advice)
- Control external parasites (ticks/lice) using dips/sprays
- Keep bedding clean to reduce worm load

5) Disease Prevention

- Isolate sick animals immediately (quarantine)
- Avoid mixing new goats directly -quarantine new goats for 2–3 weeks
- Provide clean feeders & waterers
- Proper disposal of dead animals (safe burial)

6) Regular Health Check

Watch daily for:

- Appetite loss
- Diarrhea
- Pale gums (anemia)
- Fever, cough, nasal discharge
- Lameness / swollen joints
- Rough hair coat

7) Kid Care (Most important)

- Ensure colostrum feeding within 1–2 hours after birth
- Keep kids warm & dry
- Navel dipping with antiseptic (to prevent infection)
- Vaccination/deworming on time

8) Hoof Care

- Regular hoof trimming
- Prevent foot rot by keeping floor dry

9) Record Keeping

Maintain records of:

- Vaccination dates
- Deworming dates
- Birth, breeding, milk, illness, treatment

Vaccination Schedule of Goats (India)

Disease / Vaccine	**Age / Time**	**Booster / Repeat**
PPR	3 months	Once every year
ET (Enterotoxemia / Clostridial)	3 months	Booster after 21 days, then every 6 months (before rainy/winter)
FMD	4 months	Every 6 months
Goat Pox	3 months	Once every year
HS (Haemorrhagic Septicaemia) *(if common in your area)*	6 months (before monsoon)	Once every year

Best time to vaccinate: before monsoon and winter.

Deworming Schedule of Goats

Goat Type	**Deworming Time**
Kids (1–12 months)	Start at 1 month, then every 30–45 days
Adult goats	Every 3 months (4 times/year)
Pregnant doe	2–3 weeks before kidding
Breeding buck	Every 3 months

Deworm especially before monsoon and after monsoon (when worm load is high).

External Parasite Control (Ticks/Lice/Mites)

Spray/dip is done to control external parasites like ticks, lice, mites, fleas.

- Spraying/dipping every 30–45 days (common farm practice).
- In high tick season (monsoon): interval may be reduced to 15–30 days
  It should be done: When you see itching / hair loss / wounds.
  Before introducing new goats (after quarantine)
- Keep the shed dry and bedding clean.
- Spraying over shed (Floor corners, Cracks/crevices, walls up to 2–3 feet, bedding area etc.) is important as If you spray only goats, ticks return from shed

Major diseases of Goats: symptoms, prevention and control measures

Disease	Main Symptoms	Prevention / Control
PPR	High fever, mouth ulcers, nasal discharge, cough, foul diarrhea, sudden death	Isolate sick, clean shed, avoid mixing new goats, good nutrition
Enterotoxaemia (ET)	Sudden death, severe diarrhoea, abdominal pain, bloating (often after heavy grain)	Avoid sudden feed change, don't overfeed concentrates, regular deworming
FMD	Excess salivation, mouth blisters, foot sores, lameness, low feed intake	Keep shed clean, restrict movement during outbreaks, disinfect
Goat Pox	Fever, skin nodules/boils, scabs, eye/nose discharge	Isolate affected goats, control insects, hygiene
HS	High fever, swelling in throat/neck, breathing difficulty, sudden death	Avoid wet/damp housing, reduce stress, clean water
Pneumonia	Cough, fever, nasal discharge, fast breathing	Dry & ventilated shed, avoid cold stress, no overcrowding
Mastitis	Swollen hot udder, pain, reduced milk, clots in milk	Clean milking, udder hygiene, treat early
Brucellosis	Abortion (late pregnancy), infertility, weak kids	Test & remove positive animals, avoid raw milk handling
Worm infestation	Weight loss, diarrhea, rough coat, anemia (pale eyes)	Clean shed, rotational grazing, avoid wet grazing areas
Coccidiosis (kids)	Watery/bloody diarrhea, weakness, dehydration	Clean dry floor, avoid overcrowding, clean water
Tick/Lice/Mange	Itching, hair loss, wounds, anemia, weak body	Shed cleaning , spray/dip regularly
Foot Rot	Limping, bad smell, swollen hoof	Dry floor, hoof trimming, footbath
Bloat	Left side distortion, discomfort, sudden death	Avoid sudden lush green feeding, feed dry fodder first

VIII. Marketing:

- The marketable products of goat farming include the fattened kids. manure, culled animals.
- Marketing avenues for the above products are slaughter houses and individual meat consuming customers and agriculture farms.
- Goat manure can be used for fertilizing agriculture field.

Economics to start a goat farm (20 Doe and one male)

Following assumptions were made while calculating economics

Particulars	**Detail**
Unit size	20 Does + 1 Buck
Breed	Black Bengal
Purpose	Meat production
Age at purchase	8 months
Breeding rate	90%
Kidding rate	1.5 kids/doe/year
Mortality rate	5%
Price per doe	₹ 6,000
Selling age of kids	8-10 months
Selling price of kids	₹ 5,000
Location	Rural Indian conditions

2. Capital Expenditure (Fixed Cost)

A. Cost of Animals

Particulars	**Number**	**Rate (₹)**	**Amount (₹)**
Does	20	6,000	1,20,000
Buck	1	8,000	8,000
Total Animal Cost			**1,28,000**

B. Housing & Equipment

Particulars	**Amount (₹)**
Goat shed (simple)	40,000
Feeders & water troughs	7,000
Total Housing & Equipment	**47,000**

C. Total Fixed Cost

Particulars	**Amount (₹)**
Animal cost	1,28,000
Housing & equipment	47,000
Total Fixed Cost	**1,75,000**

3. Recurring Expenditure (Annual)

Particulars	Amount (₹/Year)
Feed cost (Straw, Green fodder, Concentrate: 250gm/day/doe) (250×21 adult×30 days×3 month + 250 × 26kid ×30 dyas×3 month)	21,000
@Rs 20/ animal veterinary care (vaccination & deworming)	6,000
Labour (family labour)	Nil
Miscellaneous expenses	4,000
Total Recurring Cost	**31,000**

4. Total Project Cost

Cost Type	Amount (₹)
Fixed cost	1,75,000
Recurring cost	31,000
Total Project Cost	**2,06,000**

5. Expected Returns

A. Kid Production

Particulars	Number
Does kidded (90%)	18
Average kids per doe	1.5
Total kids born	27
Mortality (5%)	1
Kids available for sale	**26**

B. Income

Source	Quantity	Rate (₹)	Amount (₹)
Sale of kids	26	5,000	1,30,000
Sale of manure	—	—	6,000
Total Gross Income			**1,36,000**

6. Net Returns

Particulars	Amount (₹)
Gross income	1,36,000
Recurring cost	31,000
Net Profit (1st year)	**1,05,000** (Value of parent stock not included in profit)

IX. Recommendations

- Select breed based on agroclimatic condition (Black Bengal for Eastern region)
- Adopt scientific feeding and breeding practices
- Maintain proper records (Growth, mating, kidding health, expenses)
- Ensure regular vaccination and deworming
- Promote value addition for higher profitability

X. Conclusion

Scientific goat farming is economically viable and lucrative when combined with appropriate breeding, feeding, health management, and market linkage, rendering it suitable for the livelihood improvement of rural small, marginal, and landless farmers.

❐

05
CHAPTER

Pig

Reena Kamal, P.C. Chandran, Rakesh Kumar, Rajni Kumari and Kamal Sarma

Introduction

Swine rearing plays a crucial role in enhancing rural livelihoods and nutritional security in Eastern India, particularly among tribal and economically weaker communities. The region, comprising states such as Jharkhand, Odisha, Bihar, West Bengal, Assam, and Chhattisgarh, has a long tradition of pig farming, often practiced in smallholder or backyard systems. Despite the socio-economic importance of swine rearing, productivity remains low due to poor management, inadequate nutrition, traditional breeding methods, and limited access to veterinary care.

To address these challenges and unlock the full potential of pig farming, a scientifically developed Package of Practices (PoP) is essential. This PoP outlines standardized and region-specific guidelines covering breed selection, housing, feeding, breeding, health management, and waste utilization. It integrates traditional knowledge with improved scientific practices to promote sustainable pig production, higher income generation, and enhanced biosecurity.

The goal of this PoP is to serve as a practical reference for farmers, extension workers, and stakeholders in Eastern India, enabling them to adopt cost-effective and productive swine rearing systems that are environmentally sound and socially inclusive.

1. Breeds Selection

Choose breeds based on the production goals (meat, breeding, etc.) and agro-climatic conditions.

- ***Indigenous breeds:*** Ghungroo, Doom, Banda
- ***Exotic breeds:*** Large White Yorkshire, Landrace, Duroc, Hampshire
- ***Crossbreeds:*** T&D, HD-K75 (suitable for Jharkhand and NEH region)

Indigenous Breed

Breed Name	Native Region	Key Traits	Fig.
Ghungroo	North Bengal	High prolificacy (10-12 piglets), good mothering ability.	
Doom	Assam	Hardy, good for backyard farming; adult body wt. 36-50 kg	

Purnea	Bihar	Hardy, used in tribal piggery systems, mainly reared for pork and manure, adult body wt. 40-50 kg	
Banda	Jharkhand (local name)	Hardy, used in tribal piggery systems, mainly reared for pork and manure, adult body wt. 27-28 kg	
Ghurrah	Uttar Pradesh (Bareilly)	Disease resistance, hardiness, and adaptability to local conditions. These pigs can withstand dog attacks and protect their piglets without harm. Adult male weighs about 46-48 kg. Litter size is 6.85 at birth and 5.65 at weaning	

Exotic Breeds

These are high-performing breeds known for fast growth and good carcass quality, but require better management:

Breed Name	Origin	Key Traits	Fig.
Large White Yorkshire	England	Large size, fast growth, good milk yield	
Landrace	Denmark	Long body, high meat yield, prolific	
Duroc	U.S.A.	Good meat quality, disease resistant	

Hampshire	USA/UK	Large size, fast growth, good milk yield	
Pietrain	Belgium	Long body, high meat yield, prolific	

Crossbred Varieties (Developed in India)

These are developed by ICAR and SAUs by crossing exotic and indigenous breeds for improved performance under eastern region of Indian conditions:

Name of the crossbred pig varieties	Characteristics	Name of the developing organization/ institute	Fig.
Rani This pig variety has 50% Hampshire (exotic breed) and 50% Ghungroo (indigenous breed) inheritance.	This pig gains almost 75 kg body weight at slaughter age of 8 months with 1.98 cm of backfat thickness.	ICAR- National Research Centre on Pig, Guwahati, Assam	
Asha This pig variety has 25% Ghungroo, 25% Hampshire (exotic breed) and 50% Duroc (exotic breed) inheritance.	This pig variety can produce 80 kg lean pork at slaughter age of 8 months with 1.75 cm backfat thickness.	ICAR - National Research Centre on Pig, Guwahati, Assam.	
HD-K75 This pig variety has 75% Hampshire (exotic breed) inheritance and 25% indigenous inheritance of local pigs of Assam.	This pig variety attains almost 74 - 80 kg body weight at slaughter age of 8 months with 1.75-2.58 cm of backfat thickness.	All India Coordinated Research project on Pig, Assam Agricultural University at Khanapara, Guwahati, Assam	
Jharsuk This pig variety has 50 % Tamworth (exotic breed) and 50 % local pigs of Jharkhand inheritances.	This pig variety attains approximately 80 kg body weight at slaughter age of 8-10 months. It can produce 8-12 piglets in each farrowing with two farrowing each year.	All India Coordinated Research Project on Pig at Birsa Agricultural University, Ranchi.	

Lumsniang This crossbred pig variety has 75% Hampshire (Exotic) and 25% Niang Megha pig of Meghalaya inheritance.	The pig variety attained a higher body weight of 90-100 kg at 12 months of age, besides higher litter size at weaning as compared to local non-descriptive pigs' (8.56±0.77 Vs 5.23±0.54).	All India Coordinated Research Project on Pig at ICAR-Research Complex for NEH Region, Barapani	
Landlly This pig variety has 75 % Landrace (exotic) with 25 % Gurrah pig (local) inheritance.	This pig verity attains marketable weight at the age of 8 months.	AICRP on Pig centre of ICAR-Indian Veterinary Research Institute (IVRI), Bareilly	

2. Breeding Management

Factors affecting the selection of breed are:

The selection of an appropriate pig breed is critical to ensuring optimal productivity, adaptability, and profitability. The following factors should be carefully considered when choosing a breed for pig breeding programs:

- Availability of quality stock – Healthy, superior genetics for herd improvement
- Prolificacy – Larger litters and frequent farrowing
- Growth rate – Fast growth reduces rearing time and cost
- Temperament – Calm pigs are easier and safer to handle
- Carcass quality – Better meat yield and fat-lean ratio
- Feed efficiency – More weight gain per unit of feed
- Mothering ability – Good care improves piglet survival
- Market demand – Match with local consumer preferences
- Disease resistance – Reduces treatment needs, improves sustainability

Factors for selection of breeding stock:

The success of a pig breeding program greatly depends on the selection of superior breeding animals.The following criteria are critical for identifying high-quality breeding stock

- Litter size – Prefer animals producing ≥ 8 piglets per farrowing
- Vigour of piglets – Active, uniform, and strong piglets indicate good genetics
- Milking ability – Ensures healthy piglet growth and better weaning
- Temperament – Calm animals are easier to manage and less stressed
- Progeny performance – Offspring should grow fast and utilize feed efficiently
- Longevity – Long productive life with consistent breeding performance
- Fertility – High and reliable reproductive output in both boars and sows
- Free from defects – Avoid animals with physical or genetic faults

Breeding system

- **Inbreeding:** Involves breeding of related animals. This system is not adopted commercially.
- **Out breeding:** Mating of unrelated animals. This system gives good results with performance of pigs.

- **Out crossing:** Mating of unrelated animals of same breed.
- **Cross breeding:** For commercial swine production programme. It is a common method used in areas around bacon (a meat from back and side of pig) factories and preserved, cured with salt solution. It involves mating of animal between two different breeds.

Selection, Reproductive Practices and Management

Selection of Breeding Stock	
Boars	• True to breed • Masculine appearance • Long deep body • Smooth shoulders and strong legs • Sound health and performance record. • No cryptorchid condition (Both testicles should normally descend into the scrotum) • Age between 1.5 – 2 years. • Select only fertile boar with well-developed testicles • Not over fat condition • Active look • From sows with good litter size (10–12 piglets)
Gilts (young females):	• Selected from healthy litters • Reach 90–100 kg body weight by 7–8 months • Free from hereditary defects
Sows	• Sows must be from a litter whose litter size and weight at birth and weaning weight is maximum • Sow must have well developed udder with 12 teats and at least 6 teats in each row evenly distributed on belly sides. • Teat of sow must be free from any abnormal defects. • Sow must have deep body. • Select the sows that are already bred at least once. • Age of bred sows must be 2-3 years. • Sows must produce young ones every year. • Sows should have mothering ability • Must be ready for another rebreeding at the end of lactation. • Should have quiet disposition.

Reproduction guidelines	
Age at puberty	6 – 7 months
Breeding age of gilts	10-12 months
Breeding weight of gilts	90-100 kg
Breeding age of boar	18-24 months

Number of sows/boar	10 (1:10) Boar: Sow
Heat cycle	19-23 days: Average 21 days
Heat period	2-3 days (standing heat)
Mating time	Gilts – 1st day of heat. In sow – 2nd day of onset of heat
Number of services per conception	2 at a interval of 14 hours
Gestation period	112 – 114 days (3 months 3 weeks 3 days)
Suckling period	56 – 60 days
Average litter size at birth	10-14
Average litter size at weaning	8-10
Rest period	45 days
Occurrence of heat after weaning	2-10 days. This is the fertile heat
Period of mating	15 days after weaning
Volume of semen ejaculation	200 ml – 300 ml
Average number of sperm/cu mm	1 lakh (100,000)
Average age to castrate pigs	4-8 weeks
Market age for fattening pigs	6 months
Market weight at 6 months	70-75 kg
Farrowing interval	7 – 7½ months
Sows can breed upto	8-10 years
Age at puberty	6 – 7 months
Detection of heat in sows	Vulval swelling and redness; Vaginal discharge; Frequent urination; Reduced appetite; Mounting behaviour; Immobility when normal manual pressure is applied on the back region (lumbo-sacral region); Restlessness and excitement; Peculiar grunting sound ; Erection of ears when pressure is applied on the back.
Optimum time to breed sow or gilts	• Standing heat as detected by immobility of sow in oestrus particularly exhibited by erection of ears when manual pressure is applied on the back of sow. • Influence of boar contact on age at puberty in gilts. • 5 minutes of daily contact with mature boar is sufficient to stimulate early puberty in gilts providing the gilt have adequate opportunity for physical contact with boars. • Provision of guard rails at farrowing pen, farrowing crate
Breeding Interval	• Non-pregnant sows return to heat in 18–24 days • Breed sows within 7 days post-weaning for next cycle

Care of Pregnant Sows	• Flushing ration: Feeding gilts and sow liberally to increase energy intake 10-15 days prior to mating is called Flushing. • Flushing in female pigs enhances physical condition, promotes early and strong estrus, increases ovulation and litter size, shortens the weaning-to-conception interval, and reduces embryonic loss • It may be done as follows –Feed leguminous hay, cowpea, lucerne, berseem for supply of more protein, minerals and vitamins. –Extra allowance of grains. –Give multivitamin injection along –with flushing • Avoid overfeeding in early pregnancy to reduce embryonic loss • Deworm and vaccinate before farrowing • Move to farrowing pen 7–10 days before expected delivery
Breeding Records	Maintain records for each animal including: Date of heat; Mating/AI date; Boar used; Expected farrowing date; Actual farrowing date and litter size
Culling and Replacement	• Cull animals with: o Poor reproductive performance o Frequent reproductive disorders o Low productivity • Replace with genetically superior stock

Phases of the Breeding Cycle

Sow	• Fertilization • Conception (114-115 days) • Farrowing • Nursing (21-28 days) • Covered rest (~ 6 days)
Piglets	Weaning (21-28 days, 5-7 kg of body weight) Post-weaning (up to ~ 30 kg)
Followed by	Fattening of a light pig Fattening of a heavy pig Breeding new sows
Growth-fattening	~ 100kg light pig~ 6 months ~ 160kg heavy pig ~ 10 months

3. Housing Management

General Housing Guidelines

- Shelter must protect pigs from direct sunlight, rain, heat, and cold (ideal temperature: 20–25°C).
- Strong concrete floors and smooth brick walls resist rooting and are easy to clean.
- Feed and water troughs placed at the front allow easy access from outside.
- Design should allow easy observation and require less labour.

- Boars, gilts, sows, and growers can be housed in partially sheltered open yards.
- Farrowing sows require fully enclosed pens for safety and warmth.
- Use low-cost materials for rural housing; design multipurpose pens when needed.
- In large farms, G.I./M.S. pipe cages or farrowing crates can be adopted.
- Separate uncastrated males and females beyond 4 months of age.

Types of Pens in Farrow-to-Finish Farms

(i) Farrowing/Lactating Sow Pens

- Pen size: 2.5 × 4.0 m; crates: 2.4 × 1.8 m.
- Prevent piglet crushing using crates and G.I. guard rails (20–25 cm above floor).
- Maintain 32–34°C using infrared lamps, 200W bulbs, or heating plates.
- Provide creep area for piglets with feed and heat source.

(ii) Dry and Pregnant Sow Pens

- Can be housed individually or in groups (15–20) with individual feeders.
- Individual housing needed from weaning till 40 days post-service.
- Floor: Concrete slats preferred; water cleaning required if using solid floors.
- Advanced farms may use electronic sow feeders.

(iii) Weaner Pens

- Weaning age: 28–35 days; piglets require warm, clean, dry pens.
- Use plastic/wooden slatted floors or solid floor with brooding setup.
- Brooding required preventing cold stress and disease.
- Floor space: 0.4–0.5 m^2/piglet.
- Battery cages (1.5 × 1.2/1.5 m, raised floor) help reduce infections.

(iv) Fattener Pens

- Simpler housing; rows of pens with feed alleys recommended.
- Use slatted floors to reduce cleaning effort; though costlier.
- If budget-limited, use solid concrete floors with proper hygiene.

(v) Gilts and Boars

- Gilts selected at ~77 days; housed in pens like fatteners.
- Shift to dry sow pens once ready for breeding (7.5–8.5 months).
- Boars are housed individually with adequate space and management.

Thermoregulation and Brooding in Piglets

- Piglets have poor thermoregulation due to low body weight, minimal fat, and high surface area.
- Cold stress leads to diarrhoea, slow digestion, and weak immunity.

Brooding essentials:

- Ideal piglet temperature: 32–28°C (varies with weight)
- Heat sources: Infrared bulbs, heating plates, dry paddy straw bedding.
- Piglet behavior can indicate whether temperature is too hot or cold.

Table 1: Optimum Environmental Temperature for Piglets and Adult Pigs

Type of animal	Live weight (kg)	Optimum environmental temperature (°C)
Suckling Piglets	Less than 2	32
	Less than 5	28
Weaners	Less than8	28
	Less than10	26
	10–15	22
Growers	15–30	20
Finishers	30–60	18
	60–120	16
Pregnant Sows	Feed restricted	18
	In groups on straw	15
Lactating Sow		16
Boars		18

(Source: Whittemore, 1998)

Table 2: Feeding & Watering Trough Dimensions

Feeding/watering space requirements						
Types of animal	Speed/animal (cm)	Total manager length[1] (cm)	Water trough length[1] (cm)	Manger/water trough dimensions (cm)		
				Width	Depth	Height[2]
Adult pigs	60-75	6000-7500	600-750	50	20	25
Growing pigs	25-35	2500-3500	250-350	30	15	20

[1]Total length in the pen for 100 animals (cm)

[2]Height of inner wall of the manger/water trough, i.e. height at the throat of the animal

Table 3: Floor Space Requirements of Pigs

Type of animal	Floor space requirement (m^2 per animal)		Maximum number of animals per pen
	Covered area	*Open paddock*	
Boar	6.0-7.0	8.8-12.0	Individual pens
Farrowing sow	7.0-9.0	8.8-12.0	Individual pens
Weaner fattening pigs	0.9-1.8	0.9-1.8	30
Dry sow/gilt	1.8-2.7	1.4-1.8	3-10

(Source: Sastry & Thomas, 2008)

4. Feeding Management

General Feeding Guidelines

- Pigs are monogastric, utilize limited fibrous feed; adults digest fiber better than piglets.

- Feed at regular intervals; avoid leaving stale feed in troughs.
- Animal protein (e.g., fish/meat meal) should supplement plant protein in the diet.
- Swill feeding (kitchen waste) is economical; each pig requires 4–8 kg/day (ensure it's fresh).
- All pigs benefit from small amounts of green fodder or pasture grazing.
- Use ad libitum feeding (e.g., drum-type feeders) for weaners to prevent post-weaning weight loss.

Alternative Feed Resources for Pigs (Max Inclusion Levels):

- Tapioca starch waste (15–20%) – Energy-rich, can replace part of cereal in the diet.
- Rubber seed cake (15%) – Protein-rich by-product; should be detoxified before use.
- Tamarind seed (roasted, 20%) – Good energy source after roasting to improve digestibility.
- Tea waste (20%) – High in fiber; can be used as partial filler in grower/fattener ration.
- Meat offal (20%) – Excellent animal protein source, enhances growth and feed efficiency.

(Source: Kerala Agricultural University)

Table 3: Nutrients requirement of breeding stock

Type	Breed Gilts	Lactating gilts & sows	Young boars & adult boars
Live weight (kg.)	110-250	140-250	110-250
Energy and protein			
DE (M cal/kg)	3.3	3.3	3.3
ME (M cal/kg)	3.17	3.17	3.17
Crude Protein (%)	14	15	14
Inorganic nutrients (%)			
Calcium	0.75	0.75	0.75
Phosphorus	0.5	0.5	0.5

Table 4: Nutrient requirement of growing stock

Type	Weaning	Growing	Finishing
Live weight (kg)	5-12	12-50	50-100
Daily gain (kg)	0.3	0.5	0.6
Energy and protein			
DE (Mcal/kg)	3.5	3.5	3.3
ME (M cal/kg)	3.36	3.36	3.17
Crude Protein (%)	22	18	14
Inorganic nutrients (%)			
Calcium	0.8	0.65	0.5
Phosphorus	0.6	0.5	0.4
Sodium	--	0.1	--
Chlorine	--	0.13	--
Salt	0.5	0.5	0.5

(Source: National Bank for Agriculture and Rural Development)

Feeding Different Pig Classes

Boars:

- Provide 2–2.5 kg of concentrate per 100 kg body weight, adjusted based on age, condition, and breeding demand.
- Ensure the boar is neither overfed (fatty) nor underfed (run down).
- Offer green fodder regularly, especially if kept indoors.
- Year-round pasture is ideal for exercise and additional nutrition.

Dry/Pregnant Sows:

- Nutrient demands increase in late pregnancy to support foetal growth and prepare for lactation, especially proteins, vitamins, and minerals.
- Mature sows gain about 30–35 kg, and gilts gain 40–45 kg during pregnancy.
- Feed should be regulated to avoid both over conditioning and underfeeding.
- Individual feeding is preferred to ensure precise intake.
- Flushing: Provide extra feed 1–2 weeks before mating to enhance fertility and ovulation.

Farrowing Sow & Litter:

- Feed the sow light bulky laxative feed immediately before and after farrowing.
- Gradually increase to full feeding within 10 days post-farrowing.
- Provide plenty of green fodder for added nutrients.
- Feed allowance: 2.5–3 kg per 100 kg body weight + 0.2 kg feed per piglet.
- Example: A 100 kg sow with 8 piglets needs about 4.6 kg feed/day.
- Piglets should receive creep feed separately starting at 2 weeks of age, with an intake of about 10 kg per piglet before 8 weeks.

Growers/Finishers:

- Feed ad libitum or fixed amount 2–3 times/day.
- FCR ~ 4:1 (4 kg feed = 1 kg weight gain).
- Males and females grow faster than castrates; castrates are more docile.

Orphan Piglets

- Shift to foster sow; simulate scent/body size if needed.
- If not possible, hand feed with cow's milk (300–500 ml/day).
- Feed 5–6 times/day initially, reduce to 2–3 times later.
- Supplement vitamins (2–3 × infant dose) and injectable iron (e.g., Imferon).
- Provide warmth with a 60W bulb.

Table 5. Expected live weight for age under good feeding and management

Age (weeks)	Live weight, kg
4	4
8	10
12	20
20	50
28	85

Table 6. Approximate water requirements of pigs per day

Age group/Age (weeks)	Water Requirements (litres)
8	3
20	7
28	8
Pregnant pig	
First 3 months	12
Last 3 months	15
Lactating Sow with 5-8 Piglets	25
Lactating Sow with 10-12 Piglets	30
Boar	20

(Source: Kerala Agricultural University)

Table 7. Feeding Schedule by Class

Class	Diet Components
Piglets	Pre-starter (creep feed) up to 2 months
Growers (2–7 months)	Grower ration: 18–20% CP, energy ~3000 kcal/kg
Finishers (>7 months)	Finisher ration: 14–16% CP, energy ~3200 kcal/kg
Breeding stock	Balanced ration with vitamins and minerals

- Incorporate kitchen waste, rice bran, broken rice, vegetables, fermented rice (*handia*), or brewery by-products where available.
- Water should be clean and available ad libitum.

5. Health and Vaccination Schedule

Age / Stage	Health Care Activity	Vaccine / Treatment	Route & Dose
0–5 days	- Navel disinfection - Iron supplementation	Iron dextran (200 mg)	IM injection
7–14 days	- Castration (if applicable) - Deworming	Albendazole / Piperazine	Oral / as per label
	- Vitamin supplementation	Multivitamin (esp. A, D, E)	Oral or injection
		E. coli + *Clostridium perfringens*	IM
4–6 weeks	- ***Weaning***		
	- De-worming repeat	Albendazole / Fenbendazole	Oral / as per label
	- Vaccination	**FMD (Foot and Mouth Disease)**	2 ml IM
		Swine Fever	1 ml SC / IM
8–10 weeks	Booster vaccination	**FMD booster**	2 ml IM
12–14 weeks	**- Vaccination**	Swine Erysipelas	2 mL IM

Regular Practices

- Deworming: Every 2 months for all age groups
- Ectoparasite control: Use ivermectin or sprays against lice, mange
- Biosecurity: Maintain hygiene, footbath, limit farm entry
- Record keeping: Track vaccinations, deworming, growth, and disease history
- Follow regular deworming, ectoparasite control, and biosecurity protocols.

6. Pig Waste Management

Pig farming generates significant waste in the form of solid manure and liquid slurry. While rich in nutrients, pig waste can harm the environment and health if not managed correctly.

Toxicity and Environmental Impact

Unmanaged pig waste contains harmful pathogens, heavy metals (Cu, Zn), and drug residues. Its decomposition releases toxic gases like methane, ammonia, and hydrogen sulphide, contributing to:

- **Water pollution:** Runoff contaminates rivers and groundwater.
- **Air pollution:** Gases affect worker and animal health; methane contributes to climate change.
- **Soil degradation:** Over-application causes nutrient overload and heavy metal accumulation.
- **Biosecurity threats:** Improper disposal spreads diseases among animals and humans.

Pig Waste Management Methods

1. **Proper Storage**
   - ***Liquid**:* Use lined lagoons or concrete pits with covers.
   - ***Solid**:* Store in covered sheds with impermeable flooring and good drainage.
2. **Composting**
   - Controlled decomposition reduces volume and kills pathogens.
   - Methods: Windrow, static pile, in-vessel, vermicomposting.
3. **Anaerobic Digestion**
   - Converts waste into biogas (energy) and digestate (fertiliser).
4. **Land Application**
   - Apply treated manure based on soil testing and crop requirements.
   - Avoid before rain or on frozen soil.
5. **Wastewater Treatment**
   - Use mechanical, biological, or chemical systems to clean slurry.
6. **Incineration**
   - Safely burns unusable waste. Reduces volume by 90%, destroys pathogens, and avoids methane emission.

7. Economics of T&D Pig Farming: (30 Female + 3 Male Unit)

T&D crossbred pigs (Tamworth x Desi), developed by Birsa Agricultural University, Ranchi, are highly profitable black-coloured, disease-resistant pigs designed for eastern India. T&D pigs are considered highly remunerative for rural farmers in Jharkhand, Bihar, West Bengal, and the Northeast. Their black color increases their acceptability at the local market level.

1. Basic Assumptions

- Breed: T&D (Tamworth × Desi)
- Unit size: 30 breeding sows + 3 boars
- Farrowing rate: 2 litters/sow/year
- Average litter size: 8 piglets
- Piglet mortality: 10%
- Piglets weaned per sow/year: ~14
- Total piglets produced/year: 30 × 14 = 420 piglets
- Market age body weight: 75 kg
- Sale price: Rs.250/kg live weight
- Average sale value per pig: 75 kg × Rs.250 = ₹ 18,750

2. Fixed Capital Investment

Particulars	Amount (Rs.)
Pig shed construction (breeding, grower & boar pens)	6,00,000
Breeding stock (30 sows @ Rs.18,000)	5,40,000
Boars (3 @ Rs.20,000)	60,000
Feeding & watering equipment	60,000
Miscellaneous & contingency	40,000
Total Fixed Cost	**13,00,000**

3. Annual Recurring Cost

Particulars	Amount (Rs./year)
Feed cost (breeders + growers)	18,00,000
Labour (1 skilled + 1 helper)	2,40,000
Veterinary care, medicines & vaccination	80,000
Electricity, water & sanitation	40,000
Insurance & miscellaneous expenses	40,000
Total Recurring Cost	**22,00,000**

4. Total Annual Cost: Rs.**22,00,000** (Fixed capital excluded from annual cost calculation)

5. Annual Returns

Particulars	Amount (Rs.)
Sale of 420 market pigs @ ¹ 18,750	**78,75,000**
Sale of manure & farm waste	50,000
Gross Annual Income	**79,25,000**

6. Net Profit

Net Profit = Gross Income – Recurring Cost

Rs. 79,25,000 – Rs.22,00,000 = Rs.57,25,000 per year

7. Benefit–Cost (B:C) Ratio

$$\text{B : C Ratio} = \frac{79.25}{22.0} = 3.60$$

Common Terminology Used in Swine Rearing

Term		Meaning
Boar	:	An adult male pig used for breeding
Sow	:	An adult female pig that has farrowed (given birth)
Gilt	:	A young female pig that has not yet farrowed
Piglet	:	A baby pig (up to weaning)
Weaner	:	A pig that has just been weaned (generally 6–8 weeks old)
Grower	:	A pig in the growing phase (up to 40–60 kg)
Finisher	:	A pig being fattened for slaughter (60–100 kg or more)
Barrow	:	A castrated male pig
Stag	:	An older castrated male pig (after sexual maturity)
Estrus (Heat)	:	The period when the female is receptive to mating
Estrous Cycle	:	Reproductive cycle of the female (~21 days)
Ovulation	:	Release of eggs from the ovary
Mating	:	Natural breeding or artificial insemination
Conception	:	Fertilization and establishment of pregnancy
Gestation	:	Pregnancy period in pigs (~114 days)
Farrowing	:	Act of giving birth in pigs
Lactation	:	Milk production period after farrowing
Weaning	:	Separation of piglets from the sow (usually at 30–45 days)
Deworming	:	Process of removing internal parasites using anthelmintics
Vaccination	:	Giving vaccines to prevent diseases
Biosecurity	:	Measures taken to prevent disease entry and spread
Quarantine	:	Isolating animals to observe for diseases
Culling	:	Removal of animals from the herd due to poor performance or health
Scouring	:	Diarrhea in piglets or adults (common in young piglets)
Creep Feed	:	Starter feed given to suckling piglets from 7–10 days of age
Balanced Ration	:	Feed containing all essential nutrients in correct proportions
Ad libitum	:	Feeding animals as much as they want (free access)
Feed Conversion Ratio (FCR)	:	Amount of feed required to gain 1 kg of body weight
Pen	:	Enclosed area where pigs are kept
Creep Area	:	Warm space in the farrowing pen for piglets
Farrowing Crate	:	Special pen to house a sow during farrowing and lactation
Slatted Floor	:	Flooring that allows manure to fall through for cleanliness
Stocking Density	:	Number of animals per unit area of housing
Live Weight	:	Weight of the pig before slaughter
Dressed Weight	:	Weight of the carcass after removal of blood, skin, gut, etc.
By-products	:	Non-meat products like bristles, fat, organs
Slaughter Age	:	Commonly 6–7 months for market pigs

06
CHAPTER

Poultry

Rakesh Kumar, S Dayal, P C Chandran, Rajni Kumari, P K Ray, Jyoti Kumar and Reena Kamal

Poultry farming has emerged as one of the most dynamic and rapidly expanding components of the livestock sector in Bihar and the eastern region of India, contributing significantly to food and nutritional security, employment generation, and rural livelihoods. The eastern states, including Bihar, Jharkhand, West Bengal, Odisha, and eastern Uttar Pradesh, together account for a substantial share of the country's backyard poultry population, highlighting the importance of poultry as a household-level enterprise among small and marginal farmers. In Bihar, poultry rearing is widely practiced under backyard and semi-intensive systems due to small landholdings, availability of family labour, and increasing local demand for eggs and poultry meat. Eggs and poultry meat are rich sources of high-quality protein, essential amino acids, vitamins, and minerals and are widely accepted across socio-economic and cultural groups in the region.

Backyard poultry farming holds special significance in tribal and resource-poor areas of the eastern region, where it provides a reliable source of nutrition, supplementary income, and livelihood diversification. The region possesses a diverse poultry genetic resource base, comprising indigenous birds such as desi poultry of Bihar and eastern Uttar Pradesh, Hansli of Odisha, and indigenous village poultry of West Bengal and Jharkhand, which are valued for their adaptability, disease tolerance, and consumer preference. To improve productivity under low-input systems, improved dual-purpose varieties such as Vanaraja, Srinidhi, Gramapriya, Giriraja, and Kuroiler have been widely introduced, as they combine better egg and meat production with adaptability to local agro-climatic conditions and scavenging-based feeding systems.

Despite its considerable potential, poultry farming in Bihar and the eastern states faces several constraints, including high chick mortality, frequent disease outbreaks, inadequate housing, imbalanced feeding, weak biosecurity measures, and limited access to technical knowledge and veterinary services. Seasonal climatic stress, poor-quality inputs, and unorganized marketing further affect productivity and profitability, particularly among backyard and smallholder poultry farmers. Adoption of scientific and region-specific poultry management practices is therefore essential to enhance productivity, reduce losses, and ensure sustainability. A Package of Practices (POP) offers a systematic and farmer-friendly guideline covering all major aspects of poultry production. This chapter presents a comprehensive POP for poultry management applicable to backyard, semi-intensive, and small commercial systems prevalent in Bihar and the eastern region of India, with the aim of improving income, nutritional security, and livelihood sustainability.

Types of poultry farming systems:

Poultry farming can be broadly classified into three systems

Backyard poultry system

- Involves rearing small flocks of about 10-50 birds with minimum external inputs.
- Birds are allowed to scavenge freely during the day for kitchen waste, insects, grains, and greens, and are housed safely at night to protect them from predators and theft.
- Indigenous or improved dual-purpose birds (egg and meat type) are preferred due to their hardiness and disease resistance.
- Requires low investment, simple housing, and family labour, making it highly suitable for tribal, rural, and marginal farmers, women, and landless households.
- Provides regular income, household nutrition (eggs and meat), and acts as a risk-buffer livelihood activity.

Semi-intensive poultry system

- Birds are reared under partial confinement with access to an open run, allowing limited scavenging along with supplementary feeding.
- This system offers a balance between productivity and cost, combining the advantages of backyard and intensive systems.
- Requires moderate housing, fencing, and feeding inputs compared to intensive systems.
- Suitable for small and marginal farmers who want higher production than backyard poultry with manageable investment and risk.

Intensive poultry system

- Birds are fully confined under deep litter or cage systems with complete dependence on formulated commercial feed.
- Requires well-designed housing, strict biosecurity, proper feeding, and health management practices.
- Involves high initial investment but results in high productivity and faster returns when managed properly.
- Commonly practiced in commercial broiler and layer farming and suitable for farmers with adequate capital, market access, and technical knowledge.

Breed selection and procurement of chicks

Selection based on purpose

- Egg production: White leghorn, Brown leghorn, etc.
- Meat production: Commercial broilers (Cobb, Ross strains), etc.
- Dual-purpose/backyard: Vanaraja, Gramapriya, Kuroiler, Rainbow rooster, etc.

Procurement of chicks:

Day-old chicks (DOCs) should be procured from reputed hatcheries. Healthy chicks are active, alert, uniform in size, free from deformities, and have well-healed navels. Transportation stress should be minimized.

Housing Management:

Proper housing protects birds from predators, adverse weather, and diseases while ensuring comfort and productivity.

Site Selection

- Elevated, well-drained land
- Away from residential areas
- Availability of clean water and electricity
- Proper road connectivity

Housing systems

- Backyard shelter: Simple night shelter using bamboo, wood, or bricks
- Deep litter system: Most common for broilers and layers
- Cage system: Mainly for commercial layer farms

Floor space requirement

- Chicks (0-6 weeks): 0.5-1.0 sq. ft/bird
- Growers (7-18 weeks): 1.5-2.0 sq. ft/bird
- Adults: 2.5-3.0 sq ft/bird

Ventilation and lighting

Adequate ventilation is essential to remove moisture and harmful gases. Layers require 16-18 hours of light daily to maintain egg production. The backyard and semi-intensive poultry rearing practices commonly adopted by rural farmers are illustrated in Fig. 1.

Fig. 1 Backyard and semi-intensive poultry rearing systems adopted by rural farmers (Source: Author's illustration, adapted from FAO, 2020)

Brooding management

Brooding management refers to the care and management of chicks from day-old to about six weeks of age and is a critical phase determining chick survival and future performance.

- Proper brooding ensures adequate warmth, comfort, nutrition, and protection from environmental and management-related stress.
- Maintenance of optimum brooder temperature during the brooding period is essential for normal growth and health of chicks.
- Good ventilation without draught, clean and dry litter, and sufficient floor space should be ensured throughout the brooding period.
- Chicks should be provided with early access to clean and fresh drinking water and a balanced starter feed.
- Regular observation of chick behaviour helps in identifying temperature stress and management problems at an early stage.
- Proper brooding management helps in reducing early chick mortality and promotes uniform growth of the flock. The recommended brooder temperatures for different age groups of chicks are presented in Table 1.

Table 1: Brooder temperature schedule

Age	Temperature (°C)
1st week	32–34
2nd week	30–32
3rd week	28–30
4th week	26–28
5-6 weeks	24–26

(The brooder temperature should be adjusted based on chick behaviour, with crowding indicating cold stress and panting or wide dispersion indicating excessive heat.)

Temperature management

- 1st week: 32-34°C
- Reduce by 2-3°C per week until ambient temperature is reached
- Chick behaviour should guide temperature adjustments.

Early chick care

- Provide glucose and multivitamins in drinking water for the first 48 hours
- Initiate feeding within 2 hours of arrival
- Maintain dry and clean litter

Feeding and nutritional management

- Feeding and nutritional management is a key determinant of growth, egg production, health, and overall profitability in poultry farming.
- Poultry birds require a balanced diet containing adequate energy, protein, vitamins, and minerals for optimum performance.
- Any deficiency or imbalance in nutrients adversely affects bird health and productivity.
- The nutritional requirements of poultry vary with age and purpose of rearing; therefore, birds should be fed age-specific rations such as:
- Starter feed (0-6 weeks)
- Grower feed (7-18 weeks)
- Layer feed (19 weeks onwards)
- Finisher feed in broilers (5-6 weeks)
- Under practical field conditions, farmers may either use commercially available compound feeds or prepare rations using locally available ingredients following standard feeding guidelines.
- Feed should always be fresh, free from fungal contamination, and supplied in adequate quantity.
- Clean and fresh drinking water must be available at all times, as water intake directly affects feed consumption and productivity. The recommended nutrient composition of different poultry feeds and the ingredient-wise feed composition suitable for farmers are presented in Table 2 and Table 3, respectively.

Table 2: Recommended nutrient composition of poultry feed

Feed type	Age group	Crude protein (%)	Metabolizable energy (kcal/kg)	Remarks
Starter feed	0–6 weeks	20–22	2800–2900	Rapid growth and development
Grower feed	7–18 weeks	16–18	2600–2700	Body and frame development
Layer feed	18 weeks onwards	16–17	2600–2700	High calcium requirement
Broiler finisher	After 4 weeks	18–19	≥3000	Efficient meat production

(Source: BIS 2007)

Table 3: Ingredient composition (%) of poultry feed for farmers

Ingredient	Starter	Grower	Layer
Maize	50	56	51
Soybean meal / Groundnut cake	30	25	20
Rice bran / Wheat bran	10	12	15
Fish meal / Meat meal	5	3	3
Mineral mixture	2	2	2
Limestone / Shell grit	2	1	8
Common salt	0.5	0.5	0.5
Vitamin premix	0.5	0.5	0.5

(Source: Sastry and Thomas 2015)

Feeding Practices and Water Management (Farmer Tips)

- Provide balanced feed ad libitum for better growth and production.
- Use clean feeders and adjust them to the back height of birds to reduce wastage (Fig.2)
- Never offer wet, moldy, or spoiled feed.
- Introduce any change in feed gradually over 4-5 days.
- Ensure continuous supply of clean and fresh drinking water.
- Wash and disinfect waterers daily (Fig.2).
- Keep waterers in shaded and cool places, especially during summer.
- Provide adequate number of drinkers to avoid competition and stress.
- Add vitamins and electrolytes in drinking water during heat stress or disease conditions.

Fig. 2 Feeder and drinker arrangements under backyard and semi-intensive poultry systems

Health care and vaccination

- Health care and timely vaccination are essential for maintaining good health, productivity, and profitability in poultry farming.
- Clean and dry housing, regular cleaning and disinfection of sheds and equipment, balanced feeding, and continuous supply of clean drinking water help in reducing the incidence of diseases.
- Poultry birds are commonly affected by major diseases such as Newcastle disease (Ranikhet), Infectious Bursal Disease (Gumboro), fowl pox, coccidiosis, and worm infestation, which can cause serious economic losses if not properly managed.
- Vaccination is the most effective and economical method for preventing major infectious diseases in poultry and should be carried out strictly according to the recommended vaccination schedule.
- Along with vaccination, regular observation of birds for early signs of illness and immediate isolation of sick birds are necessary to prevent the spread of diseases.
- Adoption of proper biosecurity practices and timely veterinary support help in maintaining a healthy flock and ensuring sustainable poultry production. The major poultry diseases, their symptoms, and preventive measures, along with the recommended vaccination schedule, are presented in Tables 4 and 5, respectively.

Table 4: Common poultry diseases, major symptoms and preventive measures

Disease	Major symptoms	Preventive measures
Newcastle disease (Ranikhet)	Respiratory distress, greenish diarrhoea, nervous signs	Vaccination, biosecurity
Infectious Bursal Disease (Gumboro)	Depression, ruffled feathers, watery diarrhoea	Timely vaccination, clean litter
Fowl pox	Scabs and nodules on comb, wattles, and skin	Vaccination, mosquito control
Coccidiosis	Bloody diarrhoea, weakness, poor growth	Dry litter, anticoccidial drugs
Worm infestation	Weight loss, poor growth, reduced egg production	Periodic deworming, sanitation
Colibacillosis (E. coli)	Diarrhoea, reduced feed intake, mortality	Clean water, hygienic housing

(Source: ICAR 2013; Sastry and Thomas 2015)

Table 5: Vaccination schedule for poultry birds (Broilers and Layers)

Age of birds	Disease	Vaccine	Route of administration	Broiler	Layer
Day-old (at hatchery)	Marek's disease (MD)	MD vaccine (HVT / Rispens)	Subcutaneous / Intramuscular	✓	✓
5–7 days	Newcastle disease (Ranikhet) Infectious	Lasota	Eye drop / nasal drop	✓	✓
14–16 days	Bursal Disease (Gumboro) Infectious	IBD vaccine	Drinking water	✓	✓
21–24 days	Bursal Disease (Booster)	IBD booster	Drinking water	✓	✓
4 weeks	Newcastle disease	Lasota (Booster)	Drinking water	✓	✓
6–8 weeks	Fowl pox	Fowl pox vaccine	Wing web	✗	✓
8–10 weeks	Newcastle disease	R2B / Killed ND	Intramuscular	✗	✓
16–18 weeks (pre-lay)	Newcastle disease	Killed ND	Intramuscular	✗	✓
Every 3 months (laying period)	Newcastle disease	Lasota	Drinking water	✗	✓

(Sources: ICAR 2013; FAO 2019; Sastry and Thomas 2015)

Litter and waste management

- Proper litter and waste management plays an important role in maintaining bird health and preventing disease occurrence in poultry farms.
- Farmers should use dry and absorbent litter materials such as rice husk or sawdust.
- A litter depth of about 5-8 cm should be maintained for effective moisture absorption.
- Wet, caked, or foul-smelling litter should be removed immediately to avoid disease buildup.
- Litter should be stirred regularly to keep it dry, loose, and well-aerated.
- Used litter and poultry waste should be removed after each batch of birds and can be composted and utilized as organic manure.
- Dead birds must be disposed off safely through methods such as deep burial or incineration to maintain farm hygiene and prevent the spread of diseases.

Biosecurity measures

- Restrict entry of unauthorized persons and vehicles into the poultry farm.
- Provide footbaths with disinfectant at the entrance of poultry sheds.
- Maintain separate footwear and clothing for use inside the poultry shed.
- Clean and disinfect sheds, equipment, feeders, and drinkers regularly.
- Purchase chicks only from reputed and disease-free hatcheries.
- Isolate sick or newly introduced birds from the main flock.
- Dispose of dead birds safely through deep burial or incineration.
- Control rodents, flies, and wild birds around the poultry house.
- Keep the farm surroundings clean and free from stagnant water.

Egg handling and management

- Collect eggs 2-4 times daily to prevent breakage and contamination.
- Use clean hands and clean collection trays or baskets during egg collection.
- Remove cracked, dirty, or misshapen eggs separately.
- Store eggs in a cool, clean, and dry place, preferably with the broad end up.
- Avoid washing eggs unless necessary; if washed, use clean lukewarm water and dry immediately.
- Protect eggs from direct sunlight, heat, and moisture.
- Market eggs as early as possible to maintain freshness and quality.

Record keeping

Farmers should maintain records on chick purchase, feed consumption, mortality, vaccination, medication, egg production, and sales. Proper records help in monitoring performance and profitability.

Common constraints and solutions

- High mortality: Improve biosecurity and vaccination
- Feed cost: Use locally available feed ingredients

- Disease outbreaks: Early diagnosis and veterinary support
- Integration with Farming Systems: Poultry farming integrates well with crop production, fish farming, horticulture, and homestead farming systems. Poultry manure improves soil fertility and reduces chemical fertilizer use.

Marketing and economics: Marketing and profitability of poultry farming vary with the production system. Backyard and semi-intensive systems provide regular income from eggs and sale of culled birds, while broiler farming gives quick returns in a short period. The comparative economics of different poultry systems for 20 birds are presented in Table 6.

Table 6. Comparative economics of poultry farming systems (20 Birds)

Particulars	**Backyard Poultry (Layer)**	**Semi-Intensive**	**Broiler Poultry Poultry (Layer)**
Type of birds	Indigenous / Dual-purpose	Improved dual-purpose	Commercial broiler
Number of birds	20	20	20
Rearing period	12-15 months	12-15 months	35-45 days
Average eggs/bird/year	140	180	–
Total eggs produced (No.)	2,800	3,600	–
Selling price per egg (₹)	10	10	–
Income from eggs (₹)	28,000	36,000	–
Average body weight at sale (kg)	–	–	2.0
Selling price (₹/kg)	–	–	120
Income from broilers (₹)	–	–	20 birds × 2 kg × ₹120 = 4,800
Sale of culled birds (₹/bird)	₹400	₹450	–
Number of culled birds (No.)	15	15	–
Income from culled birds (₹)	6,000	6,750	–
Gross income (₹)	34,000	42,750	4,800
Cost of chicks (₹)	1,600	1,800	1,200
Feed cost (₹)	7,000	12,000	2,800
Health care & vaccination (₹)	1,000	1,200	500
Housing & miscellaneous (₹)	1,000	1,000	500
Total expenditure (₹)	10,600	16,000	5,000
Net income (₹)	23,400	26,750	–200*
Benefit-Cost (B:C) ratio	3.21: 1	2.67: 1	0.96: 1

(* Net income from broilers may increase significantly when birds are sold at higher market price or reared in multiple batches per year; Sources: ICAR 2013; Sastry and Thomas 2015; KVK field estimates)

Conclusion

Poultry farming is a profitable and sustainable enterprise for small, marginal, and landless farmers when scientific management practices are followed. Adoption of appropriate housing, balanced feeding, timely vaccination, proper litter management, and effective biosecurity measures ensures better health and productivity of birds. Backyard and semi-intensive poultry systems provide regular income through egg production, while broiler farming offers quick returns within a short period. Overall, poultry farming plays an important role in improving household nutrition, income generation, and livelihood security of farming communities.

References

Relevant references are available with the authors and can be provided on request.

07
CHAPTER

Duck

Rajni Kumari, M K Tripathi, P K Ray, S Dayal, Jyoti Kimar, Rakesh Kumar and P C Chandran

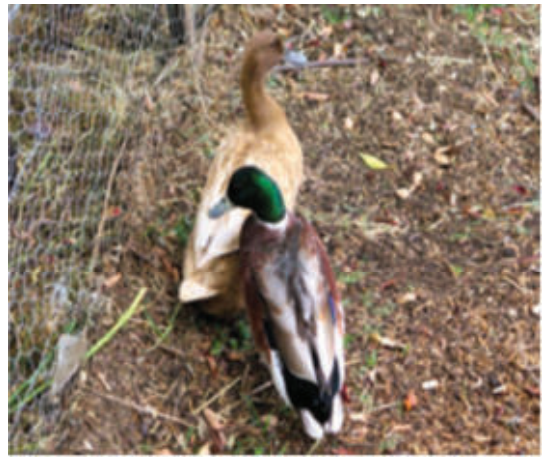
Ducks are hardy, fast-growing birds well suited for wetlands, paddy fields, and scavenging-based systems. They require less care than chickens, have high disease resistance, and produce nutrient-rich eggs.

1. Breeds and Strains

Egg-type ducks

(i) Khaki Campbell

- Developed by crossing between Mallard, Rouen and Runner ducks.
- Come in three colour varieties: khaki, dark and white.
- The Khaki Campbell drake is mostly khaki-coloured with a darker head usually olive green lacking the white ring of its Mallard ancestors.
- The Khaki Campbell duck has a more modest plumage of Khaki covering the entirety of the body.
- In male head, neck, wing is lustrous green colour.
- Average egg production is 280–320 eggs/year.



(ii) Indian Runner

- Indian Runner ducks are domesticated waterfowl from the archipelago of the East Indies (Indonesia)
- Upright, penguin-like stance and ability to run rather than waddle
- Wings are small and they cannot fly.
- The head is long, narrow, and wedge-shaped, with eyes placed high on the head.
- Height can range from 50 to 76 cm (20 to 30 inches) depending on sex.
- The three standard varieties are fawn and white, white, and penciled, with various colorations and markings.
- Average egg production is 250–280 eggs/year

Meat-type ducks

(i) Pekin

- Originated from China.
- They are large and white feathered birds
- Bill and legs are deep orange.
- White pekin is popular called as Emperor Duck.
- Having efficient feed efficiency
- Popular meat market breed.
- Fast growth, 2.5 3.5 kg in 7 weeks

Dual-purpose

(i) Nageswari

- Indigenous breed from Bangladesh and Assam,
- characterized by its black plumage with a white stripe from the neck to the breast, and eggs with a bluish tinge.
- They have a "head-high snake-like posture"
- Average egg production is 100–150 eggs per year, which average about 60 to 67 grams in weight

(ii) Maithili

- Head is bright black to greenish black in drakes and brown in ducks.
- Tail is brown to black.
- Plumage pattern is mosaic.
- Circular spots on the feathers in ducks. Body carriage is slightly upright and bill shape is horizontal. The average annual egg production per duck ranges from 30–60 eggs per annum

2. Housing Management

A. Space Requirements

Age / Type	Floor Space	Waterer Space	Feeder Space
Ducklings (0–2 wks)	0.05–0.07 m^2/bird	1 cm/bird	2–3 cm/bird
Growers (8–20 wks)	0.15–0.20 m^2/bird	2 cm/bird	6–7 cm/bird
Layers	0.25–0.30 m^2/bird	2–3 cm/bird	10–12 cm/bird

B. Housing Type

- Backyard: Simple night shelter, bamboo/country wood shed.
- Semi-intensive: House + open run + water access.
- Intensive: Deep litter system with proper ventilation.

C. Floor Litter

- Rice husk, sawdust, chopped straw (8–10 cm depth).

D. Environmental Needs

- Temperature 20–30°C
- Good air movement (avoid dampness)
- Provide bathing/pond access for 1–2 hours daily in semi-intensive systems.

3. Brooding Management (0–3 weeks)

Temp Schedule

- Week 1: 30–32°C
- Week 2: 26–28°C
- Week 3: 24–26°C

Brooding Tips

- Use deep trays with warm water to prevent chilling.
- Provide non-slip flooring (jute sack/paper).
- Avoid overcrowding.
- Allow drinking water depth such that ducklings can dip their nostrils but not submerge themselves.

4. Feeding Management

A. Nutrient Requirements

Stage	CP %	ME (kcal/kg)	Ca %	Av. P %
Starter (0–3 wks)	20–22	2800	1.0	0.45
Grower (3–20 wks)	15–16	2600	0.9	0.40
Layer	18–19	2700	3.0–3.5	0.35–0.40
Broiler/Meat	20–22	2800–2900	1.0	0.45

B. Feeding

- No need for finely ground feed; ducks accept coarser mash.
- Provide wet mash for better intake (not too watery).
- Allow free-range scavenging when possible (snails, small fish, insects).
- Provide grit for digestion (3–5 g/day).
- Provide ad-lib clean drinking water.

5. Water Management

- Ducks require water for drinking + cleaning nostrils + bathing.
- In intensive systems, allow 15 minutes pool access twice daily.
- Avoid dirty stagnant water to prevent infections.

6. Breeding Management

- Sex ratio – 1:5 (drake: duck)
- Laying begins at 20–24 weeks.

- Provide nest boxes: 1 nest per 4 birds.
- Collect and store eggs at 12–15°C before incubation (max 7 days).

Incubation

- Temperature: 37.5°C
- Humidity: 65% (day 1–24), 75% (day 25–27)
- Turning: 4–6 times/day
- Duck hatching period: 28 days (Muscovy: 35 days)

7. Health Management

Vaccination Schedule

Age	Vaccine
7–10 days	Duck Plague (optional in low-risk areas)
3 weeks	Duck Cholera
6 weeks	Ranikhet/ND (Lasota)
16–18 weeks	Booster: Duck Plague / Cholera

Common Diseases

- Duck Plague (Duck Viral Enteritis)
- Duck Cholera (Pasteurellosis)
- Botulism
- Colibacillosis
- Aflatoxicosis
- Parasitism (trematodes, roundworms)

Biosecurity

- Clean litter
- Proper water sanitation
- Rodent control
- Prevent access to wild birds

8. Economic Performance (Typical)

- **Egg ducks**: 250–300 eggs/year
- **Feed intake**: 120–150 g/day
- **Feed conversion**: 2.8–3.0 (egg), 2.5–2.7 (meat ducks)
- **Broiler ducks**: 2.5–3.0 kg in 45–55 days

9. Backyard Duck Farming

- Allow paddy field/pond access for natural feeding.
- Supplement morning & evening with 60–70 g concentrate.
- Provide night shelter to avoid predators.
- Rotate grazing areas to prevent parasitism.

10. Marketing

- Sell eggs locally (good demand in NE & South India).
- Meat ducks fetch premium price in Kerala, Bengal, Assam.
- Value addition: salted eggs, balut, smoked duck meat.

11. Do's & Don'ts

✔ **Do**

- Provide clean water daily
- Vaccinate on time
- Ensure dry flooring
- Provide proper nesting materials

✘ **Don't**

- Don't allow ducklings to swim in deep water
- Don't keep ducks on wet, muddy floors
- Don't feed stale moldy feed
- Don't overstock

12. Economics

I. ECONOMICS OF BACKYARD DUCK FARMING (20 LAYERS)

A. Initial Investment

Item	Unit Cost (₹)	Total (₹)
Ducks (20 × ₹ 250)	250	5,000
Night Shelter	–	6,000
Feeders/Drinkers	–	1,000
Miscellaneous	–	1,000
Total Initial Investment		**13,000**

B. Recurring Costs (Annual)

Item	Quantity	Rate	Amount (₹)
Feed (100 g/day × 20 birds = 2 kg/day →730 kg/year)	730 kg	₹ 28/kg	**20,440**
Health + Vaccination	–	–	1,000
Miscellaneous	–	–	1,000
Total Recurring Cost			**22,440**

C. Income

Source	Calculation	Amount (₹)
Egg sale (220 eggs per bird/year × 20 = 4,400 eggs × ₹ 8)	4,400 × 8	**35,200**
Culling sale (20 birds × ₹ 200)	–	**4,000**
Total Income		**39,200**

D. Profit

Net Profit = 39,200 – 22,440 = ₹ 16,760/year

ROI (Return on Investment): **75–80%**

II. ECONOMICS OF COMMERCIAL LAYER DUCK FARMING (200 LAYERS)

(Khaki Campbell / Indian Runner)

A. Capital Investment

Item	Amount (₹)
Shed/House (800 sq ft @ ₹ 250/sq ft)	2,00,000
Fencing/open run	20,000
Feeders/Drinkers	15,000
Water tank/system	10,000
Brooder setup	10,000
Birds (200 growers @ ₹ 250)	50,000
Total Capital Investment	**3,05,000**

B. Recurring Cost (Annual)

1. Feed Cost

- Laying ducks eat **140 g/day**
- 200 ducks → 28 kg/day
- Annual feed = 28 × 365 = **10,220 kg ~ 10.2 tons**

If feed price = ₹ 28/kg:

Feed cost = 10,220 × 28 = ₹ 2,86,160

2. Other Costs

Item	Amount (₹)
Labour (1 person)	72,000
Health & Vaccination	10,000
Electricity/Water	8,000
Litter material	5,000
Maintenance/misc	10,000
Total Other Costs	**1,05,000**

Total Recurring Cost = Feed + Other = 2,86,160 + 1,05,000 = ¹ 3,91,160

C. Income from 200 Layers

Source	Calculation	Amount (₹)
Eggs (280/bird/year × 200 = 56,000 eggs × ₹ 8/egg)	56,000 × 8	**4,48,000**
Sale of culled ducks (200 × ₹ 250)	–	**50,000**
Manure sale	–	5,000
Total Income		**5,03,000**

D. Net Profit

Net Profit = 5,03,000 – 3,91,160 = ₹ 1,11,840 / year

Profit per bird: **₹ 560–600**

Break-even period: **1.5–2 years**

III. ECONOMICS OF BROILER DUCK FARMING (PEKIN – 300 BIRDS)

Batch length: 7 weeks

FCR: 2.7–2.8

Final weight: 2.8–3.2 kg

A. Initial Investment (One-time)

Item	Amount (₹)
Shed (600 sq ft)	1,20,000
Equipment	25,000
Brooder setup	10,000
Miscellaneous	10,000
Total Capital	**1,65,000**

B. Recurring Cost (Per Batch)

1. Cost of Chicks

300 ducklings × ₹ 60 = **₹ 18,000**

2. Feed Cost

- Market weight 3 kg
- FCR 2.7 → Feed per duck = 8.1 kg
- For 300 ducks → 8.1 × 300 = **2,430 kg feed**
- Feed price = ₹ 28/kg → **₹ 68,040**

3. Other Costs

Item	Amount (₹)
Electricity	3,000
Labour	15,000
Medicine/vaccination	3,000
Litter material	2,000
Miscellaneous	4,000
Total Other Costs	**27,000**

Total Recurring Cost (Batch)

= Ducklings 18,000 + Feed 68,040 + Others 27,000

→ **₹ 1,13,040**

C. Income (Batch of 300)

Source	Calculation	Amount (₹)
Meat sale (avg 3 kg × ₹ 220/kg × 270 birds after 10% mortality)	810 kg × 220	**₹ 1,78,200**
Sale of manure & feathers	–	2,000
Total Income		**₹ 1,80,200**

D. Net Profit (Per Batch)

₹ 1,80,200 – 1,13,040 = ₹ 67,160

If 5 batches/year:

Annual Profit H ~ ₹ 3.3 lakh

Additional Economic Ratios & Indicators

1. Feed Conversion Efficiency

- Layers: 2.8–3 kg feed per dozen eggs
- Broilers: 2.7 FCR (excellent for ducks)

2. Mortality

- Brooding: 4–5%
- Grower: 1–2%
- Broiler: 8–10%

3. Benefit: Cost Ratio

- Backyard: 1: 1.7
- Commercial layers: 1: 1.25
- Broilers: 1: 1.6

4. Payback Period

- Backyard: 1 year
- Commercial: 18–24 months
- Broiler: 6–8 months

❐

08 CHAPTER

Fodder production

Manoj Kr Tripathi, Amitava Dey, Rajni Kumari, Shanker Dayal, Jyoti Kumar and P K Ray

Importance of feeding of Green Fodder:

Insufficient feeding of green fodder leads to :

- Decreased milk and meat production
- Inefficient reproduction: anestrus, repeat breeding and other infertility problems
- Digestive problems to animal
- Decreased immunity and poor health condition.
- To compensate green fodder feeding, farmer has to give concentrate feed that will increase feed cost.

Status of Fodder in India and Eastern states:

- Land available for cultivation of green fodder crops in India has remained static at around 5% of the total cropped area for the last few decades.
- Total green fodder requirement in India and states like Bihar, Jharkhand, Odisha, West Bengal, Chhattisgarh, Uttar Pradesh and Assam is 827189.3, 49406.6, 24358.6, 27700.6, 35915.8, 24430.8, 149959.2 and 22735.7 thousand tones respectively (Ajoy *et al*. 2019)
- The availability of the total green fodder in the country and the aforementioned states are 734193.8, 35399.1, 7856.8, 15277.7, 22211.7, 16339, 114499.5 and 17988.1, thousand tones respectively. (Ajoy *et al.* 2019)
- Thus, there is Percent -deficit of total green fodder in India and above states are 11.24, 28.40, 67.70, 44.80, 38.20, 33.10, 23.60, and 20.90 respectively (Ajoy *et al*. 2019)
- Total dry fodder requirement in India and states like Bihar, Jharkhand, Odisha, West Bengal, Chhattisgarh, Uttar Pradesh and Assam is 426105.3, 27857.2, 13560, 16120.2, 19943.1 15083.5, 73513 and 13007.8 thousand tones respectively (Ajoy *et al.* 2019)
- The availability of the total dry fodder in the country and above states are 326399.2, 12142.8, 6378.6, 18199.1, 6760.9, 16557.4, 51143.8 and 9614.7 thousand tones respectively (Ajoy *et al.* 2019)
- Thus, there is Percent deficit/surplus of total dry fodder in India and above states are -23.4, -56.40, -53.00, 12.90, -66.10, 9.8, -30.4 and -26.10 respectively (Ajoy *et al.* 2019).
- Reason of fodder shortage- Low land holding, negligible area under cultivated fodder, poor animal husbandry practices (Gupta *et al*. 2014).

- To get maximum return from our livestock sufficient and good quality fodder production is essential.
- Therefore, following package of practices of round the year fodder production and its balanced feeding system to livestock should be followed by the farmers to increase the profitability.

Different fodder crops grown round the year

- Fodder crops to grow in main crop land: The annual fodder like cereal fodder (maize, sorghum, oat etc.) or legume fodder (berseem, Lucerne, cow pea, rice bean, soybean, pigeon pea, horse gram etc.) are grown in main crop land.
- Fodder crops to grow under raised bed or at boundary on bunds: Perennial grass/legume fodders like Napier, Guinea, Deenanath, Para, Stylosanthes etc. are grown on main land under raised bed or at boundary on bunds.
- Fodder trees/shrubs to be planted at boundary: Fodder trees/shrubs like Moras Alba, Subabul, Tephrosia, Artocarpus, and Ficus etc. can be planted at boundary.
- Alternate sowing of cereal and legume fodder practice should be followed for soil fertility point of view.
- Different types of forages can be grown for round the year production in combination of cereal and legume for more nutritive value of forage and balance feeding.

The fodder crops grown during various seasons:

Rainy (Kharif) season:

- Multi cut Sorghum, Maize and Jowar/Bajra as cereal and cow pea (Bundel-2), rice bean (RBS-16) and soybeans (NRC-37) as legumes are grown during rainy (Kharif) season.
- Cereal fodders shall be grown under 85% area whereas, legumes could be cultivated under 15% area on up-land situation only.

Winter (Rabi) season:

- Cereal fodder oat under 40% area and legume fodder berseem/annual rye in 60% area shall be grown on same land during winter (Rabi) season.

Different fodder crops grown round the year

Types of Crop	Annual Fodder		Perennial Fodder
	Summer / Rainy Season	*Winter Season*	
Cereal	Multicut sorghum Maize Bajra/ Jowar	Oat Maize	Hybrid Napier Guinea Para Deenanath
Legume	Cow pea Rice bean Soybean	Berseem Rye Mustard	Stylosanthes Groundnut

Fodder Production Method

1. Hybrid Napier (Pennisetum purpureum)

Importance:

- It can grow at the boundary of plot on bunds for round the year production.
- Require attention in the beginning only.
- It is highly palatable and contains good amount of nutrients.
- Farmers can obtain 10-12 tons green fodder per annum from bunds area of 400m2 of one acre land (sufficient for two adult cattle @ 30kg green fodder per day)
- Land Preparation: Raised bed or bunds are prepared after adding of DAP @60kg and (750g/katha) with FYM @5t/ha.
- Sowing Time: During the month of June / July after few rainy days or before also if irrigation facility available.
- Root slip Rate: 50-60 thousand root slips of Napier var. CO3, CO4, IGFRI-6 etc. is required for one ha area.
- Sowing Method: Transplant 1-2 root slips of 25-30cm in length at one place on raised bed/ bund with the distance of plant-to-plant 50cm and row-to-row 100cm.

Irrigation and Inter-cultural Operation:

- During kharif: Irrigation is generally not required.
- During summer and winter: irrigations on need basis.
- Earthing up will require every year during winter season after application of FYM and DAP as initial stage.

Harvesting:

- First harvesting after 55-60 days of transplanting and subsequent cuttings at 60 days interval
- Total 5-6 cutting in a year.
- Total Forage Yield: 250-300 (t/ha)

Production Cost:

- Rs. 0.24/kg (first year) or Rs. 0.10/kg (subsequent years) considering different input expenditure.

2. Multi cut Sorghum (Sorghum sudanense)

Importance:

- very popular, very soft, succulent and palatable
- Fresh and tender fodder contain hydro-cyanic acid (toxic), hence after harvesting it should be kept in open air / sun at least 5-6 hours before safe feeding to avoid toxicity.
- Land Preparation: DAP @60kg/ha (750g/katha) with FYM @5t/ha at the time of land ploughing.

- Sowing Time: March – July.
- Sowing Method: Broadcasting or in line with distance of row-to-row 15cm.
- Seed Rate: Seed rate of multi cut Sudan var. Hybrid or MP Chari is 35kg/ha.

Irrigation and Inter-cultural Operation:

- During kharif season: generally, not required
- During summer: irrigation is provided after 4-5 days of germination.
- Second irrigation is required when plant attain knee height or as per need.
- Irrigation and top dressing of urea @40kg/ha will require after each fodder harvesting.

Harvesting:

- After 50-55 days of sowing when plant attains height of 140-150cm just before start of flowering.
- Second and third cutting: At 45-50 days of interval.

Production Cost:

- Multi cut Sudan fodder production cost is approximately Rs. 0.41/kg (without irrigation during rainy season) or Rs. 0.42/kg (with irrigation during summer) considering all expenditure
- Total Forage Yield: 80(t/ha)

3. Maize (Zea mays L.)

- Importance: very soft, succulent, juicy, and palatable
- The baby corn fodder, after harvesting of cobs: higher economic return as dual purpose crop
- So, the small and marginal farmers in eastern region who cannot spare land for fodder production for shake of food/cash crop production will have option to go for baby corn production as both cash and fodder crop.
- Land Preparation: DAP @ 60kg/ha (750g/katha) with FYM @5t/ha at the time of land plough
- Sowing Time: round the year. However, extreme cold weather may be avoided since it hampered growth and germination.
- Sowing Method: Line sowing is recommended. The distance between row-to-row and plant-to-plant is to be kept 30cm.
- Seed Rate: Seed rate of maize var. African tall, hybrid Shaktiman-4, baby corn var. VL-1 or local is 30kg/ha

Irrigation and Inter-cultural Operation:

- During kharif: Irrigation generally not required.
- During winter, 2 irrigations may be required, first after 10-15 days of germination and then earthing of soil.

- The second irrigation is required when plant attain knee height with subsequent top dressing of urea @ 40kg/ha (500g/katha).

Harvesting:

- After 85-100 days of sowing when plant attains height of 140-160cm and flowering started.

Production Cost:

- Maize fodder production cost is Rs. 0.56/kg (without irrigation) or Rs. 0.57/kg (with irrigation) considering different input expenditure.
- Maximum benefit cost ratio was obtained from baby corn (2.63) than hybrid maize (2.19) since it yielded 5.9t/ha green cob as an additional income.
- Total Forage Yield: Hybrid maize-55(t/ha); Baby corn (var.VL-1)- 20(t/ha)

4. Bajra (Pennisetum glaucum) or Jowar (Sorghum vulgare)

Importance:

- Important Kharif crop grown in dry or up-lands or as boundary of main cereal crop to check grazing by wild animals.
- Precaution: Fresh and tender fodder never to be fed to livestock since it contains hydro-cyanic acid.
- After harvesting fodder it should be kept in open air/sun for at-least 5-6 hours before feeding.
- Land Preparation: DAP @60kg/ha (750g/katha) with FYM @5t/ha at the time of land plough.
- Sowing Time: July – August under upland condition.
- Sowing Method: Broadcasting or in line with distance of row-to-row 15cm
- Irrigation: Normally irrigation is not required (during severe drought some irrigation is required.
- Seed Rate: 20kg/ha
- Harvesting: Fodder is harvested after 55-60 days of sowing at pre-flowering stage.
- Total Forage Yield: 40(t/ha)
- Production Cost: Rs. 0.71/kg

5. Oat (Avena sativa)

Importance:

- Important winter forage crop next to berseem, very much palatable, contains good amount of nutrients with more digestible energy than any cereal fodder and even berseem.
- Land Preparation: DAP @60kg/ha (750g/katha) with FYM @5t/ha at the time of land plough.
- Sowing Time: Rabi crop (October and November months).
- Sowing Method: Broadcasting or in line with distance of row-to-row 15cm.
- Irrigation: Crop is irrigated after 10-15 days of germination and then top dressing of urea @ 40kg/ha (500g/katha).
- Seed Rate: Seed rate of oat var. JHO-822 or Kent is 50kg/ha or 625g/katha
- Harvesting: Total 2 cutting can be taken and first cutting after 45-50 days of sowing when plant attains height of 25-35cm and next cutting- after 50-55 days

- Post -Harvest Operation: Irrigation just after harvesting and second irrigation after the gap of 20-25 days with top dressing of urea @ 40kg/ha (500g/katha).
- Total Forage Yield: 30(t/ha)
- Production Cost: Rs. 0.80/kg

6. Wheat (Triticum sativum)

Importance:

- It is recommended that wheat var. VL-829 can be grown as a dual purpose (fodder cum grain) crop to mitigate the gap of fodder scarcity.
- Harvesting of wheat as fodder reduces grain yield only 5-6% but overall total biomass yield increases 14-15 percent showing its economic significance.
- It is very much palatable and having high nutritive value similar to berseem
- Land Preparation: DAP @60kg/ha (750g/katha) with FYM @5t/ha at the time of land plough.
- Sowing Time: Beginning of November to mid- December.
- Sowing Method: Broadcasting or in line with distance of row-to-row 15cm.
- Irrigation: Crop is irrigated after 19-21 days of sowing and then top dressing of urea @ 60kg/ha
- Seed Rate: Seed rate of wheat var. VL-829 is 80kg/ha
- Harvesting: Wheat crop is harvested as fodder at 12cm from base height after 65-70 days of sowing.
- Post-Harvest Operation: Irrigation just after harvesting of fodder with subsequent application of urea @ 60kg/ha.
- Last irrigation is provided at 130 days of sowing when ear head emergence is completed with subsequent application of urea @ 40kg/ha.
- Total Forage Yield: 7-8(t/ha)

7. Berseem (Trifolium alexandrinum)

Importance:

- N-fixing legume fodder; contains high protein with soft leaves, tender stem available during the months from November to April.
- Land Preparation: DAP @60kg/ha (750g/katha) with FYM @5t/ha at the time of land plough.
- Sowing Time: October-November
- Sowing Method: Broadcasting after mixing with sand in the ratio of 1: 3 for proper distribution of seeds or in line with distance of row-to-row 30cm in dry land but irrigation immediately after sowing
- **Seed Rate**: Seed rate of berseem var. Hybrid Egypt or Wardan is 20kg/ha **Harvesting:**
- Total 4-5 cutting
- First cutting after 45-50 days of sowing when plant attains height of 20-30cm
- Subsequent cutting at 30-35 days interval

- Post -Harvest Operation: Top dressing of urea @ 40kg/ha (500g/katha) at every cutting of fodder after irrigation, however as per need middle irrigation can also be provided.
- Total Forage Yield: 70(t/ha)
- Production Cost: Rs. 0.42/kg

8. Annual Rye (Lolium multiflorum)

Importance:

- Soft, succulent, palatable, contains very high amount of digestible protein with excellent digestibility of crude fiber.
- Land Preparation: DAP @ 60kg/ha (750g/katha) with FYM @5t/ha at the time of land plough.
- Sowing Time: November to December
- Sowing Method: Line sowing is recommended with distance between row-to-row 15cm.
- Seed Rate: Seed rate of annual rye is 15kg/ha
- Irrigation and Inter-cultural Operation: Irrigation after 10-15 days of sowing and then weeding.
- Subsequent weeding and irrigation: as per need.
- Harvesting: Total 4-5 cutting
- First cutting after 60 days of sowing when plant attain height of 25-35cm subsequent cuttings: At 20 day's interval.
- Post-Harvest Operation: Weeding, irrigation and top dressing of urea @ 40kg/ha at every cutting of fodder
- Total Forage Yield (t/ha): 65
- Production Cost: Rs. 0.55/kg considering 60 manpower @Rs.200/- for FYM application, land preparation, sowing, inter-cultural operation, harvesting and irrigation; seed cost Rs. 7,500/-, FYM Rs. 10,000/-, Chemical fertilizers Rs. 2,460/-, ploughing Rs. 1,000/- and energy charges for irrigation Rs. 3,000/- per ha

9. Cow Pea (Vigna sinensis)

Importance :

- very soft, succulent and palatable amongst ruminants and contains good quality and quantity of protein for balance feeding to ruminants.
- Land Preparation: DAP @ 60kg/ha (750g/katha) with FYM @5t/ha at the time of land plough.
- Sowing Time: April to August.
- Sowing Method: Line sowing with the distance between row-to-row and plant-to-plant is 30cm.
- Seed Rate: Seed rate of cow pea var. Bundel-2, Hybrid or local is 15kg/ha or 190g/katha
- Irrigation and Inter-cultural Operation: generally, not required during kharif season.
- During summer irrigation: as per need.
- Weeding: when crop attain height of 10-15cm at 25-30 days of crop duration.
- Harvesting: At 75-80 days of crop duration
- Total Forage Yield: 30 t/ha
- Production Cost: Rs. 0.94/kg

10. Soybean (Glycine Max Merr.)

Importance:

- Excellent legume fodder crop having highest protein content of best quality.
- Dual (forage-cum-grain) type crop. Almost, 20 percent grain yield is reduced due to fodder harvesting,
- Sole feeding to small ruminants and rabbit works as maintenance ration.
- Enriches the soil health.
- Land Preparation: DAP @60kg/ha (750g/katha) with FYM @5t/ha at the time of land plough.
- Sowing Time: June to July.
- Sowing Method: Line sowing with the distance between row-to-row and plant-to-plant is 30cm.
- Seed Rate: 20kg/ha
- Irrigation and Inter-cultural Operation: Irrigation is generally not required during kharif season.
- Minimum one weeding and earthing up after almost 30days of sowing when plant attain height of 15-20cm.
- Harvesting: at 75-85 days of crop duration.
- Fodder is to be harvested 5-10cm above first node of plant and leaving few leaves for further growth.
- Plant further grow fully and start flowering for pod formation and grain yield recorded 1.5 t/ha.
- Total Forage Yield (t/ha): 10
- Production Cost: Rs. 0.57/kg

11. Rice bean (Vigna umbellata)

Importance:

- Very soft, succulent and palatable amongst ruminants and contains good amount of protein and other nutrients.
- Land Preparation: DAP @60kg/ha (750g/katha) with FYM @5t/ha at the time of land plough.
- Sowing Time: from April to August.
- Sowing Method: Line sowing with the distance between row-to-row and plant-to-plant is 30cm.
- Seed Rate: Rice bean var. RBS-16, local etc. is 15kg/ha or 190g/katha
- Irrigation and Inter-cultural Operation: Irrigation generally not requires during kharif season.
- During summer irrigation may be required after germination as per need.
- Weeding and earthing up of soil is required at 20-25 days of crop duration when plant attain height of 10-15cm.
- Harvesting: between 70-80 days of crop duration
- Production Cost: Rs. 1.77/kg
- Total Forage Yield (t/ha) 16

Carrying Capacity

Total 140 tons green fodder can be produced from one ha land which will be sufficient to meet requirements of 15-16 adult dairy cows round the year.

Table 4. Carrying capacity of one ha fodder land

Particulars	Summer / Rainy Season (April – Oct.) 215d	Winter Season (Nov. – March) 150d
Crop Composition (%)		
Cereal	85	40
Legume	15	60
Total Fodder Yield (t)	80	60
Nos. of cow feed fodder @25kg/d/head	15	16

Table 5. Daily rations for the cows and buffalo weighing about 400-500kg and producing 10 liters of milk per day (any of the following five protocol as per availability can be followed)

Composition of mixed ration	Rations				
	1	2	3	4	5
Legume fodder	25kg	—	—	45kg	15kg
Cereal fodder	—	25kg	—	20kg	15kg
Chaffed straw	6kg	5kg	8kg	2kg	6kg
Concentrate feed	3kg	4kg	6kg	—	4kg
Common salt	30g	30g	50g	50g	30g
Mineral mixture	30g	30g	50g	50g	30g
Bone meal	—	—	50g	50g	—
Vitamin AD	—	—	6g	—	—

Preservation of Excess Forage

- Excess forage can be conserved as hay or silage for use during lean period.
- Hay making requires a longer period of rain-free days, which are often rare in eastern part of India.
- So, silage preparation is best option for preservation of excess forages.

***1. Silage* :**

Silage is the cut green forages that is sealed in silo or pit without air and water and can be stored for many months upto 2 years.

Suitable crops for Silage:

Forage rich in carbohydrate, having moisture content 65-70% such as Maize, Sorghum, Oat, Hybrid Napier, Pearl Mellet, berseem etc.

Procedure of making silage:

- Construct a silo which may be surface or trench (pit). For storing 5-6 quintal green fodder, 1 meter^3 space is required.
- It is better to ensile mix forage of cereal and legume type for better nutritive value.
- Collect the forage and chop it (1-3cm size) and spread for one day in open air to reduce moisture content to the level of 60-65 percent during ensiling.
- Prepared a solution by mixing curd (500g) and molasses (500g) in 2 liters fresh water to be sprayed on chopped fodder (600kg) before filling inside silo pit.
- Fill the chopped fodder in layer wise manner of 30-35 cm and press it manually to avoid trapping of air in it and place a polythene sheet and repeat the layering of chopped fodder again.
- Cover the silo pit with thick polythene sheet after filling and pressing and put mud over it (or put weight like sand bag) to make it complete air-tight and water leaking.
- The silage is ready for use and opened from one side after 3 to 6 weeks of ensiling depending on type of fodder ensiled.
- Silage made should be inspected for presence of mold etc before offering to animals.
- Moldy silage if any should be removed.
- Silage removed from pit should be kept for some time in air before offering to animals for feeding.
- Silage has a characteristic odor which unfamiliar to livestock. Initially 5 kg of silage per adult animal can be given and slowly animal has accustomed to it and start eating after some time.

2. Hay:

- Crop with thin stem and more leaves are better suited for hay making.
- Mix legumes like lucerne with grasses to make better quality hay
- Cutting, drying and raking (collection), baling (bailer machine coils the cut hay into round shape) and storing are the steps of hay making.
- The moisture content should not be more than 15-20 percent in any case. Hence, after harvesting crop, it should immediately chopped or as such spread in sun for 3-4 days for drying as per crop.
- Weather condition shall also be considered while harvesting fodder for making hay.
- Forage crops can be harvested at maximum vegetative growth and just before approaching to maturity for maximum nutritive value.

09
CHAPTER

Health Management

Pankaj Kumar and Shruti Shaurya

Farmers should follow species-specific vaccination schedules and adhere to basic biosecurity measures, as well as good management practices, to maintain the health and productivity of cattle, buffalo, sheep, goats, pigs, and poultry.

A package of practices, known as 'POP', best suited and adoptable to the local geo-climatic situation, should be developed into guidelines. For Bihar, farmers should follow the national vaccination schedule for livestock and poultry, utilising free or subsidised government camps organised under the State Animal Husbandry Department and central schemes, such as LHDCP. Below is a practical, Bihar-Jharkhand-oriented package of practices.

VACCINATIONS

General Guidelines

- Only vaccinate animals that appear to be in good health and have been identified.
- When the weather is suitable for animals, vaccinations should be administered on the necessary schedule.
- The 4Rs—right time, right vaccine, right route and right animal—should be followed when administering vaccinations.
- Vaccinated animals should be observed for any unusual changes in symptoms and behaviour for a minimum of 24 hours and preferably for a week.
- Keep animals that have received vaccinations away from stress.
- Knowledge of the biosecurity issues associated with the use and disposal of live vaccines.

1. Cattle and buffalo

Cattle and buffaloes require vaccinations against Foot and Mouth Disease (FMD) starting at 4 months with a booster after 1 month and six-monthly after that, Haemorrhagic Septicaemia (HS) and Black Quarter (BQ) from 6 months of age followed by yearly boosters before the monsoon season (May) and generally given as a combined vaccine. In Bihar, Brucellosis calfhood vaccination is advised once in a lifetime for female calves aged 4–8 months.

Additional, non-routine vaccines may also be included based on regional needs. These include the theileriosis vaccine, given once after 3 months of age in crossbred cattle, and the annual Anthrax vaccine, which is especially important in outbreak-prone areas like Bihar and Jharkhand. It is also advisable to consider vaccination against IBR in cattle, as well as vaccination for lumpy skin disease—preferably using the LSD homologous vaccine, or at minimum, a goat or sheep pox heterologous vaccine once a year. Eastern states follow the national guidelines under the Livestock Health &

Disease Control Programme (LHDCP), with free vaccination camps routinely organised by the Animal Husbandry Departments through their veterinary hospitals and mobile veterinary units.

General vaccination schedule for cattle and buffaloes

Disease	Age for First Dose*	Booster	Revaccination
FMD	4 months and above	1 month later	Every 6 months in endemic areas.
HS**	6 months and above	None	Once a year, before the onset of the monsoon (May)
BQ**	6 months and above	None	-Do-
Brucellosis (female calves)	4–8 months	None	Once in a lifetime
Theileriosis^ (crossbreds)	3 months and above	None	Once in a lifetime.
Anthrax (outbreak areas only)	4 months and above	None	Once a year.

*Always confirm age, product and dose under the supervision of a local veterinarian. ** Combined vaccines are in general use, ^ Not in routine use

General rules for concurrent vaccination

- Inactivated + inactivated: Two or more inactivated (killed) vaccines (for example FMD + HS or FMD–HS–BQ combo + Brucella in calves) are often given on the same day at different injection sites in healthy animals.
- Live + live: Administering two live vaccines together (for example, two different live viral vaccines) is more likely to cause interference. Therefore, a gap of a few weeks is often recommended,

DEWORMING

Deworming may seem like a simple routine step, but when done properly and scientifically, it can make a significant difference in an animal's health. It helps prevent and control internal parasites using either chemical dewormers or effective herbal options. These internal parasites—nematodes, cestodes, trematodes and protozoa—can cause a range of issues in livestock, from digestive problems and anaemia to weight loss and poor productivity. Despite this, deworming remains one of the most overlooked practices and is often performed without a clear strategy.

For adult cattle managed under open grazing systems, we usually suggest deworming at least twice a year—once at the beginning of the monsoon (May–June) and again after the monsoon season. In calves, deworming typically starts between 1 and 3 months of age and is then repeated every three months during the first 6–12 months. The exact schedule depends on how much they graze and the

parasite pressure in the area. The choice of dewormer—whether chemical or herbal—should be guided by faecal tests, the animal's species, age, physiological condition, and overall grazing risk.

Different animals are susceptible to various specific parasites. Buffalo calves often struggle with toxocariasis. Cattle frequently face nematodes, lungworms, and liver flukes. In sheep and goats, tapeworms and coccidiosis are common problems. Horses, on the other hand, tend to have issues with strongyles, ascarids, and tapeworms.

Ectoparasite control:

Ectoparasites are various types of ticks, mites, lice, fleas, and biting flies, among others, which may spend part of their time on animals, disturbing them, feeding on them, causing trauma due to their bites, and also transmitting many infections, such as Trypanosoma, Theileria, Anaplasma, Babesia, and LSD, etc. Their control involves an Integrated Pest Management (IPM) approach, combining chemical treatments (pour-ons, injectables, sprays) with biological and management methods (good nutrition, housing), as well as strategic methods (monitoring, resistant breeds).

Chemical Control Methods include the application of acaricides, such as O. P compounds, pyrethrins, and pyrethroids, as well as macrocyclic lactones. They are applied as a pour-on, spray, dip, or injection, depending on the preparation and species. Depending on the chemical acaricide selected, the dose and application method must be followed according to the manufacturer's instructions and under the guidance of a veterinary doctor. Do not use the same acaricidal compound continuously for many years; rotate active ingredients, as advised by a veterinarian, to slow resistance. Clean housing reduces mite/louse survival; proper pasture management minimises fly breeding sites, such as dung pits and stagnant water, as well as crevices in the wall and floor. Biological control for ectoparasitic is useful to prevent resistance.

Key Considerations:

- Resistance: Overuse of chemicals creates resistance; IPM is crucial.
- Timing: Apply treatments strategically (e.g., start of fly season).
- Environmental Factors: Rain can wash off pour-ons applied; high humidity favours ectoparasites.

Important Tips:

- Always calculate dewormer doses based on the animal's actual body weight to ensure proper efficacy and avoid under- or overdosing.
- Deworming animals before vaccination helps improve the immune response and leads to better protective immunity.
- Practising pasture rotation lowers the parasite load on grazing land and reduces reinfection.
- Avoid blanket, whole-herd deworming as a routine habit; targeted treatment helps slow the development of anthelmintic resistance.

- Select deworming products carefully by considering the animal's physiological state—pregnancy, lactation, growth, or stress all influence drug choice and safety.
- In sheep and goats, the FAMACHA system is an effective targeted tool. Examining the colour of the lower eyelid helps identify animals showing anaemia due to blood-feeding worms, such as Haemonchus, so that only those truly in need of treatment receive it.
- State veterinary departments and local livestock authorities often provide region-specific deworming and vaccination calendars. These guidelines should be followed and adapted using faecal egg counts and professional veterinary advice.
- Alongside deworming, ensure animals have continuous access to clean water, balanced nutrition with appropriate minerals, and are kept in clean, dry housing with regular disinfection to minimise infection pressure. New or sick animals should always be isolated, and mixing with outside herds should be avoided.
- Seek veterinary help immediately if you observe sudden fever, excessive salivation, lameness, or abortions.

2. Sheep, goats and pigs

In small ruminants, vaccinate against peste des petitis ruminants (PPR), enterotoxaemia (ET), FMD, and pox, and repeat as per a yearly or six-monthly schedule where recommended (detailed below).

In pigs, vaccinate against classical swine fever and FMD with a primary dose in young piglets, followed by a booster approximately one month later, and then administer annual revaccination. After the emergence of African swine fever, vaccinating against this disease should also be a subject of debate, given the availability of the vaccine.

Disease Vaccine	Primary dosing	Booster dosing	Route
PPR	After 3 months of age	After 3 years, preferably annually in endemic areas.	SC
FMD	-Do-	After 1 month of the primary dose, and then twice annually	IM
ET	-Do-	After 1 month of the primary dose, and then annually	SC, usually before monsoon
Goat Pox	-Do-	-Do-	SC in goats only
Sheep Pox	-Do-	-Do-	SC in sheep only
Tetanus Anti-Toxin	Before castration and after kidding	SOS	SC 1500 unit

Maintain dry, well-ventilated pens, avoid overcrowding, deworm animals at least twice a year, and quarantine purchased animals for 2–3 weeks before mixing them with the existing herd. It is good practice to deworm 7-15 days before vaccination for a better protective titre.

3. Poultry

Health management practice in the poultry sector depends to a large extent on biosecurity practices and the types and duration of poultry farming. In general, broiler birds are kept for a short duration of 2 months, while birds reared under backyard farming or as layers may be reared for up to 1 year. Therefore, vaccination and management strategies vary to minimise the cost of production and losses. In general, the key vaccines for chickens are Marek's disease (MD) (administered at day-old), Newcastle disease (ND or Ranikhet) administered at different intervals, infectious bursal disease (IBD or Gumboro), fowl pox, infectious bronchitis, and others as advised for broilers or layers.

For layers birds, give MD at hatchery or 0 day, ND (Lasota) and IBD in the first weeks, fowl pox around 4–7 weeks, ND (R2B strain) again before laying, and follow any additional farm specific vaccines as per veterinarian. The broiler birds can be kept by giving MD, ND and IBD vaccination only. Regular debeaking is required in birds to prevent vices such as cannibalism, vent picking, and egg breaking etc.

Strict biosecurity in the farm by keeping control on entry of visitors, using footbaths, dedicated farm clothing, good litter management, clean water, rodent and wild bird control, and "all in and all out" planned batches.

General health management tips

1. Always keep vaccines in the cold chain, follow correct dose, route and withdrawal periods, and never use expired or improperly stored vaccines.
2. Maintain farm health records (vaccination, deworming, treatments, mortality), and regularly consult local veterinary officers for area specific disease risk and government vaccination camps.
3. Provide clean, dry, and well-ventilated sheds to protect animals against rain and heat. Kaccha or concrete floors with proper slope or inclination can help prevent foot problems and respiratory issues among animals due to high humidity in Bihar.
4. Isolate sick animals,
5. The carcasses should be disposed of through deep burial or incineration to prevent the spread of disease.
6. Provide a well-balanced nutrition package comprising green fodder, dry fodder, and mineral mixture.
7. Colostrum feeding to newborn @ dose of 7-10% of their body weight per day, immediately after birth.
8. Conduct deworming of calves once a month until they attain six months of age, and for the adults, three times within the year.
9. Ensure that clean drinking water is always available.

10. Maintain a quarantine for newly purchased animals for 2–4 weeks.
11. Inspect animals twice a day to observe signs of reproductive heat and maintain herd fertility.
12. When vaccinating goats, poultry, or cattle together, use separate needles to prevent cross-contamination.
13. Coordinate these vaccinations with the government camps run by the Animal & Fisheries Resources Department, local veterinary hospitals, and Jeevika/ SHG workers so that vaccines are free or low-cost.
14. Always vaccinate healthy animals only. Keep vaccines in an icebox, use new and sterile needles or disposable syringes, and record dates so that boosters are not missed in the future.
15. Start with the healthiest group first, kept in the least dirty area. The principle is not to go from obviously sick animals to healthy ones without changing or cleaning equipment.
16. Wash or disinfect hands, boots and any reusable equipment when changing from birds to goats/cattle and vice versa.

Daily and Routine Care

- Clean, dry, well-drained sheds with good ventilation and protection from extreme heat and rain reduce respiratory and foot diseases.
- Supply balanced ration-green fodder, dry fodder, concentrate, and mineral mixture along with always clean drinking water to support immunity and milk production.
- Maintain fixed time schedules for milking, cleaning of udders and sheds and remove dung and leftovers every day to minimise mastitis, worms and flies.

Caring for calves and young stock

Provide colostrum to calves within the first few hours of birth and continue for at least 3 days to develop natural immunity.

- Keep the calf pens dry, provide bedding, deworm at 1.5–2 months, and then every 3–6 months, depending on local advice. Finally, ear tag or identify calves for record-keeping purposes.
- Debudding and castration should be undertaken when climatic conditions are fair and under the strict supervision of a veterinarian.
- Avoid overcrowding and mixing very young calves with older animals to reduce the risk of pneumonia, diarrhoea, and parasite transmission.

PART B : FISH FARMING

10
CHAPTER

Composite Fish Farming

Tarkeshwar Kumar, Kamal Sarma, S.K. Ahirwal and Vivekanand Bharti

Composite fish farming (polyculture) is the practice of culturing multiple compatible fish species together in the same water body, utilizing different feeding zones (surface, column, bottom) to maximize productivity per unit area.

1. Key Benefits

- Efficient utilization of pond resources (food, space, water)
- Higher total yield compared to monoculture
- Better utilization of water column and higher water productivity
- Economically viable for small and marginal farmers

2. Recommended Species Combination (Indian Major Carps + Exotic Carps)

Feeding Zone	Indian Species	Exotic Species	Percentage in Stocking
Surface feeder	Catla (*Catla catla*)	Silver carp	20-30%
Column feeder	Rohu (*Labeo rohita*)	Grass carp	30-40%
Bottom feeder	Mrigal (*Cirrhinus mrigala*)	Common carp	40-50%

Other compatible species for intercropping**:** minor carps, freshwater prawns, kawai, depending on availability. Incorporation of these species can be more remunerative.

3. Pond Preparation Package

Pond Construction & Renovation

- Pond Size: 0.5–1.0 hectare, depth 2–2.50 m
- Dyke slope: 2:1 (horizontal: vertical). Optimum slop can leads to better pond bundh stability and can be used for fruit and vegetable crop production.
- Inlet & outlet with mesh screens
- Lime application: 100 -150kg/ha (based on soil pH) as initial dose
- Organic manure: 10,000 kg/ha cow dung or compost per year
- Fertilization:
  - Single Super Phosphate (SSP): 150-200 kg/ha/y
  - Urea: 200 -250 kg/ha/ y

Stocking

- Fingerling size: 120–150 mm. Average body weight (30-50g)

- Stocking density: 8,000–10,000 fingerlings/ha
- Stocking ratio example: Catla 30%, Rohu 30%, Mrigal 20%, Silver carp 10%, Grass carp 10%
- Stocking time: Early morning or late evening
- Acclimatization: Gradually mix pond water in transportation containers before release
- Grading & sorting by species and size. Uniform stocking size of fishes give better results.

4. Daily Management Practices

Feeding

- Supplementary feed: Rice bran + mustard oil cake (1:1 ratio) or pelleted feed (sinking or floating)
- Daily ration: 2–3% of total fish biomass
- Feeding frequency: Twice daily (morning & evening)
- Feeding places: Multiple fixed sites, bag feeding or broadcast method of feeding

B. Fertilization Schedule

	Organic Manure (kg/ha)	Inorganic Fertilizer (kg/ha)
Initial dose	2,000	SSP: 25 kg, Urea: 30 kg
Monthly basis dose	1,000	SSP: 25, Urea: 30

C. Water Quality Monitoring

- pH: 7.5–8.5 (check weekly)
- Dissolved oxygen: >5 mg/L (aerate if <4 mg/L)
- Transparency: 30–40 cm (Secchi disc)
- Water exchange**:** 10–20% monthly basis if possible and also fill the pond for evaporation and seepage

D. Health Management

- Regular fish sampling once in a month for feeding adjustment and also for observation of health related issues.
- Salt treatment (250 kg/ha) for new stock
- Liming (30-40 kg/ha monthly) to maintain pH

5. Harvesting & Marketing

- Partial harvesting: Start after 6–8 months (size-based)
- Final harvesting: After 10–12 months by complete draining
- Production: 4,500-5,000 kg/ha/year
- Live fish transport with oxygen packing for distant markets

6. Economic Package for 1 Hectare Pond

Item	Cost (₹)
Pond preparation (liming, manure)	25,000
Fingerlings (10,000 pieces)	1,00,000
Feed (12 months)	2,50,000
Fertilizers	25,000
Labour	60,000
Miscellaneous	20, 000
Total Investment	4,60,000
Production	4.500 kg
Sale Value (@[1] 180/kg)	8,10,000
Net Profit	**3,50,000**

7. Record Keeping

Maintain daily records of:

- Feed provided
- Water quality parameters
- Fish growth sampling (monthly)
- Mortality count
- Expenses and sales

8. Government Schemes & Support

- Pradhan Mantri Matsya Sampada Yojana (PMMSY) – Subsidy up to 40–60%
- State fisheries departments – Training, technical guidance
- NGOs & KVKs – Demonstration ponds, capacity building

9. Sustainability Practices

- Can be incorporated in the form of integrated farming with ducks, poultry, or horticulture
- Rainwater harvesting for pond replenishment
- Use of bio-fertilizers and herbal disease control
- Crop rotation with fruit or vegetables in pond dyke

10. Key Precautions in Composite Fish Farming

- Prevent overstocking by strictly following recommended species ratios and densities (e.g., 8,000–10,000 fingerlings/ha) to avoid competition for food, oxygen stress, and stunted growth.

- Maintain water quality by regularly checking pH (7.5–8.5), dissolved oxygen (>5 mg/L), and transparency; aerate the pond if needed and avoid excessive organic or chemical fertilization.
- Avoid overfeeding and use high-quality, balanced feed: Over feeding leads to deterioration of water quality parameters as well as economic loss
- Stocking with healthy, disease-free fingerlings from certified hatcheries and quarantine them before stocking to prevent the introduction of parasites or infections into the pond.
- Secure the pond perimeter with fencing, nets, or screens to keep out predators (birds, snakes, mammals) and prevent the entry of unwanted or wild fish species.

11. Conclusion

Composite fish farming is a scientifically optimized polyculture system that enhances productivity through trophic complementarity and efficient resource utilization. Its success depends on stringent management of stocking ratios, water quality, and biosecurity to maintain ecological balance and prevent disease and mortality. When executed with precision, it represents a sustainable and economically viable model for enhancing aquaculture output specially for small and marginal farmer.

11 CHAPTER

Pen Culture System

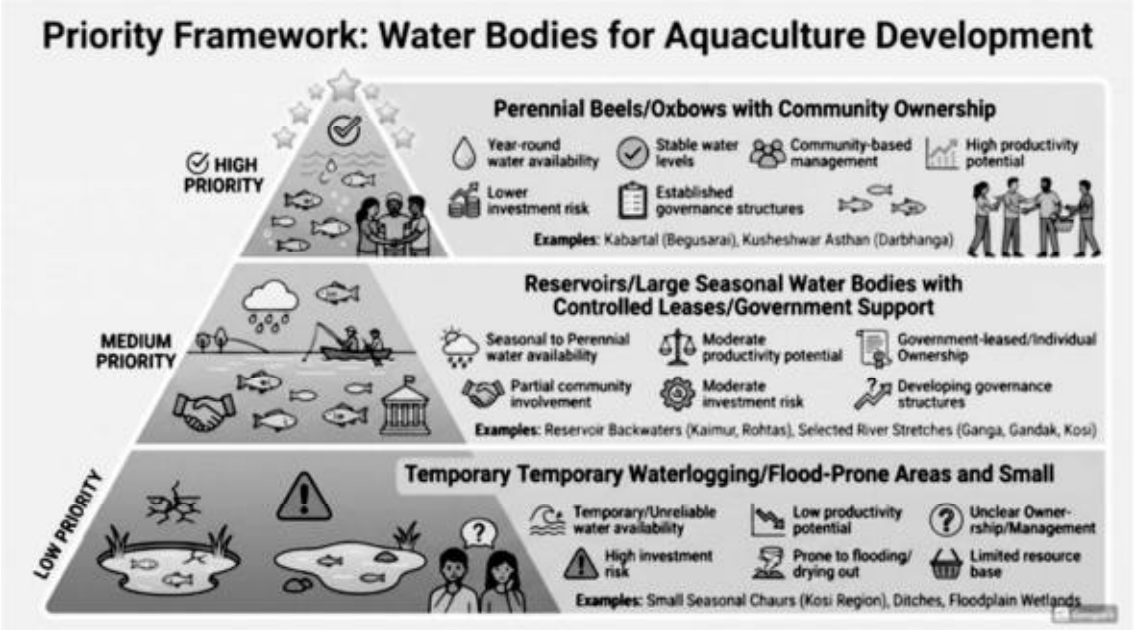
Tarkeshwar Kumar, Kamal Sarma, S.K. Ahirwal and Vivekanand Bharti

Eastern India contains extensive floodplain wetlands in the form of oxbow lakes—locally known as *mauns, chaurs, jheels,* and *beels*—particularly in the states of Assam, West Bengal, Bihar, and eastern Uttar Pradesh. These wetlands hold special significance for India's inland fisheries due to their role in supporting the livelihoods of millions of people. However, fish yields from these wetlands remain far below their potential. Stock enhancement can be a key technological intervention for improving the productivity of these ecosystems, and it requires a consistent supply of quality fish seed of appropriate size. In this context, in situ production of carp fingerlings through pen culture and releasing the same in the beels/ oxbow lakes for table size fish production can be practiced for stock enhancement and to achieve higher production.

1. Site Selection: Critical Parameters

Water Body Type: Ideal for floodplain wetlands (e.g., Doloni in Assam, *Mauns* of Bihar), oxbow lakes (*Jheels* in WB, *Chaurs* in Bihar), irrigation reservoirs, and riverine pools with minimal current. Generally shallow water or one side land mass is preferred for pen culture.

Parameter	Optimal Range	Critical Limits
Water depth	2-4 meters	Minimum 1.2m in dry season
Water retention	8+ months	Minimum 6 months for single crop
Current velocity	<0.2 m/sec	Maximum 0.5 m/sec
pH	7.0-8.5	6.5-9.0 (tolerable)
Dissolved Oxygen	>5 mg/L	>3 mg/L (critical)
Ammonia	<0.1 mg/L	<0.3 mg/L
Turbidity (Secchi)	30-50 cm	20-80 cm



2. Pen Design and Construction

- ***Size:*** 500 - 2000 sq.m. (Start small; 0.05 - 0.2 Ha). Recommended starter size: 20m x 25m (500 sq.m).
- ***Shape:*** Rectangular or square for easier management and net installation.

- ***Materials:***

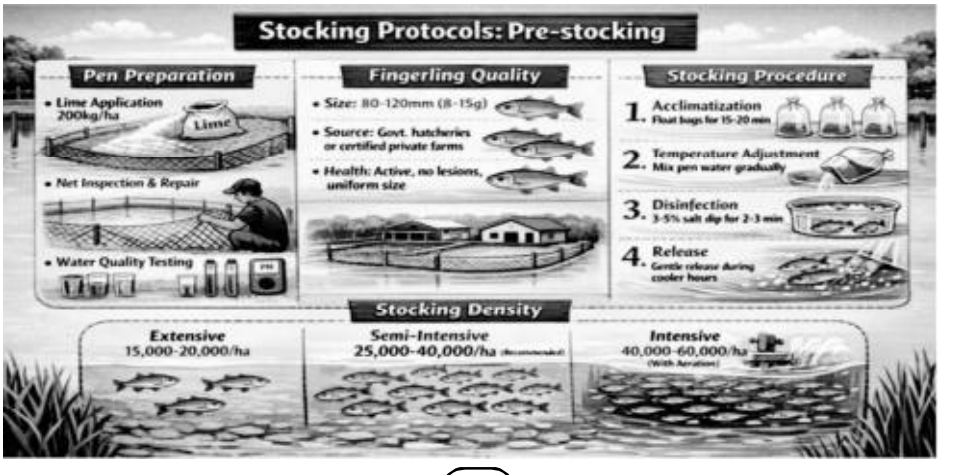
Component	Material Options	Life Span	Cost (approx.)
Supporting poles	Treated bamboo, G.I. pipes, PVC	2-5 years	₹ 200-800/piece
Net enclosure	HDPE knotless (15-25mm)	3-4 years	₹ 40-60/m²
Floats	PVC drums, sealed bamboo, foam	3-5 years	₹ 150-300/float
Anchors	Concrete (20kg), stone bags	5+ years	₹ 200-500/anchor
Top netting	Bird net (50mm), nylon	2-3 years	₹ 20-30/m²

- ***Construction Steps***
  - Pole installation at 3-4m intervals
  - Net hanging with double stitching at seams
  - Bottom sealing using sinkers or buried netting
  - Top net installation for predator control
  - Feeding platform construction (2m² per pen)
  - Access gate with secure locking mechanism

3. Species Selection

Species	Stocking %	Temperature Range	Special Advantage
Rohu (*Labeo rohita*)	35-40%	25-35°C	High market demand
Catla (*Catla catla*)	20-25%	25-32°C	Surface feeder, fast growth
Mrigal (*Cirrhinus mrigala*)	15-20%	22-30°C	Bottom feeder, hardy
Silver Carp	10-15%	20-30°C	Phytoplankton control
Common Carp	5-10%	15-30°C	Benthic stirring, weed control

4. Stocking Protocols



5. Feeding Regime

- ***Principle:*** In pens, natural food (plankton) is primary, but supplementary feeding is mandatory for higher yields.
- ***Feed Types:***
  - Farm-made feed: Rice bran (de-oiled), mustard oil cake (DOC), groundnut cake in 2:1:1 ratio.
  - Formulated floating pellets (preferred for better FCR and water quality).
- ***Feeding Rate & Schedule:***
  - Start at 5% of body weight, gradually reducing to 2-3% by harvest.
  - Feed twice daily (9-10 AM and 4-5 PM) at fixed places (feeding platforms).
  - Adjust based on consumption (check feeding trays) and water quality (reduce during cloudy days).

6. Water Quality and Health Management

Parameter	Frequency	Corrective Measures
Dissolved Oxygen	Daily (dawn/dusk)	Aeration, water exchange, reduce feeding
pH	Weekly	Lime (if <7), alum (if >9)
Ammonia/Nitrite	Monthly	Water exchange, reduce stocking, zeolite
Transparency	Weekly	Organic manure (if >50cm), water exchange (if <20cm)
Temperature	Daily	Adjust feeding rate

7. Health Management

- ***Argulosis (Fish Lice)***
  - Symptoms: Scratching, red spots
  - Treatment: Salt dip (3%), Butox spray (1ml/100L)
- ***Bacterial Gill Rot***
  - Symptoms: Pale gills, mucus
  - Treatment: Potassium permanganate dip (5ppm), oxytetracycline feed
- **Epizootic Ulcerative Syndrome (EUS)**
  - Symptoms: Ulcers, red sores
  - Prevention: Lime application, stress reduction
  - Treatment: Salt + CIFAX bath

- ***Health Management Calendar:***
  - June: Lime treatment (200kg/ha)
  - July: Stocking with salt dip
  - Sept: First health check, deworming if needed
  - Nov: Mid-season health assessment
  - Jan: Pre-harvest health check

8. Harvesting Strategies

- ***Partial Harvest (Size Grading):***
  - Months 4-6: Remove fast-growing individuals
  - Use selective gill nets or cast nets
  - Benefits: Reduces competition, improves cash flow
- ***Final Harvest:***
  - Method: Complete draining or seine netting
  - Timing: Early morning to minimize stress
  - Duration: Complete within 2-3 days

9. Expected Yield and Economics (1000 m² Pen)

- Capital Cost (Year-1): ₹ 80,000 - ₹ 1,00,000 (Pen construction, nets, etc.)
- Operational Cost/Cycle: ₹ 60,000 - ₹ 80,000 (fingerlings, feed, labour, misc.)
- Expected Revenue (@ ₹ 200/kg): ₹ 2,00,000 - ₹ 2,50,000 (for 1000-1250 kg yield)
- Net Profit/Cycle (1st Year): ₹ 60,000 - ₹ 70,000 (After covering operational cost; capital cost amortized over 3-5 years).

10. Institutional Support and Convergence

- NGOs/CBOs: For group formation (Fishermen Cooperatives/SHGs), conflict resolution, and micro-credit.
- Government Schemes:
  - Pradhan Mantri Matsya Sampada Yojana (PMMSY): Subsidy for pen construction, inputs.
  - State Fisheries Dept.: Supply of fingerlings, training, and extension support.
  - NABARD/KCC: For aquaculture credit.
- Research & Training: ICAR-RCER, Patna for tailor-made training.

11. Risk Mitigation and Contingencies

- Floods: Design pens to withstand water level rise. Use strong anchors and tall netting.

- ***Theft/Poaching:*** Community vigilance, locking gates, night watchmen.
- ***Water Quality Deterioration:*** Keep aerators ready; avoid overfeeding.
- ***Disease Outbreaks:*** Maintain stock register, quick consultation with fisheries officials.
- ***Insurance:*** Explore Aquaculture Insurance products (available under PMMSY).

12. Conclusions

Pen culture represents a transformative and sustainable opportunity for the Eastern regions of India to harness their vast, underutilized perennial water bodies including floodplain wetlands, beels, oxbow lakes, and reservoirs for enhanced fish production, livelihood generation, and nutritional security. By adopting a community-centric, semi-intensive approach with scientific site selection, appropriate pen construction, balanced species and feed management, and proactive risk mitigation, this practice can significantly boost decentralized aquaculture. Success hinges on strong convergence of government schemes like PMMSY, institutional support from cooperatives or FPOs, and continuous capacity building, ultimately transforming traditional fishery practices into organized, profitable, and climate-resilient enterprises that empower local communities while conserving aquatic ecosystems.

12 CHAPTER Breeding and Culture of Magur fish

Tarkeshwar Kumar, Kamal Sarma, S.K. Ahirwal and Vivekanand Bharti

Clarias magur (Magur) is a high-value, nutrient-rich catfish species facing population decline in the wild. Therefore, standardized breeding and rearing protocols are essential for sustainable aquaculture and conservation.

1. Broodstock Management

- Source: Collect healthy brooders (85–121 g) from reliable markets or fish hatcheries.
- Stocking Ratio: Maintain females to males at 3:2.
- Pond Setup: Use earthen ponds (~800 m²) with a central trench for refuge.
- Feeding: Provide commercial feed with 40% crude protein at 2% body weight twice daily.
- Conditioning: Transfer brooders to cement tanks 3 months before breeding for acclimatization.

2. Induced Breeding Protocol

2.1. Hormone Administration

- Hormone: Use WOVA-FH (SGnRH analogue + domperidone).
- Optimal Dose: Females 1.0 ml/kg body weight and Males 1.0 ml/kg body weight
- Injection Time: Afternoon (~17:00 hrs).
- Observation: Check for free oozing of eggs after 18 – 20 hours based on the maturity of fish.

2.2. Egg Stripping and Fertilization

- Method: Dry stripping; collect eggs on dry stainless-steel plates.
- Sperm Preparation: Macerate testes in 0.85% saline to prepare sperm suspension.
- Fertilization: Mix eggs and sperm gently using sterilized feathers; activate with 50 ml water. Distribute 1000–1500 eggs per medium size plastic tub in a flow-through hatchery system. Care to be taken that eggs are evenly distributed in all around the tub.

2.3. Hatching and Larval Collection

- Water Flow: Maintain gentle flow and optimum aeration to maintain sufficient DO throughout the incubation of eggs.

- Hatching Time: 24–30 hours post-fertilization based on the prevailing water temperature.
- Yolk Sac Absorption: Larvae rely on yolk sac for 3 days post-hatching.

3. Larval Rearing (0–30 Days)

3.1. Tank Setup

- Use FRP tanks with soil substrate (5 cm), pipes, and stones for shelter.
- Maintain water depth at 10 cm initially, gradually increasing to 30 cm. Higher water depth leads to mass mortality.

3.2. Feeding Schedule

- Days 1–7: Milk powder, boiled egg yolk suspension, powdered supplementary feed etc.
- Days 8–30: Live plankton, egg custard, fishmeal-based starter feed (38–40% protein).
- Frequency: Two times in a day
- Water Exchange: As per requirement around 30-40% water can be exchange based on quality of water and after feeding.

4. Fry to Fingerling Rearing (30–120 Days)

4.1. Feed Transition

- Days 31–60: Commercial sinking pellets (30–35% protein) at 10% body weight and live plankton.
- Days 61–90: Reduce feeding to 5% body weight. Live plankton also can be given for better survival and growth.
- Days 91–120: Further reduce to 4% body weight and also regular plankton feeding.

4.2. Water Management

- Exchange: 30% water every 4 – 7 days.
- Cleaning: Siphon out uneaten feed and waste without disturbing substrate.

5. Juvenile Production (90 Days)

5.1. Protein Requirement Study

- Optimal Protein Level: 35% for best growth and survival.
- Feed Preparation: Use locally available ingredients (see Table 1 in paper).
- Feeding Rate: 3% body weight, adjusted monthly based on the average body weight of the fish.

5.2. Growth Monitoring

- **Parameters**: Body weight gain, feed conversion ratio (FCR), survival rate.

6. Water Quality Management

- Temperature: 24–30°C
- pH: 7.3–8.5
- Dissolved Oxygen: 5.0 –6.0 mg/L
- Alkalinity: 180–200 mg/L
- Ammonia: <0.05 ppm

7. Key Performance Indicators

- Fertilization Rate: Up to 70 -75%
- Hatching Rate: Up to 80-85%
- Survival Rate:
  - Larval stage: > 30%
  - Juvenile stage: Up to 90% at 30–35% protein
- **Growth**: for 120 days: 20-30 g

8. Grow out culture

8.1. Pond Preparation & Stocking

- Use earthen ponds (0.5–1.0 ha) with a depth of 1.5–2.0 m.
- Lime application (200–300 kg/ha) and fertilization with organic manure to boost natural productivity.
- Stock healthy fingerlings (15 -25 g) at a density of 30,000–40,000 per ha for monoculture.

8.2. Feeding Management

- Use floating or sinking pellets with 30–35% protein for optimal growth.
- Feed at 3–5% of body weight daily, split into two meals (morning and evening).
- Adjust feeding rates based on monthly sampling and water temperature.

8.3. Water Quality Maintenance

- Maintain dissolved oxygen > 5 mg/L; use aerators if needed, especially during early morning.
- Keep pH between 7.0–8.5 and ammonia levels < 0.5 ppm.
- Conduct water exchanges (20–30%) to reduce waste accumulation and to achieve better environmental condition.

8.4. Health & Disease Management

- Regularly check for signs of diseases like fin rot, gill parasites, and bacterial infections.
- Use probiotics in feed to improve gut health and immunity.
- Quarantine new stock before introduction; avoid overstocking to reduce stress.

8.5. Growth Monitoring & Harvest

- Sample monthly to track growth, adjust feeding, and estimate biomass.
- Target harvest size: 150–200 g (5–7 months of culture).
- Use partial harvesting to maintain optimal stocking density and improve growth rates.

9. Challenges and Recommendations

- ***Larval Survival****:* Critical stage; requires optimized feeding and water quality.
- ***Protein Level****:* 35% protein diet recommended for best FCR and growth.
- ***Mineral Nutrition****:* Higher protein diets improve better mineral assimilation in muscle.
- ***Hatchery Design****:* Use flow-through systems with aeration and gentle water movement.

10. Conclusion:

Standardized induced breeding with WOVA-FH at 1.0 ml/kg, coupled with a 35% protein diet and phased water-quality management, significantly enhances *Clarias magur* larval survival and juvenile growth. This integrated approach ensures sustainable seed production and improves culture performance, supporting both aquaculture expansion and species conservation. Further refinement of larval rearing protocols remains essential to maximize overall survival and commercial viability.

13 CHAPTER Freshwater prawn polyculture

Tarkeshwar Kumar, Kamal Sarma, S.K. Ahirwal and Vivekanand Bharti

Polyculture refers to the simultaneous cultivation of two or more compatible fish species that optimizes resource use efficiency, ecosystem stability, and overall productivity from an unit area. In Bihar, integrating of giant freshwater prawn (*Macrobrachium rosenbergii*) with Indian Major Carps (Catla, Rohu, Mrigal) offers a promising sustainable farming avenue for aquaculture diversification and income.

1. Why Polyculture with Prawns and Carps?

- Resource Efficiency: Prawns utilize leftover feed and fish waste, reducing input costs.
- Ecological Balance: Prawn and carps efficiently utilize the food niche produced in the pond itself.
- Diversification: Multiple species improve better economic gain compared to monoculture.
- Higher Profitability: Prawns fetch high market prices, and carps provide bulk biomass.

2. Site and Pond Preparation

Pond Requirements:

- Size: 0.5–1.0 hectare, depth 1.5–2.0 meters
- Soil Type: Clay-loam with good water retention
- Water Source: Freshwater (Surface Water, Groundwater, Rainwater)

Preparation Steps:

1. Draining & Drying: Dry pond bottom for 2–3 weeks to eliminate pathogens.
2. Liming: Apply 250–300 kg/ha of lime based on soil ph.
3. Manuring: Apply 2500 kg cow dung, 500 kg poultry manure, and 100 kg super phosphate/ha (initially).
4. Filling: Fill pond with filtered water to avoid predator entry.
5. Aeration: Provide aerators in intensive systems.

3. Stocking Strategy

Species	Stocking Density (per ha)	Size at Stocking
Giant Freshwater Prawn	10,000–15,000 post-larvae (PL)	PL15–PL20 (15–20 mm)
Indian Major Carps (IMC)	5,000–6,000 fingerlings	50–100 g
Ratio (Prawn: Carp)	~2:1 to 3:1	

Note: Stock prawns first, allow 15–20 days before introducing carps.

4. Water Quality Management

Parameter	Optimal Range
Temperature	25–32°C
pH	7.0–8.5
Dissolved Oxygen	5–7 ppm
Visibility	40–50 cm
Ammonia	< 0.1 ppm
Nitrite	< 0.1 ppm

Note: use aerators if DO falls below 4 ppm.

5. Feeding Management

- Prawns: Provide 25–30% protein pelleted feed in evening. Initial feeding rate: 20% of prawn biomass, reducing to 5% as they grow
- Carps: Supplement with cereal-based or commercial carp feed. For carps feeding 10% of carp biomass, reduce to 3% as they grow

6. Health and Growth Monitoring

- Provide shelters: Use bamboo poles, PVC pipes etc., as a hiding place for prawn to reduce cannibalism and mortality specially during moulting.
- Regular checks: Observe moulting, and signs of disease.
- Record growth: Sample every 2 weeks to adjust feeding.

7. Harvesting

- Partial Harvesting: Use seine nets to remove market-sized prawns (≥50 g) and carps (≥1 kg).
- Final Harvest: Drain pond completely; handpick remaining prawns and fish.
- Harvest Timing: 6–8 months for prawns and carps.

8. Expected Yield

Species	Yield per Hectare (6–8 months)
Prawns	400–500 kg
Indian Carps	3,500 - 4,000 kg
Total	**3.900 - 4.500 tonnes**

9. Challenges & Mitigation

Challenge	Solution
Cannibalism in prawns	Provide hiding place; adequate feeding; stock with uniform size species
Seed availability	Source from certified hatcheries; establish local seed production units
Market linkage	Tie-up with cooperatives, exporters, or local markets
Water quality fluctuation	Regular monitoring; use bio filters; avoid overfeeding

10. Conclusion

Giant Freshwater Prawn polyculture with Indian Major Carps presents a sustainable, profitable, and resource-efficient model for Bihar's as well as for eastern region in aquaculture sector. It aligns with the state's available water resources, farmer readiness for diversification, and growing market demand for high-value fish. However, success depends on:

- Reliable seed and feed supply chains
- Technical support in pond management and water quality
- Training & capacity building for farmers
- Strong market linkages for both domestic and export markets

With institutional support from ICAR-RCER, state fisheries departments, and private sector involvement, prawn polyculture can significantly enhance aquaculture output, farmer income, and nutritional security.

14 CHAPTER

Seed Production of Kawai

Tarkeshwar Kumar, Kamal Sarma, S.K. Ahirwal and Vivekanand Bharti

Anabas testudineus, commonly known as climbing perch or kawai, is a hardy, air-breathing freshwater fish with high market demand in eastern and north-eastern India. Due to habitat degradation, overexploitation, and lack of quality seed, its wild population has declined. This document outlines a semi-artificial breeding and rearing protocol for mass seed production and grow-out culture of *A. testudineus*.

1. Broodstock Management

- ***Pond Preparation:***
  - Use earthen ponds (40 m × 20 m) with a deeper central section (10 m × 5 m × 1.2 m).
  - Maintain aquatic weeds and rice plants for cover.
  - Install a peripheral dyke (0.5 m) and fine mesh plastic net to prevent escape.
- ***Stocking and Feeding:***
  - Maintain around 300 healthy brooders with a 1:1 male-to-female ratio.
  - Feed daily with commercial feed (22-25% protein).
  - Apply cow dung at 20-25 kg/ha/month for natural productivity.
  - Maintain water depth at 15–20 cm in shallow areas and ~1 m in deeper zones.

2. Broodstock Conditioning and Induced Breeding

- ***Selection of Brooders:***
  - Select mature fish (10–12 cm, 18–20 g) during the breeding season (April–August).
  - Females: bulging abdomen, visible genital papillae, ooze ova on gentle pressure.
  - Males: slender, white milt oozes on pressure.
- ***Conditioning:***
  - Transfer 20 mature brooders to cement cisterns.
  - Feed with high-protein pellets (35% protein) at 5% of biomass for 15 days.
- ***Hormone Injection:***
  - Use Ova-FH hormone (SGnRH analogue + domperidone + glycerol) at 0.1 ml/fish intramuscularly.
  - Release injected brooders into the deeper part of the breeding pond.
- ***Spawning and Hatching:***
  - Spawning occurs within 24–26 hours' post-injection.

- Eggs float on the water surface.
- Hatching occurs within 24–36 hours.
- Fry collection after 50 days by fine mesh net and handpicking.
- Expected yield: >100 fry/m^2 (36 mm, 0.83 g).

3. Nursery Management

- ***Pond Preparation***:
  - Use small earthen ponds (100–500 m^2) or cement cisterns.
  - Apply agricultural lime ($CaCO_3$) @2-3kg/100m^2 and organic manure (cow/ poultry) @ 8-10kg/100m^2 to promote zooplankton.
  - Use probiotics (30g/100m^2) with molasses for faster plankton growth.
- ***Stocking and Rearing***:
  - Maintain water depth at 0.3–0.45 m (1–1.5 ft).
  - Stock 4000–5000 spawns/m^2.
  - After 10 days, supplement with 35% protein feed, plankton, and tubifex worms.
  - At one month, fry reach ~4 cm and 3–4 g with 40–50% survival.
  - Use indoor intensive systems to improve survival rates.

4. Grow-Out Culture

- ***Pond/Cement Tank Preparation***:
  - Earthen ponds: 0.05–0.2 ha with straight dykes to prevent escape.
  - Cement tanks: 15–20 cm soil substrate; aquatic plants (water hyacinth, *Pistia*) covering 30–40% of surface.
  - Install plastic net fencing to deter predators and bird netting to prevent bird attacks.
- ***Stocking Density***:
  - Earthen ponds: 5–6 fish/m^2 (lower density for better growth).
  - Cement tanks: 65–70 fingerlings/m^2.
- ***Feeding and Water Quality***:
  - Feed 3–5% of body weight daily with high-protein (e”35%) feed.
  - Monitor water quality regularly (pH 6.5–8.0, DO >4 mg/L, temperature 25–32°C).
- ***Harvest***:
  - Marketable size (50–60 g) reached in 10–12 months in earthen ponds.
  - In tanks, growth may be faster due to controlled conditions.

5. Health Management

- ***Common Diseases***:
  - Bacterial infections (e.g., *Aeromonas*), fungal infections, and parasites.

- ***Preventive Measures***:
  - Regular water exchange and aeration.
  - Use of probiotics and immunostimulants in feed.
  - Salt (400kg/ha) for new stock.
- ***Treatment***:
  - Antibiotics (oxytetracycline) or antifungal (malachite green) as per need under expert guidance.

6. Economic Viability

- Approx. ₹ 0.50–1.00 per fry (including hormone, feed, labour).
- Grow-Out Cost: ₹ 70–80/kg production cost.
- Market Price: ₹ 150–200/kg in domestic markets (West Bengal, Bihar, Assam).
- Profit Margin: 50–60% under optimal management.

7. Conclusion

Semi-artificial breeding of *Anabas testudineus* offers a sustainable solution to the shortage of quality seed and supports the conservation of this declining species. With proper broodstock management, hormone-induced breeding, and optimized nursery and grow-out practices, farmers can achieve high survival rates and profitable yields. This package of practice provides a scalable model for commercial kawai aquaculture in India and similar tropical regions.

Fig. Earthen Fish Pond for kawai culture

Fig Harvested Anabas testudineus

15 CHAPTER

Seed rearing in Biofloc system

Tarkeshwar Kumar, Kamal Sarma, S.K. Ahirwal and Vivekanand Bharti

Biofloc Technology is a sustainable aquaculture system that enhances water quality, reduces feed costs, and promotes high-density farming by converting toxic nitrogenous wastes into microbial protein. It is particularly suitable for omnivorous and detriticolous species like *Pangasius hypophthalmus* (Pangasius).

1. Species Suitability

- ***Ideal Species:*** Omnivorous and hardy species that can tolerate moderate to high suspended solids. Examples**:** *Pangasius hypophthalmus*, Tilapia, Shrimp, Carp, Catfish (Magur & Singhi), Kawai, etc.
- ***Pangasius Traits:*** Fast-growing, high market demand, tolerant to varied water conditions, and capable of utilizing biofloc as supplemental feed.

2. System Setup and Tank Preparation

Materials Required:

- FRP/cement tanks or lined ponds (e"10 m^3 recommended for seed rearing)
- Aeration system (air blowers or air diffusers)
- Water source: Clean, pollution and chlorine-free water. Boring water is also can be used.
- Carbon sources (molasses, jaggery, wheat flour)
- Nitrogen sources (urea, feed and faecal matter)
- Probiotics (commercial grade)
- Water testing kits (for estimation of pH, ammonia, nitrite, nitrate, dissolved oxygen, TSS)
- Lime and salt

Step-by-Step Tank Preparation:

Step	Activity	Dosage/Instruction
1	Fill tank with water & start aeration	Continuous
2	Add lime ($CaO/Ca(OH)_2$)	50–100 mg/L
3	Add salt (NaCl)	1 g/L
4	Mix well & wait	12–15 hours
5	Add nitrogen source (urea/feed)	5–10 mg/L
6	Add carbon source (molasses/jaggery)	100 mg/L
7	Mix well & wait	12–15 hours
8	Add probiotics	30–40 mg/L
9	Wait for floc development	24–48 hours
10	Floc maturation period	7–10 days
11	Stock fish seed	150 – 250 per m^3

3. Water Quality Management

Parameter	Optimal Range
Dissolved Oxygen (DO)	>5 mg/L
pH	7.0–8.5
Temperature	26–32°C
Ammonia (NH_3)	<0.5 mg/L
Nitrite (NO_2^-)	<0.5 mg/L
Nitrate (NO_3^-)	<50 mg/L
Alkalinity	100–150 mg/L
C:N Ratio	10:1 to 15:1
Total Suspended Solids (TSS)	200–300 mg/L (preferable)

Water quality monitoring: Test on regular basis during the first month.

4. Feeding and Nutrition

- Feed Type:- protein (28–32%) sinking/ floating pellets.
- Feeding Rate: 1–2% of body weight per day, divided into 2–3 times.
- Biofloc as supplement: Reduces feed requirement by 20–30%.
- Carbon supplementation: Maintain C: N ratio by adding molasses/wheat flour as needed.

5. Stocking and Harvesting

- Seed Size: 1–2 cm preferred (preferable average body weight d" 1.0 g)
- Stocking Density: 150- 250 seeds/m^3.
- Rearing Period: 80-100 days to reach 15–25 g.
- Harvesting: Partial or complete harvest using nets; avoid stress.

6. Health Management

- Common Issues: Bacterial infections, parasitic infestations, gill damage due to high TSS.
- Prevention: Maintain good water quality, avoid overfeeding, regular probiotics addition.
- Treatment: Salt baths, herbal extracts, or approved antibiotics under guidance. Only used after consultation with experts and unnecessary application should be avoided.

7. Advantages of BFT for Pangasius

- Preferable for the farmers having less land holding
- Reduced water exchange (up to 80-90% savings).
- Lower feed cost due to biofloc consumption.
- Higher stocking density and survival rate (80–90%).
- Environmentally sustainable (waste recycling).
- Improved Feed Conversion Ratio and growth performance.

8. Challenges and Mitigation

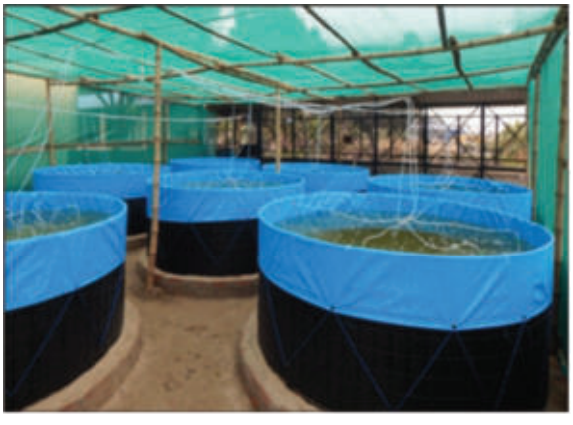
Challenge	Mitigation Strategy
High oxygen demand	Continuous aeration must be provided for better survival of the seed. Use backup aerators. Dissolved oxygen should be continuously monitored. Use automated monitoring systems can be preferred.
TSS accumulation	Install settling tanks; regular siphoning
Skilled labour shortage	Training programs for the workers
Effluent management	Reuse water for agriculture; bio-filtration
System crash risk	Regular water testing; avoid overfeeding

9. Economic Viability

- Initial Investment: Moderate (tank, aeration, testing kit).
- Operational Cost: Reduced due to lower feed cost and water use.
- Return on Investment (ROI): High if managed properly; suitable for small and medium farmers.
- Market: Pangasius has steady demand in domestic and export markets.

10. Conclusion

Biofloc Technology offers a sustainable, productive, and economically viable method for rearing *Pangasius hypophthalmus* seeds. By converting waste into nutritional biomass, BFT reduces environmental impact, lowers production costs, and enhances fish growth and survival. Although it requires careful management of water quality and oxygen levels, the benefits including high yields, reduced water usage, and improved feed efficiency make it a promising approach for modern aquaculture. With proper training, infrastructure, and monitoring, BFT can significantly contribute to food security and farmer livelihoods in tropical and subtropical regions.



Biofloc unit

Harvest of biofloc reared pangiaus fingerling

भाकृअनुप
ICAR

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch