PCDS FMCBS
Technical Feasibility Report for Livestock Farms Scheme Gomal Zam Dam Command Area
August 5, 2023

Submitted by: **The Kaizen Company LLC**

This report is made possible by the support of the American people through the United States Agency for International Development (USAID). The contents of this report are the sole responsibility of The Kaizen Company and do not necessarily reflect the views of USAID or the United States Government.

ACTIVITY INFORMATION

Activity Name:	Pakistan Capacity Development Services (PCDS) Financial Management and, Assessment, Feasibility, and Capacity Building Support Services for Gomal Zam Dam Command Area Development
Activity Start Date and End Date:	Oct 13, 2020 – Oct 12, 2024
Name of Prime Implementing Partner:	The Kaizen Company, LLC
Task Order Number:	72039120F00005
Name of Subcontractors/Sub-awardees:	
Major Counterpart Organizations:	Department of Agriculture, KP. Gomal Zam Dam Command Area Development Project

TABLE OF CONTENTS

List of Acronyms

CLA	Collaborating, Learning, and Adapting
CLIN	Contract Line-Item Numbers
CPFF	Cost Plus Fixed Fee
COR	Contracting Officer's Representative
DAI	Degree Awarding Institution
DDL	Development Data Library
DOHS	Department of Health, Sindh
DMP	Data Management Processes
DSA	Daily Subsistence Allowances
DQA	Data Quality Assessment
FFP	Firm Fixed Price
FMCDS	Financial Management and Capacity Building Services
GFR	General Financial Rule
GST	General Sale Tax
GIS	Geographical Information System
G2G	Government to Government
IR	Intermediate Result
IDIQ	Indefinite Delivery Indefinite Quantity
LMS	Learning Management System
MoNHSR&C	Ministry of National Health Services, Regulations, and Coordination
MoU	Memorandum of Understanding
MEL	Monitoring, Evaluation & Learning
MIS	Management Information System
MOU	Memorandum of Understanding
NHV	National Health Vision 2025
O&M	Operation and Maintenance
P&D Dept.	Planning & Development Department
PC-I	Planning Commission Proforma-I
PFMRAF	Public Financial Management Risk Assessment Framework
PMU	Project Management Unit
PPRA	Public Procurement Regulatory Authority
PSC	Project Steering Committee
QA/QC	Quality Assurance / Quality Control
QMR	Quarterly Monitoring Report
QPRs	Quarterly Progress Reports
RBM	Result Based Monitoring
RFP	Request for Proposals
RMP	Risk Management Plan
SOP	Standard Operating Procedure
SOW	Scope of Work
STTA	Short-Term Technical Assistance
ToR	Terms of Reference
ToT	Training of Trainer
TO	Task Order
TOM	Task Order Manager
USAID	United States Agency for International Development

1. EXECUTIVE SUMMARY

This Technical Feasibility Report provides a comprehensive assessment of the viability of **establishing, upgrading, and scaling smallholder livestock farms with herd sizes ranging from 20 to 100 animals** within the Gomal Zam Dam Command Area. The assessment evaluates the full livestock production system under prevailing local conditions, including animal genetics, feed and fodder availability, water access, housing and farm infrastructure, animal health and biosecurity, labor and management capacity, and access to extension and support services. The proposed livestock development model adopts an **integrated, farm-systems approach**, combining the introduction of locally adapted improved breeds, optimized feeding and fodder production systems supported by reliable irrigation, preventive animal health and veterinary services, low-cost but technically sound housing improvements, targeted cash grants to address short-term liquidity constraints, and sustained extension support to strengthen farm management and technical skills.

The analysis demonstrates that, under the **existing agro-climatic conditions, improved water availability resulting from the Gomal Zam Dam, and current market demand for livestock products**, smallholder livestock farms in the command area are **technically viable, operationally realistic, and environmentally sustainable**. The proposed schemes are designed to enhance productivity per animal while maintaining stocking rates compatible with local feed and water resources, thereby reducing pressure on rangelands and minimizing environmental degradation. Social feasibility is reinforced through inclusive beneficiary targeting, with explicit provisions for the participation of women and vulnerable households, and through community-based approaches to animal health, fodder management, and market engagement. Overall, the livestock development interventions are strongly aligned with the irrigation investments made under the Gomal Zam Dam project and provide a **clear, practical pathway for converting water infrastructure benefits into sustained increases in household incomes, improved food and nutrition security, and expanded rural employment opportunities** across the command area.

2. PROJECT CONTEXT AND RATIONALE FOR TECHNICAL FEASIBILITY ANALYSIS

2.1 Regional Context

The Gomal Zam Dam Command Area is located within a **semi-arid agro-ecological zone** characterized by low and erratic rainfall, high evapotranspiration rates, and pronounced seasonal temperature extremes. Recent climatic trends indicate **increasing climate variability**, manifested through extended dry spells, delayed or unpredictable monsoon patterns, and a rising frequency of heat stress events. These conditions have historically constrained both crop and livestock productivity and have increased the vulnerability of smallholder farming systems to climate-related shocks. The introduction of regulated irrigation through the Gomal Zam Dam represents a critical structural intervention aimed at mitigating water scarcity risks and stabilizing agricultural production in the region.

Farming systems within the command area are predominantly **mixed crop–livestock systems**, in which livestock play a complementary and multifunctional role alongside crop production. Crop residues such as wheat straw, maize stover, and sorghum stalks constitute a major component of livestock feed, while animal manure contributes to soil fertility and nutrient recycling within irrigated and rainfed fields. However, prior to the availability of reliable irrigation, fodder production was largely seasonal and insufficient, resulting in chronic feed deficits during dry periods. This has limited herd productivity, constrained opportunities for livestock intensification, and increased reliance on low-quality roughages with poor nutritional value.

Historically, **livestock productivity in the command area has remained low** due to a combination of structural and technical constraints. These include limited access to improved and locally adapted breeds, inadequate availability of quality feed and fodder, weak animal health and veterinary service coverage, and suboptimal housing and husbandry practices. Smallholder farmers have traditionally relied on indigenous or poorly managed crossbred animals with low genetic potential, leading to low milk yields, slow growth rates, and high susceptibility to disease and environmental stress. Feed shortages during critical periods have further exacerbated productivity losses and increased animal mortality, particularly among young stock.

Despite these constraints, livestock remains a **primary livelihood asset** for rural households in the Gomal Zam Dam Command Area, serving as a key source of regular income, household nutrition, savings, and risk management. For smallholders with limited landholdings, livestock provides a flexible and liquid asset that can be sold or leveraged during periods of financial stress. Livestock ownership is particularly important for **women**, who are often responsible for day-to-day animal care and derive direct benefits from milk production, poultry rearing, and small ruminant management. However, the full economic and productive potential of livestock has yet to be realized due to the persistent technical, resource, and service delivery constraints that characterize the region.

Within this context, the combination of **improved irrigation infrastructure, targeted livestock development interventions, and strengthened extension and veterinary services** presents a significant opportunity to transform existing low-input, low-output livestock systems into more productive, resilient, and market-oriented enterprises. Addressing feed availability, genetic improvement, and animal health within the framework of mixed farming systems is therefore central to unlocking the livelihood potential of livestock in the Gomal Zam Dam Command Area.

2.2 Rationale for Livestock Development

Livestock development represents a strategically sound and economically justified intervention for the Gomal Zam Dam Command Area, particularly in the context of smallholder-dominated mixed farming systems and increasing climate variability. Compared to purely crop-based production systems, livestock enterprises offer **higher income elasticity**, greater resilience to climatic and market shocks, and stronger linkages to household nutrition and employment. When integrated with improved irrigation infrastructure, livestock development provides an effective mechanism for translating water investments into sustained and inclusive rural growth.

Livestock production exhibits **high income elasticity relative to crops**, meaning that incremental improvements in livestock productivity generate disproportionately higher gains in household income. Smallholder livestock enterprises—particularly dairy, small ruminant fattening, and poultry—produce marketable outputs on a regular basis and respond quickly to improvements in genetics, feeding, and animal health. Unlike staple crops, which are subject to seasonal harvest cycles and price volatility, livestock products such as milk, meat, and eggs provide continuous revenue streams and allow farmers to respond flexibly to market demand. As a result, investments in livestock development tend to yield faster and more stable income growth for smallholders, making them a particularly effective poverty-reduction instrument in semi-arid rural settings.

Livestock development also enables the **efficient utilization of crop residues and irrigated fodder**, enhancing overall farm system efficiency and resource use. In the Gomal Zam Dam Command Area, mixed crop–livestock systems generate substantial quantities of crop residues, including wheat straw, maize stover, and sorghum stalks, which are otherwise of limited economic value. Livestock convert these low-value by-products into high-value animal protein, thereby improving nutrient recycling and reducing on-farm waste. The availability of reliable irrigation water under the Gomal Zam Dam further strengthens this synergy by enabling the cultivation of high-yield fodder crops and forage legumes, reducing seasonal feed deficits and stabilizing livestock productivity

throughout the year. This integration maximizes returns on both land and water resources while reducing pressure on communal grazing areas.

A further justification for livestock development lies in its ability to provide **year-round cash flow for rural households**, which is critical for financial stability and risk management among smallholders. Livestock enterprises generate frequent and predictable income through daily milk sales, periodic animal sales, and regular poultry production, allowing households to meet recurring expenses such as food purchases, education, health care, and farm inputs. This continuous cash flow reduces reliance on distress sales of assets, high-interest borrowing, or seasonal migration, particularly during lean periods between crop harvests. For women and land-poor households, livestock—especially small ruminants and poultry—often represent the most accessible and controllable source of independent income.

In addition to income effects, livestock development has **strong nutrition and food security impacts** at both household and community levels. Livestock products such as milk, meat, and eggs are rich sources of high-quality protein and essential micronutrients, including calcium, iron, and vitamins, which are critical for child growth, maternal health, and overall dietary diversity. Increased availability and affordability of animal-source foods contribute directly to improved nutritional outcomes, particularly for women and children. Furthermore, livestock serve as a form of food security insurance, allowing households to buffer consumption during periods of crop failure or market disruption through the sale or consumption of animals and animal products.
Overall, livestock development within the Gomal Zam Dam Command Area is justified not only on economic grounds but also on **efficiency, resilience, nutrition, and social inclusion considerations**. When aligned with improved irrigation, fodder production, veterinary services, and extension support, livestock development offers a high-impact pathway for enhancing rural livelihoods, strengthening food systems, and maximizing the developmental returns on large-scale water infrastructure investments.

The availability of **controlled irrigation water** significantly enhances fodder reliability, making livestock intensification technically viable.

3. OBJECTIVES OF THE LIVESTOCK FARM SCHEMES

The overarching objective of the proposed livestock farm schemes is to transform existing low-input, low-output livestock production systems in the Gomal Zam Dam Command Area into **productive, resilient, market-oriented, and socially inclusive enterprises**. The schemes are designed to complement irrigation investments under the Gomal Zam Dam by directly linking improved water availability to fodder production, animal productivity, and household income generation. The specific objectives of the livestock farm schemes are outlined below.

3.1 Increase Milk, Meat, and Poultry Productivity per Animal

The first objective is to significantly increase **per-animal productivity** across cattle, small ruminants, and poultry, thereby improving overall farm output without proportionally increasing herd sizes. This objective focuses on enhancing biological performance through the adoption of improved and locally adapted breeds, balanced feeding regimes, and improved animal health management. Increased milk yields per cow, higher growth rates in sheep and goats, improved reproductive performance, and higher egg and meat output in poultry are expected outcomes. By concentrating on productivity per animal rather than herd expansion, the schemes aim to raise farm incomes while maintaining stocking rates compatible with local feed, water, and land resources.

3.2 Improve Technical Efficiency of Smallholder Livestock Farms

A core objective of the schemes is to improve the **technical and managerial efficiency** of smallholder livestock farms. This includes optimizing input use—such as feed, water, labor, and veterinary services—to maximize output and profitability. Interventions will promote improved housing designs, appropriate stocking densities, structured feeding schedules, and basic farm record-keeping to support informed decision-making. Extension services will focus on strengthening farmers' technical skills in husbandry, reproduction, and farm management, enabling them to reduce avoidable losses, improve feed conversion efficiency, and adopt cost-effective production practices suited to smallholder conditions.

3.3 Reduce Mortality and Disease Incidence

Reducing animal mortality and disease prevalence is a critical objective underpinning the technical feasibility of the livestock schemes. High mortality rates, particularly among young stock, currently represent a major source of economic loss for smallholders. The schemes aim to establish **preventive animal health systems**, including regular vaccination, deworming, parasite control, and improved biosecurity measures at the farm level. Strengthened linkages with public and private veterinary service providers will ensure timely disease diagnosis and treatment. Improved housing, hygiene, and nutrition will further enhance animal immunity and resilience, resulting in lower mortality rates and more stable farm performance.

3.4 Promote Climate-Resilient and Resource-Efficient Practices

Given the semi-arid nature of the Gomal Zam Dam Command Area and increasing climate variability, the schemes place strong emphasis on promoting **climate-resilient and resource-efficient livestock production practices**. This objective includes the adoption of heat-tolerant and drought-resilient breeds, improved housing designs that reduce heat stress, and efficient water use through properly designed watering systems. Fodder production systems will emphasize irrigated forages, drought-tolerant fodder crops, and fodder conservation techniques such as silage and hay-making to mitigate seasonal feed shortages. Efficient manure management and nutrient recycling will further enhance environmental sustainability and reduce the ecological footprint of livestock farming.

3.5 Strengthen Participation of Women and Vulnerable Households

Strengthening the participation of **women and vulnerable households** is a cross-cutting objective of the livestock farm schemes. Livestock production activities are well-suited to household-based management and offer significant opportunities for women's economic participation and empowerment. The schemes will incorporate gender-sensitive beneficiary selection criteria, ensure women's access to livestock assets, training, and extension services, and promote women's involvement in farmer and livestock producer groups. Special attention will be given to smallholders with limited landholdings and resources, ensuring that scheme design, investment requirements, and support mechanisms remain accessible and inclusive.

3.6 Integrate Livestock Production with Irrigated Agriculture

The final objective is to strengthen the **integration of livestock production with irrigated agriculture**, thereby enhancing overall farm system productivity and resilience. Improved irrigation under the Gomal Zam Dam provides a reliable foundation for increased fodder production, which in turn supports higher livestock productivity. The schemes promote close linkages between crop and livestock enterprises, including the use of crop residues as feed, the application of livestock manure to improve soil fertility, and coordinated farm planning to optimize land and water use. This

integrated approach maximizes the returns on irrigation investments and reinforces the sustainability of both crop and livestock production systems within the command area.

4. TARGET BENEFICIARIES

The livestock development schemes are designed to support smallholder farmers in the Gomal Zam Dam Command Area, with a specific focus on households that maintain a manageable herd size and possess the capacity to adopt improved production practices. The selection of target beneficiaries and livestock parameters is informed by local agro-ecological conditions, resource availability, and socio-economic factors, ensuring that interventions are technically feasible, economically viable, and socially inclusive.

Parameter	Description
Herd Size	20–100 animals
Livestock Types	Cattle, sheep, goats, poultry
Beneficiaries	Smallholder farmers, women-headed households
Location	Gomal Zam Dam Command Area
Experience	Minimum basic livestock rearing experience

4.1 Herd Size

Targeted herds range from **20 to 100 animals per farm**, a size that balances productive efficiency with the resource constraints typical of smallholder households. Herds at this scale allow for the implementation of **improved feeding, housing, and animal health practices** while remaining manageable within household labor capacities. Smaller herds facilitate close supervision, improved record-keeping, and adherence to recommended husbandry protocols, which are essential for enhancing productivity, reducing mortality, and ensuring sustainability. Herd sizes within this range also allow beneficiaries to participate in **group-based extension services, collective feed procurement, and marketing arrangements**, optimizing economies of scale without overextending household resources.

4.2 Livestock Types

The schemes encompass multiple livestock species—**cattle, sheep, goats, and poultry**—reflecting the mixed farming systems prevalent in the command area. Each species has been selected for its adaptability to local agro-ecological conditions and contribution to household income, nutrition, and food security:

- **Cattle:** Primarily for milk production, draft support, and meat, using improved or crossbred dairy animals.
- **Sheep and goats:** Suited for meat and secondary dairy production, with rapid reproductive cycles and resilience to semi-arid conditions.
- **Poultry:** Layers and broilers provide frequent, low-cost protein and cash income, particularly accessible to women-headed households.

This species diversification allows households to **spread risk, maximize returns on available feed and fodder, and enhance year-round income and nutrition**.

4.3 Beneficiaries

The livestock schemes specifically target **smallholder farmers**, including **women-headed and vulnerable households**, who rely heavily on livestock as a primary livelihood asset. Beneficiary selection prioritizes households with limited landholdings but demonstrated capacity to manage and benefit from livestock interventions. Special attention is given to women-headed households because livestock management activities—particularly small ruminants and poultry—provide women with

direct control over income and improved household nutrition, thereby enhancing gender equity and social inclusion.

4.4 Location

All interventions are concentrated within the **Gomal Zam Dam Command Area**, leveraging the benefits of improved irrigation infrastructure to support year-round fodder production and ensure reliable water supply for livestock. The schemes are tailored to local **climatic conditions, water availability, and market access**, and are aligned with broader regional development objectives, including increased rural income, improved food security, and sustainable land and water use.

4.5 Experience Requirement

Eligible beneficiaries are required to have **minimum basic experience in livestock rearing**, ensuring they possess foundational knowledge of animal husbandry, feeding, and basic health management. This criterion facilitates **rapid adoption of improved practices**, reduces training requirements, and enhances the likelihood of technical and financial success. For households with limited experience, the program includes **structured training and extension support**, allowing beneficiaries to acquire the necessary skills to manage larger, more productive herds effectively.

5. FARM TYPOLOGIES COVERED

The proposed livestock development schemes under the Gomal Zam Dam Command Area are designed around distinct farm typologies, reflecting the diversity of smallholder capacities, available resources, and market opportunities. Each typology integrates considerations of herd/flock size, labor availability, management intensity, feed and fodder requirements, and market orientation. The selection of typologies ensures that interventions remain technically feasible, economically viable, and manageable within the labor and managerial capacity of smallholders.

5.1 Dairy-Oriented Cattle Farms

Dairy-oriented farms are focused primarily on milk production for household consumption and sale, with herd sizes ranging from 10–40 improved or crossbred cows. These farms are designed for households with sufficient land for fodder cultivation and access to water for irrigation and livestock consumption. Key characteristics include:

- Breeds: High-yield, heat- and drought-tolerant dairy breeds (e.g., Sahiwal, Red Sindhi, or crossbreds).
- Feeding: Integration of irrigated fodder crops, crop residues, and supplemental concentrate feed to ensure consistent milk yield throughout the year.
- Housing: Low-cost, ventilated cattle sheds with sloped floors and drainage, ensuring hygiene and animal comfort.
- Labor: Primarily family-managed, with tasks distributed across milking, feeding, cleaning, and minor health interventions.
- Market Linkage: Milk sold to local collection points or dairy cooperatives, providing regular cash flow.

This typology emphasizes productivity per animal rather than herd expansion, optimizing profitability and reducing environmental pressures from overstocking.

5.2 Mixed Cattle–Small Ruminant Farms

Mixed farms combine dairy cattle with sheep and goats, enabling smallholders to diversify income streams and reduce risk associated with market or climatic fluctuations. Typical herd/flock composition includes 5–10 cows and 15–30 small ruminants. Key features:

- Integration: Crop residues from irrigated agriculture are efficiently recycled as feed; manure is used to improve soil fertility.
- Technical Management: Separate housing for cattle and small ruminants, but integrated feed planning to maximize use of available roughages.
- Resilience: Mixed species provide buffer against disease outbreaks, feed shortages, or climate shocks, enhancing overall system sustainability.
- Income Streams: Milk, meat, and occasional sale of young stock or surplus animals provide a continuous flow of income throughout the year.

This typology balances labor and management intensity, allowing households to adopt improved practices across multiple livestock species without exceeding capacity.

5.3 Small Ruminant Fattening Units

Small ruminant fattening units are specialized systems focused on rapid weight gain and meat production for market sale. Typical units consist of 20–50 sheep or goats, depending on household capacity and feed availability. Key design elements include:

- Feeding: Concentrate-based rations supplemented with crop residues and cultivated fodder to achieve optimal growth rates.
- Housing: Simple but secure pens that protect animals from predators and reduce disease risk.
- Animal Selection: Use of fast-growing, locally adapted breeds (e.g., Beetal, Kajli, or Lohi) with strong disease resilience.
- Market Orientation: Animals are sold at predetermined market weights to ensure predictable cash flow.
- Labor Requirements: Low to moderate, focusing on feeding, health monitoring, and record-keeping.

This typology allows households to capitalize on high-value market opportunities while remaining manageable within smallholder labor constraints.

5.4 Backyard and Semi-Commercial Poultry Farms

Poultry farms are designed to support small-scale, family-managed operations that generate regular income and improve household nutrition. Depending on household capacity and market access, units may range from 50–200 birds. Key components include:

- Poultry Types: Improved local layers for egg production and broilers for meat.
- Housing: Low-cost, well-ventilated poultry sheds with nesting boxes and predator protection.
- Feeding: Balanced commercial or home-mixed feeds with access to clean water; crop residues or kitchen waste may supplement feed.
- Labor: Activities such as feeding, egg collection, vaccination, and cleaning are compatible with household labor availability, often involving women and youth.
- Market Linkages: Eggs and meat sold in local markets or through producer groups, ensuring a steady and flexible cash flow.

Backyard and semi-commercial poultry operations complement larger livestock enterprises, providing frequent income, enhancing dietary diversity, and promoting inclusion of women and vulnerable households in income-generating activities.

5.5 Cross-Cutting Considerations Across All Typologies

- All farm typologies are designed to remain within the management and labor capacity of smallholders, ensuring that technical improvements can be sustained without external labor dependency.
- Each typology emphasizes integration with irrigated fodder production, preventive animal health management, and efficient resource utilization, maximizing productivity while minimizing environmental impact.

- The typologies are scalable and adaptable, allowing households to expand or diversify operations as skills, resources, and market opportunities grow.

6. TECHNICAL FEASIBILITY ANALYSIS

6.1 Breed Selection and Genetic Improvement

Selection Criteria

i. Heat and Drought Tolerance

Given the semi-arid climate of the Gomal Zam Dam Command Area, livestock must be able to **withstand high temperatures, prolonged dry periods, and intermittent feed shortages** without significant loss of productivity. Breed selection prioritizes animals with:

- Adaptation to high ambient temperatures and solar radiation.
- Efficient water utilization and metabolic resilience under feed scarcity.
- Tolerance to variable grazing and fodder availability, ensuring sustained milk, meat, or egg production under semi-intensive management.
- For example, indigenous and crossbred cattle such as **Sahiwal and Red Sindhi** demonstrate superior heat tolerance compared to exotic breeds, while goats such as **Beetal and Kamori** thrive in dry conditions with minimal supplemental feed.

ii. Disease Resistance

Livestock in smallholder systems are often exposed to **endemic diseases**, including foot-and-mouth disease, Peste des Petits Ruminants (PPR), parasitic infestations, and poultry viral infections such as Newcastle Disease. Selected breeds must have **proven resilience to prevalent local diseases** and a history of surviving and reproducing under routine exposure. Disease-resistant breeds reduce the need for intensive veterinary interventions, lower mortality rates, and ensure continuity of production, particularly in households with limited access to veterinary services.

iii. Local Availability and Acceptance

Breed selection emphasizes **readily available and locally accepted genetic stock**, facilitating adoption, cultural acceptance, and access to inputs such as replacement animals and breeding services. Familiar breeds simplify farmer training, reduce risk of rejection due to cultural preferences, and support local market integration. For example:

- Cattle: Sahiwal, Red Sindhi, and locally maintained crossbreds.
- Sheep: Kajli and Lohi, widely recognized for meat quality and adaptation.
- Goats: Beetal and Kamori, preferred for both meat and milk.
- Poultry: Improved local layers and broilers with proven performance under backyard conditions.

iv. Productivity Under Smallholder Conditions

Selected breeds must demonstrate **high productive efficiency under low- to medium-input management systems**. This includes:

- Milk yield for dairy cattle that can sustain household consumption and generate surplus for sale.
- Growth rates and feed conversion efficiency in sheep and goats suitable for fattening and market sale.
- Egg and meat output in poultry that is achievable with smallholder feeding and housing practices.
- Reproductive efficiency, including calving, kidding, and hatching intervals compatible with smallholder labor availability.

v. Genetic Improvement Strategies

- To further enhance productivity and resilience, the schemes incorporate **strategic genetic improvement measures** tailored to smallholder systems:
- **Selective Breeding:** Use of superior sires within local herds to gradually improve herd performance while maintaining adaptation traits.
- **Artificial Insemination (AI):** Introduction of high-performing, locally adapted bulls or bucks to improve milk yield, growth rates, and reproductive efficiency. AI programs are coupled with **training for farmers and local technicians** to ensure correct implementation.
- **Crossbreeding Programs:** Strategic crossbreeding of indigenous and exotic breeds to enhance productivity while retaining climate resilience and disease tolerance.
- **Breeding Record Management:** Maintenance of accurate breeding and performance records to inform future selection decisions and monitor improvements.
- **Community-Based Breeding Initiatives:** Encouragement of **village-level bull and buck services**, whereby households collectively manage breeding stock, improving access, reducing costs, and maintaining genetic diversity.

vi. Implementation Considerations

- **Smallholder Suitability:** Only breeds that perform well under **semi-intensive management systems**, with moderate feed and labor inputs, are considered.
- **Monitoring and Evaluation:** Regular performance monitoring, including milk yield, growth rates, reproductive success, and health indicators, ensures genetic improvement strategies are effective and adaptive.
- **Integration with Feed and Health Interventions:** Breed selection is closely coordinated with **fodder production, feeding programs, and veterinary services** to maximize the productivity of genetically superior animals.

6.2. Recommended Breed and Justification

The success of smallholder livestock schemes in the Gomal Zam Dam Command Area depends critically on selecting breeds that combine high productivity with climate resilience, disease tolerance, and adaptability to low- to medium-input management systems. The following livestock breeds have been recommended based on local agro-climatic conditions, market potential, and smallholder capacities.

Livestock	Recommended Breeds	Justification
Cattle	Sahiwal, Red Sindhi, Crossbred	High milk yield, climate resilience
Sheep	Kajli, Lohi	Meat productivity, arid adaptation
Goats	Beetal, Kamori	Dual-purpose, hardy
Poultry	Improved local strains	Adaptability, disease tolerance

6.2.1 Cattle

Recommended Breeds: Sahiwal, Red Sindhi, and locally adapted Crossbreds.
Justification:

- **High Milk Yield:** These breeds consistently demonstrate above-average milk production under semi-intensive smallholder management, supporting both household nutrition and income generation through sale of surplus milk.
- **Climate Resilience:** Indigenous breeds such as Sahiwal and Red Sindhi exhibit excellent tolerance to heat stress and prolonged dry periods, maintaining productivity in the semi-arid conditions of the Gomal Zam Command Area.
- **Disease Resistance:** These breeds have inherent resilience to common endemic diseases, reducing mortality risk and reliance on intensive veterinary care.

- **Crossbreeding Potential:** Locally adapted crossbreds allow gradual improvement in milk yield while retaining the hardiness and low maintenance requirements of indigenous cattle.

6.2.2 Sheep

Recommended Breeds: Kajli and Lohi.
Justification:

- **Meat Productivity:** Both breeds are well-suited for meat production, exhibiting favorable growth rates, carcass quality, and market acceptability.
- **Adaptation to Arid Conditions:** Kajli and Lohi sheep thrive in semi-arid climates, tolerating feed and water scarcity better than exotic breeds.
- **Reproductive Efficiency:** High reproductive rates contribute to regular availability of marketable stock, enhancing cash flow for smallholders.
- **Low Maintenance:** These breeds perform well under smallholder grazing and semi-intensive management systems, requiring minimal supplemental inputs.

6.2.3 Goats

Recommended Breeds: Beetal and Kamori.
Justification:

- **Dual-Purpose:** These goats provide both milk and meat, increasing flexibility and resilience for smallholder households.
- **Hardiness:** Beetal and Kamori are robust breeds capable of tolerating heat, feed shortages, and variable management conditions.
- **Rapid Growth and Early Maturity:** Fast growth rates and early reproductive maturity improve economic returns for smallholders, particularly in fattening or breeding enterprises.
- **Adaptability:** These breeds integrate well with crop-livestock systems, utilizing crop residues and irrigated fodder efficiently.

6.2.4 Poultry

Recommended Breeds: Improved local strains (layers and broilers).
Justification:

- **Adaptability:** These birds are well adapted to the local climate and smallholder management systems, maintaining productivity under backyard or semi-commercial setups.
- **Disease Tolerance:** Improved local strains exhibit greater resistance to common poultry diseases such as Newcastle Disease and Infectious Bursal Disease, reducing mortality and veterinary costs.
- **High Productivity:** Layers produce frequent eggs for both household consumption and market sale, while broilers provide rapid meat production, generating regular cash flow.
- **Low Input Requirements:** These strains can thrive with moderate feed inputs and simple housing, making them suitable for women-headed households and labor-constrained smallholders.

6.3 Housing and Farm Infrastructure

6.3.1 Cattle Housing

Cattle housing is designed for dairy and mixed-cattle smallholder farms, with the following key specifications:

- Space Requirements: Each cow or buffalo should have 2.5–3.0 m^2 of stall space, allowing adequate room for lying, standing, and movement within the pen. Sufficient space reduces stress, prevents injuries, and supports healthy weight gain and milk production.

- Orientation: Housing should ideally face South-East, maximizing natural light and minimizing heat stress during peak sunlight hours. Proper orientation also supports ventilation and air circulation within the shed.
- Flooring: Floors should be sloped cement or raised earthen platforms, ensuring drainage of urine and wash water, reducing hoof problems and preventing waterborne diseases. Sloped floors also facilitate easier cleaning and manure management.
- Ventilation: Open-sided walls with ridge vents at the roof allow for continuous airflow, preventing heat accumulation, reducing humidity, and minimizing respiratory problems. Natural ventilation complements the semi-arid climate of the region, promoting animal comfort with minimal energy input.
- Additional Features: Feeding alleys and water troughs should be conveniently located within the housing layout. Manure management areas should be designated to facilitate composting or biogas production, promoting sustainable waste utilization.

6.3.2 Sheep and Goat Housing

Housing for sheep and goats is designed for small ruminant fattening units and mixed smallholder farms, emphasizing protection, hygiene, and ease of management:

- Space Requirements: Each animal should have 0.5–1.0 m² of pen space, sufficient for lying, feeding, and moving without crowding, which is critical for growth and reproductive performance.
- Flooring: Raised floors with straw bedding keep animals dry, reduce parasite load, and provide thermal insulation against heat and cold. Bedding should be regularly replaced to maintain hygiene.
- Fencing: Pens must be predator-proof, using wire mesh or wooden fencing to protect animals from dogs, foxes, and other local predators. This also reduces stress and prevents loss of animals, especially during nighttime or grazing periods.
- Ventilation and Shelter: Housing should be partially enclosed to protect animals from extreme sun, rain, and wind while allowing adequate air circulation. Roofs made of lightweight, reflective materials help regulate temperature.
- Additional Considerations: Feeding and water points should be easily accessible to all animals, and manure collection systems integrated for composting or fodder enhancement.

6.3.3 Poultry Housing

Poultry housing is designed for backyard and semi-commercial operations, with attention to space, ventilation, and protection:

- Space Requirements:
  - Layers: 0.1–0.2 m² per bird to ensure comfort, prevent overcrowding, and optimize egg production.
  - Broilers: 0.3–0.5 m² per bird to accommodate faster growth and higher feed intake.
- Ventilation: Natural ventilation is provided through open sides with wire mesh, allowing airflow while preventing entry of predators. Good ventilation prevents respiratory diseases and reduces heat stress, which is particularly important during summer months.
- Nesting and Roosting: Layers should have nesting boxes at a ratio of 1 box per 4–5 birds to encourage egg laying and reduce breakage. Roosting perches should be installed to allow natural sleeping behaviors.
- Flooring: Raised or slatted floors are preferred to maintain hygiene and facilitate manure collection. Litter such as wood shavings or straw should be regularly replaced to prevent ammonia buildup and parasite infestation.
- Biosecurity: Poultry houses should include controlled entry points, footbaths, and clean water supply to minimize disease risk, particularly in semi-intensive backyard setups.

6.3.4 Integrated Farm Infrastructure Considerations

- Water Supply: Troughs and drinkers should be strategically placed to ensure all animals have continuous access to clean water. Water points must be regularly cleaned to prevent contamination.
- Feed Storage: Covered, rodent-proof silos or sheds are required to store concentrate feed, fodder, and crop residues safely, preserving quality and reducing losses.
- Waste Management: Manure collection pits or composting areas should be incorporated into housing design. Options such as biogas plants can add value while reducing environmental impact.
- Accessibility: Housing should allow easy access for feeding, cleaning, veterinary interventions, and animal handling, optimizing labor efficiency for smallholder households.

Outcome:

Well-designed housing and farm infrastructure in the Gomal Zam Dam Command Area will:

- Reduce animal stress, disease incidence, and mortality.
- Increase milk, meat, and egg productivity.
- Facilitate efficient management by smallholder farmers, including women and vulnerable households.
- Support sustainable integration of livestock production with irrigated crop systems.

6.4 Feed and Fodder Systems

6.4.1 Feeding Strategy

An efficient and sustainable feed and fodder system is fundamental to improving livestock productivity, profitability, and resilience within the Gomal Zam Dam command area. The feeding strategies proposed under the feasibility analysis were designed to reflect local agro-ecological conditions, water availability, cropping patterns, and the economic capacity of smallholder and commercial producers. Emphasis was placed on optimizing the use of locally available feed resources while strategically supplementing diets to address nutritional gaps.

Livestock	Feed Composition
Cattle	60–70% roughage, 30–40% concentrate
Sheep/Goats	Grazing + concentrate supplementation
Poultry	Balanced feed (18–22% protein)

For cattle production systems, a balanced feeding regime consisting of 60–70 percent roughage and 30–40 percent concentrate was identified as technically and economically optimal. Roughage sources include green fodder crops (such as berseem, maize, and sorghum), crop residues, and improved forage varieties made possible through enhanced irrigation. Concentrate feeds—comprising oilseed cakes, cereal by-products, and formulated feed mixes—are required to meet energy and protein requirements, particularly for lactating and high-yielding animals.
This feeding strategy improves milk yield, reproductive performance, and animal health while maintaining affordability for farmers. The feasibility analysis also considered seasonal fodder shortages and promoted fodder conservation practices such as silage and haymaking to stabilize feed availability throughout the year

Sheep and goat production systems within the command area rely primarily on grazing-based feeding, supplemented with concentrates during critical physiological stages such as growth, pregnancy, and lactation. Natural rangelands, fallow fields, and crop residues form the backbone of small ruminant nutrition. However, overgrazing risks and seasonal variability necessitate targeted supplementation to sustain productivity.
Concentrate supplementation improves weight gain, kidding/lambing rates, and survival of young stock, particularly during dry periods. The proposed feeding approach balances low-cost grazing with

strategic inputs, ensuring economic viability for pastoral and mixed-farming households while reducing pressure on communal grazing resources.

For poultry production, the feasibility studies recommended the use of balanced commercial or on-farm formulated feeds containing 18–22 percent crude protein, tailored to the specific production stage (starter, grower, and layer/broiler). Proper feed formulation is critical for achieving optimal growth rates, feed conversion efficiency, and egg or meat production.
The analysis emphasized reliable access to quality feed ingredients, local feed milling opportunities, and cost control mechanisms to maintain profitability. Improved feeding practices were identified as a key driver for scaling up smallholder and semi-commercial poultry operations within the command area.

Across all livestock systems, the feed and fodder strategies incorporated risk mitigation measures related to climate variability, water availability, and market price fluctuations. Improved fodder production under irrigated conditions, diversification of feed sources, and farmer training on ration balancing were integral components of the proposed interventions. These measures ensure that enhanced livestock productivity is environmentally sustainable, economically viable, and resilient to external shocks.

6.4.2 Fodder Production

Sustainable fodder production is a critical pillar of livestock development within the Gomal Zam Dam command area, particularly in the context of expanding irrigated agriculture. The feasibility analysis emphasized the development of a diversified fodder base that maximizes the benefits of improved water availability while reducing seasonal feed shortages and production risks. The proposed fodder production system integrates irrigated fodder crops, efficient use of crop residues, and fodder conservation techniques to ensure year-round feed availability.
The introduction and expansion of irrigated fodder crops such as maize, sorghum, and lucerne were identified as high-impact interventions for improving feed quantity and quality. Maize and sorghum provide high biomass yields and are well-suited to the climatic conditions of the command area, particularly during the summer season. Lucerne, as a perennial leguminous fodder, offers high protein content, improves soil fertility through nitrogen fixation, and provides multiple cuttings throughout the year.
The feasibility assessment evaluated water requirements, cropping calendars, and expected yields to ensure compatibility with the irrigation scheduling of the command area. These fodder crops were shown to significantly enhance livestock productivity by supplying energy- and protein-rich feed, especially for dairy cattle and small ruminants.

6.4.3 Utilization of Crop Residues

Efficient utilization of **crop residues such as wheat straw and maize stover** forms an essential component of the fodder strategy, particularly for smallholder farmers with limited landholdings. These residues, which are readily available following harvest, provide a low-cost source of roughage and help reduce reliance on purchased feeds.
The feasibility analysis also emphasized the importance of improving the nutritive value of crop residues through chopping, urea treatment, and strategic supplementation with concentrates or leguminous fodder. These practices enhance digestibility and intake, allowing farmers to convert otherwise low-value by-products into productive livestock feed while minimizing waste.

6.4.4 Silage and Hay Production for Lean Periods

Seasonal variability in fodder availability—especially during dry and winter periods—was identified as a major constraint to consistent livestock productivity. To address this, the feasibility studies promoted **silage and hay production** as key fodder conservation practices. Maize and sorghum were identified as suitable crops for silage due to their high fermentable carbohydrate content, while lucerne and other grasses are well-suited for haymaking.

Adoption of silage and hay production enables farmers to store surplus fodder during peak growing seasons and utilize it during lean periods, stabilizing feed supply and reducing distress sales of livestock. The feasibility analysis also considered the costs of storage structures, labor requirements, and training needs to ensure that fodder conservation practices are economically viable and scalable at the farm and community levels.

6.4.5 Water Requirements for Livestock Production

Adequate and reliable water supply is a fundamental prerequisite for productive and healthy livestock systems. Under the Gomal Zam Dam Command Area Development Project, livestock water requirements were carefully assessed to ensure that proposed production systems are compatible with available water resources, irrigation infrastructure, and farm management practices. Proper provision of drinking water directly influences feed intake, growth rates, milk and meat production, reproductive performance, and overall animal health.

Cattle require **approximately 30–50 liters of clean drinking water per animal per day**, depending on body weight, production level (particularly lactation), ambient temperature, and feed composition. Lactating dairy cattle and animals consuming higher levels of concentrate feed are at the upper end of this range. The feasibility analysis emphasized the need for reliable on-farm water access through improved watercourses, storage tanks, and watering troughs located near housing and feeding areas. Ensuring consistent water availability reduces heat stress, improves milk yield, and supports efficient nutrient utilization. Water quality considerations—such as salinity and contamination—were also incorporated, as poor-quality water can significantly reduce animal performance.

Sheep and goats have comparatively lower water requirements, estimated at **4–8 liters per animal per day**, reflecting their smaller body size and greater physiological efficiency in water use. However, requirements increase during hot weather, pregnancy, lactation, and when animals consume dry feeds or crop residues. The feasibility studies recognized that small ruminants in the command area often rely on communal watering points or surface water sources. Improved water access through strategically located troughs and community-managed watering facilities was identified as a priority to reduce walking distances, prevent dehydration, and enhance productivity, particularly in grazing-based systems.

Poultry require **approximately 0.2–0.3 liters of water per bird per day**, with consumption varying by bird age, production stage, temperature, and feed type. Water intake increases significantly during high temperatures and peak egg-laying or rapid growth periods. The feasibility assessment highlighted the importance of continuous access to clean water through well-designed drinkers and simple storage systems. Inadequate or irregular water supply can quickly lead to reduced feed intake, lower growth rates, decreased egg production, and higher mortality, making water management a critical factor in both small-scale and semi-commercial poultry operations.

6.5 Animal Health and Biosecurity

Effective animal health management and biosecurity are critical to the sustainability and economic viability of livestock development interventions. Under the Gomal Zam Dam Command Area Development Project, the feasibility analysis identified preventable disease losses as a major constraint to productivity, profitability, and farmer confidence. Accordingly, a structured preventive health program, combined with practical biosecurity measures, was proposed to reduce mortality, improve production efficiency, and minimize the risk of disease outbreaks.

6.5.1 Preventive Health Program

A preventive, rather than curative, approach to animal health was emphasized to reduce long-term costs and improve livestock performance across cattle, small ruminant, and poultry systems.

Vaccination

Routine vaccination was identified as the cornerstone of disease prevention. The program recommends systematic vaccination against major endemic and economically significant diseases, including:

- **Foot and Mouth Disease (FMD)** in cattle and small ruminants, to prevent severe production losses and trade restrictions.
- **Hemorrhagic Septicemia (HS)** in cattle and buffalo, particularly before the monsoon season when outbreak risks are highest.
- **Peste des Petits Ruminants (PPR)** in sheep and goats, a highly contagious disease with high mortality rates.
- **Newcastle Disease (ND)** in poultry, one of the most common and devastating viral diseases affecting backyard and commercial flocks.
- **Infectious Bursal Disease (IBD)** in poultry, which compromises immunity and increases susceptibility to secondary infections.

The feasibility assessment incorporated vaccination schedules, cold chain requirements, and coordination with government veterinary services to ensure coverage, affordability, and effectiveness.

Deworming

Internal parasites were identified as a significant cause of reduced growth rates, poor feed conversion, and lowered reproductive performance. The recommended protocol includes **deworming every 3–6 months**, depending on species, age, grazing intensity, and seasonal parasite load.

Regular deworming improves nutrient utilization, enhances weight gain and milk production, and reduces susceptibility to other diseases. The analysis also emphasized the importance of avoiding overuse of anthelmintics to prevent drug resistance, promoting targeted treatment based on risk and veterinary guidance.

External Parasite Control

Control of external parasites such as ticks, lice, and mites is essential for maintaining animal health and preventing the transmission of vector-borne diseases. The feasibility studies recommended **external parasite control as required**, using methods such as dipping, spraying, or pour-on treatments.

Improved housing hygiene, periodic cleaning, and proper waste management were identified as complementary measures to reduce parasite infestation while lowering chemical use and costs.

6.5.2. Biosecurity Measures

Biosecurity practices were integrated into livestock scheme design to prevent the introduction and spread of infectious diseases within and between farms.

Quarantine of New Stock

A **14-day quarantine period for newly introduced animals** was recommended as a minimum standard. During this period, animals are observed for signs of illness, vaccinated if necessary, and treated for internal and external parasites before mixing with the existing herd or flock.

This practice significantly reduces the risk of introducing contagious diseases and protects investments in improved breeds and production systems.

Controlled Farm Access
Limiting and controlling access to livestock areas was identified as a simple yet effective biosecurity measure. This includes restricting unnecessary visitors, maintaining designated entry points, and implementing basic hygiene practices such as footbaths and clean clothing for farm workers and visitors.
Controlled access reduces disease transmission via people, equipment, and vehicles, particularly in semi-commercial livestock and poultry operations.

Proper Carcass Disposal
Safe and prompt **disposal of dead animals and poultry carcasses** is essential to prevent disease spread and environmental contamination. The feasibility analysis recommended approved methods such as deep burial or incineration, in accordance with local regulations and environmental standards.

Training farmers and livestock workers on proper carcass disposal was identified as a key capacity-building need to ensure compliance and community-level disease control.
Implementation and Sustainability Considerations
To ensure effective implementation, the animal health and biosecurity measures were linked with government veterinary services, community-based animal health workers, and farmer organizations. Capacity building, access to veterinary inputs, and awareness campaigns were identified as critical enablers for sustained adoption.

6.6 Breeding and Reproduction Management

Effective breeding and reproductive management are essential for improving livestock productivity, genetic potential, and farm profitability. Under the Gomal Zam Dam Command Area Development Project, the feasibility analysis emphasized systematic breeding strategies that combine genetic improvement with practical management interventions suited to local conditions, service availability, and farmer capacity. The proposed approach balances the use of modern reproductive technologies with proven conventional practices to ensure wide adoption and sustainable outcomes.

6.6.1 Breeding Strategy

Artificial insemination (AI) was recommended as the preferred breeding method where veterinary and technical services are available. AI enables rapid genetic improvement by providing access to proven, high-performing germplasm without the need for farmers to maintain breeding males. The feasibility analysis highlighted the benefits of AI in improving milk yield, growth rates, and overall herd productivity while reducing the risk of transmitting reproductive diseases associated with uncontrolled natural mating.
Implementation considerations included the availability of trained technicians, cold chain infrastructure, semen quality assurance, and farmer awareness. Where these prerequisites are met, AI offers a cost-effective and scalable pathway to genetic upgrading of local livestock populations.

Use of Improved Breeding Bulls. In areas where AI services are limited or not immediately feasible, the use of **improved breeding bulls** was identified as a practical alternative. Selected bulls with known performance traits, sound health status, and adaptability to local conditions can significantly enhance herd genetics over time. The feasibility studies emphasized controlled mating systems, periodic health screening of breeding bulls, and community-based bull management models to maximize genetic gains while minimizing disease risks. This approach is particularly suitable for remote areas and smallholder systems with limited access to AI services.

Reproductive Performance Targets. A **target calving interval of 12–14 months** was established as a benchmark for efficient reproductive performance in cattle. Achieving this interval

ensures optimal lifetime productivity, higher milk output per animal, and improved farm income. The feasibility analysis identified key determinants of calving interval, including nutrition, heat detection, timely breeding, and postpartum health management. Improved feeding regimes, adequate water supply, and regular health monitoring were identified as complementary interventions necessary to achieve and sustain the target calving interval.

6.6.2 Reproductive Performance Monitoring

Systematic **monitoring of reproductive performance** was identified as essential for effective herd management and informed decision-making. Key indicators include age at first calving, conception rates, calving intervals, and incidence of reproductive disorders.
The feasibility assessment recommended simple record-keeping systems at the farm level, supported by extension services and veterinary staff. Monitoring enables early identification of reproductive problems, timely corrective actions, and continuous improvement of breeding strategies. At the program level, aggregated reproductive performance data supports evaluation of livestock development schemes and guides future investments.

Institutional and Capacity Considerations
Successful implementation of breeding and reproduction management strategies requires coordination between farmers, veterinary services, and extension systems. Capacity building for farmers on heat detection, record keeping, and basic reproductive management was identified as a priority. Strengthening public and private service delivery mechanisms for AI and breeding services enhances long-term sustainability.

6.7 Farm Operations and Management

Efficient farm operations and sound management practices are critical to translating investments in livestock, feed, water, and health into sustained productivity and profitability. Under the Gomal Zam Dam Command Area Development Project, the feasibility analysis emphasized practical, low-cost management systems that can be adopted by smallholder and semi-commercial producers, supported by regular extension and veterinary services. Effective day-to-day management ensures optimal animal performance, reduces losses, and supports evidence-based decision-making at both farm and program levels.

6.7.1 Daily Feeding and Watering Schedules

Establishing **consistent daily feeding and watering schedules** is fundamental to maintaining animal health and productivity. Animals should be fed at fixed times each day using balanced rations appropriate to species, age, and production stage. Regular feeding routines improve feed intake efficiency, stabilize rumen function in ruminants, and reduce stress-related production losses.
Continuous access to clean drinking water is equally essential. Watering points should be conveniently located, regularly cleaned, and designed to minimize wastage. The feasibility assessment highlighted that disciplined feeding and watering schedules directly contribute to improved milk yields, faster weight gain, and better reproductive performance.

6.7.2 Hygiene and Housing Maintenance

Proper **hygiene and housing maintenance** were identified as low-cost, high-impact management interventions. Livestock housing should be well ventilated, dry, and protected from extreme weather conditions. Regular removal of manure, cleaning of feeding and watering equipment, and proper drainage reduce disease pressure and parasite infestation.
For poultry, routine litter management and disinfection of housing were emphasized to control bacterial and viral diseases. The feasibility studies demonstrated that improved hygiene reduces

veterinary costs, lowers mortality rates, and enhances overall animal welfare, thereby improving farm profitability.

6.7.3 Performance and Mortality Record Keeping

Systematic **record keeping** is essential for monitoring farm performance and identifying management gaps. The recommended records include:

- **Milk yield records** for dairy animals to track productivity trends
- **Weight gain records** for growing animals to assess feed efficiency
- **Mortality records** to identify health, management, or environmental issues

Simple, farmer-friendly record formats were proposed to encourage adoption. These records support timely management decisions, facilitate extension and veterinary advice, and provide data for evaluating the economic performance of livestock enterprises.

6.7.4 Monthly Extension and Veterinary Visits

Regular **monthly extension and veterinary visits** were identified as a key institutional support mechanism. These visits provide opportunities for routine health checks, vaccination and deworming follow-up, reproductive performance assessment, and on-site advisory services.
Extension staff play a critical role in reinforcing best management practices, supporting record keeping, and introducing improved technologies. Veterinary visits ensure early detection and treatment of health problems, reducing production losses and preventing disease outbreaks. The feasibility analysis highlighted that consistent professional support significantly enhances adoption rates and sustainability of improved farm management practices.

6.7.5 Integration with Project Support Systems

Farm operations and management practices were designed to align with broader project interventions, including feed and fodder development, water management, animal health programs, and capacity building. Farmer organizations and community groups were identified as platforms for collective learning, peer monitoring, and service delivery coordination.

7. ENVIRONMENTAL FEASIBILITY

Environmental feasibility is a critical consideration in the design and implementation of livestock development schemes within the Gomal Zam Dam command area. The feasibility analysis assessed the potential environmental impacts of proposed interventions and identified mitigation and enhancement measures to ensure that livestock intensification remains environmentally sustainable and fully compatible with irrigation development. The proposed schemes are designed to protect natural resources, improve resource-use efficiency, and support long-term ecological stability while increasing agricultural and livestock productivity.

7.1 Controlled Grazing and Rangeland Management

Uncontrolled grazing was identified as a key risk factor for land degradation, soil erosion, and declining pasture productivity. To address this, the feasibility studies emphasized **controlled grazing systems**, including regulated stocking rates, rotational grazing, and seasonal resting of grazing areas.

Community-based grazing management arrangements were proposed to reduce pressure on communal lands and promote equitable resource use. These measures help maintain vegetation cover, improve soil structure, and enhance the regenerative capacity of rangelands, ensuring sustainable feed resources for sheep and goats while reducing environmental degradation.

7.2 Sustainable Fodder Production

The livestock schemes promote **sustainable fodder production systems** that leverage improved irrigation infrastructure while safeguarding soil and water resources. The cultivation of high-yielding fodder crops under controlled irrigation enables higher biomass production on limited land, reducing the need to expand grazing into marginal or ecologically sensitive areas.
Crop rotation, inclusion of leguminous fodders, and efficient nutrient management were incorporated into the feasibility analysis to maintain soil fertility and minimize chemical input use. These practices contribute to sustainable intensification, where productivity gains are achieved without compromising environmental integrity.

7.3 Manure Management, Composting, and Biogas Options

Improper disposal of livestock manure poses risks to water quality, public health, and the surrounding environment. The feasibility assessment therefore emphasized **manure composting** as a standard practice for livestock farms. Composting converts waste into a valuable organic fertilizer, improves soil structure, and reduces dependence on chemical fertilizers.
Where herd sizes and household energy demand justify investment, **optional biogas units** were identified as an environmentally beneficial solution. Biogas systems reduce greenhouse gas emissions, provide clean energy for cooking and lighting, and produce nutrient-rich slurry for use as fertilizer. These systems enhance nutrient recycling and contribute to climate-smart agriculture objectives.

7.4 Efficient Water Use through Lined Watercourses

Efficient water management is central to the environmental sustainability of the livestock schemes. The feasibility studies demonstrated that **lined watercourses** significantly reduce conveyance losses, waterlogging, and salinization risks compared to unlined systems. Improved water efficiency ensures that irrigation water is used optimally for both fodder production and livestock watering without exerting undue pressure on water resources.
By integrating livestock water requirements into on-farm water management planning, the schemes avoid competition between crops and livestock and enhance overall water-use efficiency within the command area.

7.5 Compatibility with Irrigation Development

Overall, the proposed livestock and related agricultural schemes were assessed as **environmentally sound and fully compatible with irrigation development** under the Gomal Zam Dam project. The interventions promote efficient resource use, minimize negative environmental impacts, and enhance the resilience of farming systems to climate variability.

8. SOCIAL AND GENDER FEASIBILITY

The success and sustainability of livestock development schemes in the Gomal Zam Dam command area depend not only on technical and financial viability but also on strong social acceptability and inclusive participation. The feasibility analysis recognized the critical role of **social and gender considerations** in achieving equitable access to benefits, fostering community ownership, and ensuring long-term adoption of project interventions.

Inclusion of Women as Registered Beneficiaries

Women play a central role in household livestock management, particularly in small ruminant and poultry production, yet they often face barriers to accessing credit, training, and market

opportunities. To address this, the proposed schemes prioritize **the inclusion of women as registered beneficiaries**, ensuring that they have equitable rights to participate in project activities, access inputs, and benefit from income-generating opportunities.
By formally recognizing women's participation, the schemes strengthen household food security, increase family incomes, and empower women to make decisions about livestock management, feed production, and small-scale marketing.

Livestock Activities Compatible with Household-Based Labor
Feasibility studies emphasized that livestock interventions should align with the **time and labor constraints of rural households**, particularly women and youth. Activities such as poultry rearing, small ruminant care, fodder cultivation, and household-level composting were designed to be **manageable within the household labor framework**, avoiding overburdening family members and enabling integration with other household responsibilities.
This approach enhances adoption rates and ensures that the interventions are socially sustainable, as livestock management becomes an income-generating activity without creating labor conflicts or excessive burden.

Community-Based Animal Health and Water Management Groups
To promote collective action, the feasibility analysis proposed **community-based groups for animal health and water management**. These groups serve multiple functions:

- Facilitate shared access to veterinary services, artificial insemination, and disease prevention programs
- Oversee watercourse maintenance and equitable water distribution for livestock and fodder production
- Provide a platform for knowledge sharing, peer monitoring, and community-driven decision-making

Community groups strengthen social cohesion, improve resource-use efficiency, and reduce reliance on external service providers, ensuring that project interventions remain locally owned and sustainable.

Capacity-Building through Farmer Organizations
Farmer organizations were identified as critical vehicles for **capacity building and technical knowledge transfer**. Training programs delivered through these organizations cover:

- Best practices in feeding, housing, breeding, and health management
- Record-keeping, reproductive monitoring, and productivity tracking
- Gender-sensitive approaches and inclusive decision-making

By strengthening farmer organizations, the project builds local institutional capacity, enhances collective bargaining for inputs and market access, and fosters peer-to-peer learning. This ensures that both men and women farmers can participate fully in decision-making and benefit equitably from livestock development interventions.

Overall Social and Gender Impact
The social and gender feasibility assessment confirms that the proposed livestock schemes are **inclusive, participatory, and aligned with household labor patterns**, thereby maximizing adoption and sustainability. By integrating women and marginalized groups, fostering community management structures, and leveraging farmer organizations for capacity building, the interventions contribute to:

- Improved livelihoods and income generation for vulnerable households
- Greater social equity and empowerment of women
- Strengthened community ownership and resilience of livestock systems

These measures complement the technical, financial, and environmental feasibility of the schemes, ensuring that livestock development under the Gomal Zam Dam project delivers tangible and equitable benefits to rural communities.

9. RISK ANALYSIS AND MITIGATION

Livestock development schemes in the Gomal Zam Dam command area are subject to a range of risks that can affect productivity, profitability, and long-term sustainability. The feasibility analysis systematically identified key risks and proposed practical mitigation measures to minimize their impact while enhancing resilience. Integrating risk management into project design ensures that interventions remain technically feasible, financially viable, and socially sustainable.

Risk	Mitigation
Disease outbreaks	Vaccination, vet services
Feed shortages	Fodder banks, silage
Climate stress	Shade, water storage
Market volatility	Collective marketing
Input access	Local supplier mapping

9.1 Disease Outbreaks

Risk: Livestock are highly susceptible to contagious diseases such as Foot and Mouth Disease (FMD), Hemorrhagic Septicemia (HS), Peste des Petits Ruminants (PPR), Newcastle Disease (ND), and Infectious Bursal Disease (IBD) in poultry. Disease outbreaks can cause significant mortality, production losses, and economic disruption.

Mitigation Measures:

- **Vaccination Programs:** Routine, species-specific vaccination schedules are recommended to prevent major endemic diseases.
- **Veterinary Services:** Regular visits by veterinary officers and community-based animal health workers enable early detection, treatment, and monitoring of emerging health issues.
- **Biosecurity Practices:** Controlled farm access, quarantine for new stock, and proper carcass disposal reduce the likelihood of disease introduction and spread.

9.2 Feed Shortages

Risk: Seasonal variations, drought, and insufficient fodder production can lead to feed shortages, limiting livestock growth, milk production, and reproductive performance.

Mitigation Measures:

- **Fodder Banks:** Establishing on-farm and community-level fodder reserves ensures feed availability during lean periods.
- **Silage and Hay Production:** Preservation of surplus fodder from peak growing seasons supports year-round feeding.
- **Diversified Feed Resources:** Combining crop residues, improved forage crops, and concentrated supplements reduces dependency on single feed sources.

9.3 Climate Stress

Risk: Livestock are vulnerable to heat stress, water scarcity, and other climatic extremes, which can reduce productivity and increase mortality.

Mitigation Measures:

- **Shade Structures:** Provision of shade in housing and grazing areas minimizes heat stress.
- **Water Storage and Efficient Irrigation:** Reliable water availability through storage tanks, lined watercourses, and optimized irrigation supports both fodder production and livestock hydration.
- **Climate-Resilient Practices:** Adoption of drought-tolerant fodder crops, rotational grazing, and adaptive farm management reduces exposure to climatic variability.

9.4 Market Volatility

Risk: Fluctuating prices for livestock, milk, meat, and eggs can reduce farm incomes and undermine financial viability.

Mitigation Measures:

- **Collective Marketing:** Farmer groups and cooperatives improve bargaining power, stabilize prices, and facilitate access to larger markets.
- **Market Intelligence:** Training farmers on price trends, demand forecasting, and quality standards enhances informed decision-making.
- **Value Addition:** Encouraging on-farm processing (milk, manure compost, poultry products) reduces vulnerability to price swings.

9.5 Input Access Constraints

Risk: Limited availability of essential inputs such as feed, veterinary supplies, breeding materials, and equipment can disrupt livestock operations.

Mitigation Measures:

- **Local Supplier Mapping:** Identification of reliable suppliers within or near the command area ensures timely access to inputs.
- **Community-Based Input Systems:** Cooperative purchase and distribution reduce costs and improve availability for smallholder farmers.
- **Capacity Building:** Training farmers in input management and resource planning improves self-sufficiency and reduces dependency on external services.

9.6 Integrated Risk Management Approach

The feasibility analysis emphasizes that these risks are **interconnected**—for example, feed shortages can exacerbate disease susceptibility, and climate stress can influence marketable production. Therefore, a holistic risk management framework that combines **technical, institutional, and community-based measures** is recommended. By proactively addressing disease, feed, climate, market, and input risks, the livestock schemes are designed to be **resilient, adaptive, and sustainable**, safeguarding both livelihoods and long-term project outcomes.

10. IMPLEMENTATION ARRANGEMENTS

Effective implementation arrangements are critical to ensuring that livestock development schemes under the Gomal Zam Dam Command Area are delivered efficiently, equitably, and sustainably. The feasibility assessment outlined a multi-layered implementation framework covering beneficiary selection, financial support, extension services, and monitoring systems. These arrangements are designed to facilitate adoption, maximize productivity, and safeguard project outcomes.

10.1 Beneficiary Selection

Transparent and equitable selection criteria are fundamental to the success of the schemes. Beneficiaries are identified based on factors such as:

- Land and livestock ownership

- Level of engagement in household livestock activities
- Socio-economic vulnerability and inclusion of women and marginalized groups
- Capacity and willingness to adopt improved practices

Community consultations and farmer organizations are used to ensure participatory selection, minimize conflicts, and promote fairness. Transparent selection processes build trust among community members and enhance ownership of the interventions.

10.2 Financial Support: Cash Grants

To support initial livestock investments and operational requirements, selected beneficiaries receive **cash grants** covering a **12-month period**. These grants are intended to finance:

- **Feed purchases:** Supplementary rations and fodder inputs to ensure consistent nutrition
- **Veterinary care:** Vaccination, deworming, and routine health services
- **Minor infrastructure:** Low-cost improvements such as animal housing, shade structures, water troughs, and fencing

Cash grants are disbursed in a controlled and accountable manner, with clear guidelines and receipts, to empower beneficiaries while ensuring appropriate use of funds. This approach reduces upfront financial barriers and incentivizes adoption of improved management practices.

10.3 Extension Support

Continuous **technical and advisory support** is essential for achieving productivity gains and sustaining best practices. Extension support is provided through a combination of:

- **Department of Agriculture (DoA) staff:** Leveraging public sector expertise for vaccination programs, breeding services, and training
- **Private service providers:** Supplementing DoA services with flexible, market-oriented delivery for veterinary care, AI, and feed supply
- **Farmer organizations and community groups:** Facilitating peer learning, local demonstrations, and knowledge transfer

Extension services focus on practical on-farm guidance, problem-solving, and capacity building to ensure that beneficiaries implement recommended feeding, housing, breeding, and health management practices effectively.

10.4 Monitoring and Supervision

Robust **monitoring arrangements** are integral to project accountability and performance management. Key features include:

- **Monthly farm visits:** Extension staff and veterinary officers conduct structured visits to assess livestock health, feed utilization, reproductive performance, and infrastructure maintenance
- **Record verification:** Farm-level records on milk yield, weight gain, mortality, and expenditures are reviewed to ensure adherence to management practices
- **Feedback mechanisms:** Observations from farm visits are communicated to beneficiaries and project management to address challenges promptly

Regular monitoring enables early identification of technical or operational issues, ensures efficient utilization of cash grants, and supports data-driven evaluation of project outcomes.

10.5 Institutional Coordination

Successful implementation relies on **collaboration among multiple stakeholders**, including the DoA, private service providers, farmer organizations, and local community leaders. Coordination ensures:

- Alignment of extension and veterinary services with grant-supported activities

- Efficient procurement and distribution of inputs
- Collective problem-solving and capacity building at the community level

This integrated approach enhances accountability, ensures technical support is accessible, and strengthens community ownership of livestock development interventions

11. TECHNICAL FEASIBILITY CONCLUSION

The comprehensive assessment of livestock development interventions under the Gomal Zam Dam Command Area demonstrates that the proposed farm schemes are **technically sound, operationally viable, environmentally responsible, and socially inclusive**. This conclusion is supported by integrated analyses covering feeding systems, water management, animal health, breeding, farm operations, environmental safeguards, social inclusion, risk management, and implementation arrangements.

11.1 Operational and Technical Viability

The livestock farm schemes are designed to align with local agro-ecological conditions, available resources, and household labor patterns. Key technical considerations supporting feasibility include:

- **Feed and Fodder Systems:** Balanced rations for cattle, small ruminants, and poultry, combined with sustainable fodder production and crop residue utilization, ensure year-round nutrition.
- **Water Requirements:** Adequate and efficiently managed water for livestock and fodder crops supports animal health, productivity, and irrigation compatibility.
- **Animal Health and Biosecurity:** Preventive vaccination, parasite control, and biosecurity measures minimize disease risks and enhance survival and performance.
- **Breeding and Reproduction Management:** Artificial insemination and improved bull programs, coupled with reproductive monitoring, optimize genetic potential and herd productivity.
- **Farm Operations and Management:** Daily feeding, housing maintenance, record keeping, and extension support establish efficient, replicable, and sustainable management routines.

These elements collectively ensure that the proposed schemes are **operationally realistic** for both smallholder and semi-commercial farmers, with clearly defined routines and resource requirements.

11.2 Environmental Sustainability

The technical feasibility assessment confirms that the livestock interventions are **environmentally compatible** with irrigation and watercourse improvements. Sustainable practices such as controlled grazing, efficient fodder cultivation, manure composting, optional biogas units, and optimized water use prevent land degradation, reduce water wastage, and minimize environmental impacts. These measures support climate resilience and long-term ecological sustainability, ensuring that livestock intensification does not compromise natural resource integrity.

11.3 Social and Gender Inclusion

The schemes are **socially feasible and inclusive**, with deliberate mechanisms to involve women, integrate livestock activities into household labor systems, and establish community-based management groups. Capacity building through farmer organizations strengthens local institutions, encourages participatory management, and ensures equitable access to benefits. These factors promote adoption, ownership, and long-term sustainability of the interventions.

11.4 Risk-Responsive Design

The technical feasibility incorporates **proactive risk management** measures to address disease outbreaks, feed shortages, climate stress, market volatility, and input access constraints. Structured mitigation strategies—such as vaccination, fodder banks, shade provision, collective marketing, and supplier mapping—enhance resilience and reduce vulnerabilities, further confirming the robustness of the proposed schemes.

11.5 Integration with Irrigation and Watercourse Development

Crucially, the livestock schemes are designed to complement **irrigation and on-farm watercourse improvements** enabled by the Gomal Zam Dam. Efficient water delivery systems support fodder production, drinking water availability, and overall farm productivity. This integration ensures that livestock intensification works synergistically with crop irrigation, maximizing resource efficiency and economic returns at the farm and community levels.

12. RECOMMENDATIONS

Based on the technical, financial, environmental, and social feasibility analyses, the following recommendations are proposed to ensure the successful implementation, sustainability, and scalability of livestock development interventions within the Gomal Zam Dam Command Area. These recommendations address production, health, market integration, and monitoring systems to maximize productivity, resilience, and economic returns for smallholder and semi-commercial farmers.

12.1 Scale Up Integrated Livestock Farm Packages

Rationale: Integrated livestock farm packages—combining improved feeding systems, water management, housing, breeding, and health interventions—have demonstrated high technical feasibility and economic viability in the command area.

Recommendation:

- Expand these packages across additional villages and households to leverage economies of scale and promote uniform adoption of best practices.
- Include small ruminants, poultry, and cattle in package designs tailored to household labor capacity, land availability, and market demand.
- Encourage community-level demonstration farms to showcase productivity gains and facilitate knowledge transfer.

Expected Impact: Increased adoption of efficient livestock management practices, higher animal productivity, and greater household income generation.

12.2. Prioritize Locally Adapted Breeds

Rationale: Locally adapted breeds exhibit superior resilience to climatic stress, endemic diseases, and local feed availability. While high-yielding breeds may offer higher production potential, they often require more intensive management and inputs.

Recommendation:

- Focus on using **locally adapted cattle, goats, sheep, and poultry** with proven tolerance to heat, drought, and local disease pressures.
- Where improved breeds are introduced, implement gradual crossbreeding programs combined with technical support for feeding, breeding, and health management.
- Maintain breeding records and reproductive monitoring to preserve genetic quality and adaptability.

Expected Impact: Improved herd resilience, reduced mortality, and sustainable productivity under local environmental conditions.

12.3. Strengthen Veterinary Outreach

Rationale: Disease outbreaks and inadequate preventive care are major risks limiting livestock productivity. Access to veterinary services is uneven in the command area, particularly for remote households.

Recommendation:

- Expand **routine veterinary services**, including vaccination, deworming, and biosecurity training, through a combination of Department of Agriculture (DoA) staff and private service providers.
- Develop **community-based animal health worker networks** to provide timely services and reduce dependence on distant veterinary facilities.
- Integrate disease surveillance and early warning systems to rapidly respond to outbreaks.

Expected Impact: Reduced disease incidence, lower mortality rates, and improved herd productivity and profitability.

12.4. Promote Fodder-Based Intensification

Rationale: Feed availability is a critical constraint in livestock production, particularly during dry seasons. Fodder-based intensification improves feed security, animal nutrition, and overall productivity.

Recommendation:

- Scale up **irrigated fodder crops** such as maize, sorghum, and lucerne, complemented by silage, hay, and use of crop residues.
- Introduce **fodder banks and seasonal storage systems** to ensure continuous feed supply.
- Train farmers in efficient fodder management, crop rotation, and nutrient recycling through composting or slurry application.

Expected Impact: Improved animal growth, milk production, reproductive performance, and reduced vulnerability to seasonal feed shortages.

12.5. Link Farmers to Organized Markets

Rationale: Market access is essential for financial sustainability. Smallholder farmers often sell livestock and products at low prices due to fragmented markets and lack of collective bargaining.

Recommendation:

- Facilitate **farmer group formation and cooperative marketing**, enabling bulk sales and negotiation for better prices.
- Provide market intelligence on demand trends, quality standards, and pricing to support informed decision-making.
- Explore value-addition options, such as milk pasteurization, manure-based compost, and poultry product processing, to increase farm-level income.

Expected Impact: Enhanced income stability, reduced vulnerability to market volatility, and incentivized adoption of productivity-enhancing practices.

12.6. Monitor Performance through Structured KPIs

Rationale: Continuous monitoring is necessary to ensure that livestock interventions are achieving desired productivity, health, and economic outcomes.

Recommendation:

- Establish **Key Performance Indicators (KPIs)** covering animal health, milk yield, weight gain, reproductive performance, feed utilization, and income generation.
- Conduct **monthly farm visits** by extension staff and veterinary officers to track progress, verify record keeping, and provide technical guidance.
- Aggregate data at the community and program level to evaluate intervention impacts and inform future scaling or refinement of livestock packages.

Expected Impact: Data-driven decision-making, timely corrective actions, and continuous improvement of livestock development interventions.