

Draft

Slaughtering Facility Report (Report #2)

**Consultancy Services for Agro Business Planning, Technologies
and Marketing advice and Implementation Support under Livestock
and Dairy Development Project (LDDP)**

Package:SD-67

**Department of Livestock Services, Ministry of Fisheries and
Livestock**

Government of Bangladesh

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Prepared By



in joint venture with



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Table of Contents

ABBREVIATIONS	vi
1. EXECUTIVE SUMMARY	1
2. INTRODUCTION	3
2.1 Background.....	3
2.2 Rationale	3
2.3 Objectives	4
2.4 Approach and Methodologies	5
3. CONTRIBUTION OF LIVESTOCK IN ECONOMIC DEVELOPMENT	6
3.1 Role of livestock in rural economy of Bangladesh.....	6
3.2 Contribution of Livestock in Bangladeshi GDP	7
3.3 Livestock population and production	8
3.4 SWOC Analysis of livestock growth and its impact on lives and livelihoods.....	10
4. REGULATORY MECHANISMS FOR SLAUGHTERING FACILITIES.....	11
4.1 Regulatory and policy framework in Bangladesh on slaughtering activities.....	11
4.2 Challenges faced by Livestock subsector in Bangladesh	13
4.3 Measures undertaken by national and local self-governments on enforcement	16
4.4 Regulation related to meat inspection	16
4.5 Surveillance and quarantine of imported animals.....	16
4.6 Regulations on 'Halal Certification for slaughtered meat in Bangladesh	17
5. LANDSCAPE OF SLAUGHTERING FACILITIES IN BANGLADESH.....	19
5.1 Meat and meat-based products in Bangladesh	19
5.2 Red meat value chains in Bangladesh.....	19
5.3 SOWC Analysis of beef value chains	24
5.4 Slaughtering of animal in Bangladesh for meat consumption	24
5.5 Present scenario of slaughtering in Bangladesh	25
5.6 Organized Slaughtering places	26
5.7 Approximate meat production in two City Corporations of Dhaka City	28
5.8 Present status of slaughtering facilities.....	29
5.9 Modern slaughterhouse	30
5.10 Privately owned modern slaughterhouses in Bangladesh	31
5.11 Mapping the role of existing BDS.....	32
6. BUSINESS FEASIBILITY OF SLAUGHTERING FACILITIES.....	34

6.1 Market size and characteristics of the market for beef	35
6.2 Retail market of beef and other meats	36
6.3. Beef market segments, products, and customer preferences.....	37
6.4 Current trends and expected future market growth.....	38
6.5 Existing slaughtering facilities and their business prospects	39
6.6 Backward and Forward Linkages.....	40
6.7 Slaughtering facilities and process flow in the modern facilities	41
6.8 Business models in slaughtering facilities	42
6.9 Revenue streams for the business models	46
6.10 Co-benefits of the proposed facilities and business models.....	46
6.11 Social and gender safeguards in developing public slaughtering facilities	47
6.12 Environmental safeguards and benefits	49
6.13 Waste management and disposal system.....	50
6.14 Clean energy intervention in modern slaughtering facilities	52
7. FINANCIAL FEASIBILITY STUDY.....	52
7.1 Key Assumptions	52
7.2 Projected income expenditure statement.....	56
8. MONITORING AND EVALUATION OF SLAUGHTERING FACILITIES	59
9. WAY FORWARD.....	60
REFERENCES	64
ANNEX 1.....	65
SAMPLE EXPRESSION OF INTEREST (EOI) DOCUMENT FOR OPERATING SLAUGHTERHOUSE.....	65
ANNEX 2.....	69
Draft guidelines for hygiene and sanitation in slaughterhouse	69
ANNEX 3.....	86
Economic evaluation of clean energy interventions in slaughtering facilities	86

List of Tables

Table 1. Types of slaughtering facilities	5
Table 2. Approaches and methodologies for developing business plans.....	5
Table 3. Contribution of Livestock to Bangladesh GDP in 2020-21	7
Table 4. Livestock population of Bangladesh (number in lakh).....	8
Table 5. Demand, production, availability of milk, meat and eggs (2020-21)	9
Table 6. Responsible line departments and their roles	12
Table 7. Challenges to implement slaughtering regulations and possible solutions.....	14
Table 8. Different marketing channels of beef value chain	21
Table 9. Definition of actors in Beef value chains	22
Table 10. Average number of animals slaughtered on daily basis	28
Table 11. Estimated meat production in Dhaka City on daily basis.....	28
Table 12. Availability of land and other conditions in three city corporation	31
Table 13. Breakdown of meat supply to the consumer market in Bangladesh (2020-21).....	35
Table 14. Live weight of animals slaughtered and of total herd (2020-21)	35
Table 15. Retail prices of all category of meats	36
Table 16. Characteristics of PPP modalities in operating Slaughtering facilities	44
Table 17. Reaction of the stakeholders	48
Table 18. Slaughtering Capacity (Large Ruminants)	53
Table 19. Slaughtering Capacity (Small Ruminants)	53
Table 20. Annual Cost of Services provided by the Slaughterhouse (in BDT)	54
Table 21. Assumptions* on economics and price escalation	54
Table 22. Assumptions* on Revenue Streams (in BDT)	55
Table 23. Projected Income & Expenditure of Modern Slaughterhouse (City Corporations) ..	56
Table 24. Projected Income & Expenditure of slaughtering facilities at Municipality/District level	57
Table 25. Projected Income & Expenditure of improved wet markets with slaughtering facilities.....	58
Table 26. Proposed categorization of slaughtering facilities	61
Table 27. A2.1: Land required for Slaughter houses	71
Table 28. A2.2. Human resources requirements	79
Table 29. A2.3: Standards for Content of Chemical in Slaughter House Effluent.....	81
Table 30. A2.4: DOE Standards for Waste from Industrial Water Discharge in Bangladesh ..	81
Table 31. A2.5. Compliance Audit Score Sheet for Slaughtering facilities	82
Table 32. A3.1. Economic analysis of SWH system	95
Table 33. A3. 2. Economics of grid connected Solar PV system	97
Table 34. A3.3. Economics of off-grid Solar PV system	98
Table 35. A3.4. Economic analysis of biogas system	99

List of Figures

Figure 1. Decadal trend in share of Livestock in National GDP	8
Figure 2. Production of Milk and Meat during 2011-12 to 2020-21	9
Figure 3. Production of Egg during 2011-12 to 2020-21	9
Figure 4. Generic marketing channel of beef cattle in Bangladesh	20
Figure 5. Bangladesh beef value chain map	22
Figure 6. Slaughtering facilities in Krishi Market, Mohammadpur, Dhaka	29
Figure 7. Schematic diagram on Slaughterhouse Market Mapping.....	34
Figure 8. Backward and forward linkages.....	40
Figure 9. Business Model 1 Slaughtering facility run by public agency.....	43
Figure 10. Business Model 2: Slaughtering facility run under PPP mode	44
Figure 11. Business Model 3: Slaughtering facility run under PPP mode	45
Figure 12. A2.1 Sections in a modern slaughter house	74
Figure 13. A2.2 Work process flow in a slaughter house.....	75
Figure 14. A3.1 Contribution of electrical loads in typical slaughterhouse	87
Figure 15. A2.2 Different LED lighting applications	89
Figure 16. A2.3 Flat plate solar water heating system	90
Figure 17. A2.4 Evacuated tube solar water heating system.....	90
Figure 18. A2.5 Schematic of fixed dome digester	93
Figure 19. A2.6 Floating drum biogas system	93
Figure 20. A2.7 Flexible balloon digester system	94
Figure 21. A2.8 Energy star rated electrical appliances.....	94

List of Photographs

Photograph 1. Food for cattle fattening	11
Photograph 2. Bulls are more popular animal for slaughtering during the Eid-UI-Azah.....	21
Photograph 3. Slaughtering on the road side in Rangpur	27
Photograph 4. Slaughtered animals at Krishi market at Mohammadpur, Dhaka	30
Photograph 5. Slaughtering facilities at Gollamari, Khulna City Corporation.....	38
Photograph 6. Slaughtering slabs maintained by Rangpur City Corporation	41

ABBREVIATIONS

ASF	Animal Source Food
ATDP	Agro-based Industries and Technologies Development Project
BBS	Bangladesh Bureau of Statistics
BDS	Business Development Services
BDT	Bangladeshi Taka
BMPIL	Bengal Meat Processing Industries Limited
BOT	Build Operate and Transfer
BSTI	Bangladesh Standards and Testing Institution
CAGR	Compound Annual Growth Rate
CCC	Chattagram City Corporation
DLS	Department of Livestock
DNCC	Dhaka North City Corporation
DSCC	Dhaka South City Corporation
EMP	Environment Management Plan
EOI	Expression of Interest
ETP	Effluent Treatment Plant
FAO	Food and Agriculture Organization of the United Nation
FSA	Food Safety Authority
GAP	Global Action Plan
GDP	Gross Domestic Product
HAACP	Hazard Analysis Critical Control Point
KCC	Khulna City Corporation
LDDP	Livestock and Dairy Development Project
LFP	Livestock Food Products
LPG	Liquefied Petroleum Gas
MT	Metric Tonnes
OIE	Organization for Animal Health
PPP	Public Private Partnership
RCC	Rajsahi City Corporation
ROOT	Rehabilitate Own Operate Transfer
WHO	World Health Organization
WTO	World Trade Organization

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1 US\$ = 89.84 BDT (As on 31 March 2022)

1. EXECUTIVE SUMMARY

Modernization of slaughtering facilities across the country under LDDP is under the Sub-component B2: Critical and Climate Resilient Public Infrastructure for Livestock Development (IDA US\$110.21 million) and will finance (in the form of grants) public and collective climate resilient infrastructure for value chain development to address barriers to livestock processing, food safety and marketing. This will include: (i) improvement of slaughtering at local wet markets and selected pilot slaughterhouse support at district level and in major cities to hygienically meet slaughter capacity needs at peak times (e.g., during major festivals and during extreme climate events). These slaughter and market facilities investments will upgrade or replace dilapidated and decaying buildings that are leading to chronically bad hygiene and pose a significant hazard to the health and welfare of workers, livestock, consumers and the wider environment.

This report has been prepared after consulting with the stakeholders and few rounds of field visits to Rajshahi, Khulna, Bagerhat and Dhaka city slaughterhouses. The approach of the report followed the steps to develop long term viable-cost effective and market linked plan for each type of slaughtering facilities and environment friendly waste disposal/management systems. The methodology adopted followed a holistic view of documenting the existing condition and provide recommendation to upgrade the system within the scope of our work.

The study revealed that demand of food from animal resources gradually gaining importance in Bangladesh due to high level of awareness on the existing poor nutritional outcome from the food being consumed by the majority of the population which resulted in increased contribution of livestock in the GDP of the country (in absolute amount) and provided resilience to this sub-sector during the global pandemic situation due to COVID19. The challenges faced by the livestock sector is nearly stagnant growth (CAGR) in its population which however is contrary in case of poultry birds which grown at a rate of 27% due to the changing habits of food consumption among the young population in Bangladesh.

The slaughtering practices in Bangladesh is traditionally dependent on the wet market as the customers prefer fresh meat (95% of both beef, mutton and poultry) which has a negative effect on the growth and development of scientific and slaughtering facilities in the country. Furthermore, around 55% of the cattle slaughtered during the festival 'Eid-al-Adha' and rest during the whole year which makes the slaughtering as a way of life and not a business proposition. This might be the reason that the organized private sector participation is less than expected. However, the silver lining is that the by increasing awareness on the positive economic and public health perspective of food safety compliance and requirements for meat business, the government of Bangladesh is becoming more inclined towards improving compliance practices. On the other hand, competent authorities now need to pay increased attention towards the enforcement of food safety compliance practices of private operators at the wet market level.

Most of the slaughterhouses in the country are lacking basic amenities such as light, ventilation and water. Due to the scarcity of water, butchers cannot wash carcasses and clean slaughterhouses properly. They often clean carcasses manually carrying water in a bucket. They clean the stomach in the pond resulting in huge water contamination. The slaughtering and carcass-dressing processes are performed in open areas in highly unhygienic conditions and the meat is sold with little or no veterinary inspection. Carcasses are prepared in unhygienic conditions in local slaughterhouses. In rural and urban areas, towns and even in cities, the slaughtering of animals is still done by unauthorized butchers in fields, bushes, backyards or roads, where killed animals are eviscerated and dressed.

To support the endeavour of the government of Bangladesh to improve the climate resilient public infrastructure of the slaughtering facilities through a robust business model exploring all aspects of business process has been prepared. While developing the business models for climate resilient public infrastructure in the form of proving safe slaughtering facilities, we propose three (3) types business process which may be accepted based on their merits and context: (a) Business Model 1: Public infrastructure run by the public institutions (specialized government agencies, city corporations, municipalities or other local governing bodies), (b) Business Model 2: Public infrastructure operating under public-private-partnership (PPP) mode (joint operation by the local authorities and private entities under an agreed standard operating procedure) and (c) Business Model 3: Public infrastructure run by private entities under a long-term agreement/lease (with continuous monitoring and evaluation of the performance in terms of food safety and hygiene). The proposed business models are backed by various revenue streams to defray the operational cost which however are not covering all the cost. A detailed cost benefit analysis is calculated to examine the strength and weakness of the revenue streams for future corrections by enhancing the fee-based income of the public agencies. The income and expenditure statements (based on certain practical estimations) indicate that the modern slaughterhouse proposed in 3 city corporations when operated by the public agencies (city corporations/municipalities) will not be able to cover the operational costs and the proposed PPP model (Business model 2) may be a suitable replacement for improved efficacy. The other two types of slaughtering facilities are somehow able to recover their operational costs (in short term) considering the current level of cost and revenue streams.

The recommendations made in the report were based on the primary and secondary survey results in compliance with the political economy of Bangladesh and are doable within a medium-term time frame. The emphasis was provided to leverage the public infrastructural facilities to attract private investments in the sector for better scalability.

2. INTRODUCTION

2.1 Background

This report is a part of Sub-Component B2 on ‘Critical and Climate Resilient Public Infrastructure’ under the Component B on ‘Market linkages and value-chain development’. As the modern and scientific slaughtering facilities are considered as public infrastructure, they are being established with full financial support from the project categorized as *sub-grant* as per the ‘Grant Manual’ of LDDP. Keeping this view, this report (Slaughtering facility)¹ the consulting team during its meeting on 2nd January 2022 and subsequent meetings held on 10 and 27 January 2022 agreed that this report will cover the following deliverables as per the submission in the Inception Report:

D3.1 Analyze the progress on practices of upgraded slaughtering facilities and preparation of location specific operational business model;
D3.2 Assess the scale of adaptation of the technology by the slaughterers, butchers and its impact on their productivity, and consumers behaviour.

2.2 Rationale

Food is a basic and most important component of economic life, not only from the point of view of the subsistence and health, but also it forms a large part of the wage goods, thereby affecting the availability of already meager income of the large populace for meeting the other ingredients of economic life. Food products of animal origin have played a key role as suppliers of human calories and proteins in virtually all parts of the world since the beginning of recorded history. Many research findings have pointed towards structural changes in food consumption patterns that are occurring throughout the developing world in recent past in terms of increasing importance of Livestock Food Products (LFP's) in the diets of the people.

Bangladesh is aspiring to become a developed nation by 2041. In this context, it becomes pertinent to deliberate on the quality of life that people of the country would have by 2040. One of the basic and most important parameters of determining quality of life is the status of nutritional security of the nation. Growth rate in total consumption of different livestock food products in Bangladesh is higher than some developed countries. The highest consumption growth rate in Bangladesh is found in case of large animals (mainly beef) followed by small ruminants (mainly goats) and poultry products (mainly chicken and ducks). The increased consumption of livestock food products comes from changes in the diets of people fueled by urbanization, population and income growth and Bangladesh is not an exception to course of these events. The accompanying increased production of Livestock Food Products to match the demand would not be without problems, in terms of environmental sustainability, nutritional and public health concerns,

¹ Please note that the deliverable D3.3 (*Strategies development for setting and linking the smallholder groups with dairy hubs and processing plants through POs and VMCCs.*) will be covered in Value Chain Analysis report and/or other reports related to matching grant facilities.

industrialization of livestock production at the cost of small holder livestock farmers, etc. would be major challenges to resolve².

There are approximately 5000 licensed butchers³ using either the public slaughtering facilities or common slaughtering slabs in the wet markets/other markets and private establishments. There are many unregistered butchers⁴ those who perform slaughtering of animals on their own places or along the road side. The city corporations in major cities of the country do have 2-3 slaughtering facilities which are mostly underused and in worn-out condition. There is only one (1) organized export-oriented, modern, integrated abattoirs cum meat processing plant in the country. It is likely that some more export plants will be developed in the future, given Bangladesh's export focus on meat to the countries in middle-east and other deficit nations. There are more than 200 specialized chicken meat processing and packaging units which are meeting the increasing demand of processed chicken in the country.

2.3 Objectives

The objective of this sub-component B2 is to increase producers' linkage with the profitable markets, improve the volume, quality and safety of livestock products⁵ being marketed, and decrease transaction costs along the value chains. Furthermore, legislative and regulatory enforcement for the slaughtering of animals function poorly. Should this practice remain, private sector will be hesitant to invest in hygienic slaughtering and meat processing facilities, as consumers are not willing to pay a premium for certified meat slaughtered and processed under hygienic conditions. Food safety standards are set by the Bangladesh Standard Testing Institute (BSTI) and food safety surveillance through Bangladesh Food Safety Authority (FSA). Nevertheless, key challenges remain to attaining basic food safety, including the relevant standards for livestock and livestock products of the World Organization for Animal Health (OIE) and the food safety standards of Codex Alimentarius Commission set by the Food and Agriculture Organization (FAO) and the World Health Organization.

These set of sub-grants (in fact 100% grants) are available for LDDP sub-component B2 and will support the realization of building critical infrastructure with main focus on improving slaughter and meat processing at the wet markets, constructing new slaughter facilities in the districts and ultra-modern facilities at the metropolitans. The beneficiaries of these sub-grants will be mainly municipalities and city corporations for the slaughter houses and renovations of wet markets. A sum of US\$94.3 million has been earmarked for upgrading/new slaughtering and meat processing facilities with focus on hygiene improvement and provisioning for freezing the products for upmarket customers. The sub-grant allocations as envisaged are:

² Chapter 3 of this report provides further information in this regard.

³ Estimated figure

⁴ Numbers are not available

⁵ With special reference to large animals (beef), small ruminants and chickens (as applicable).

- Improvement of wet markets by moving animals slaughtering out of the wet markets (allocation of US\$51.6 million for 192 units with an average unit cost of US\$256,000);
- Slaughtering facilities at the district level (allocation of US\$12.7 million for 20 units with an average unit cost of US\$635,000);
- Developing modern slaughterhouse and cold chains and rendering facilities in the metropolitan areas (allocation of US\$30.0 million for 3 units with an average unit cost of US\$10.0 million).

2.4 Approach and Methodologies

As per various rounds of discussions with the LDDP Project Implementation Unit (PIU), it is quite clear that this report will focus on the potentials of business, mainstreaming hygiene as an approach to the public slaughtering facilities. In this regard, the consulting team is being entrusted to develop business plans for all types of proposed facilities. We agreed to follow the below mentioned matrix (Table 1) while developing the business plan:

Table 1. Types of slaughtering facilities

Types of Animals to be slaughtered	Targeted Growth Centres for Slaughtering Facilities		
	Wet Markets	Districts	City Corporation
Large Animals (cattle/buffalo)	Yes	Yes	Yes
Small (Goat/Lamb)	Yes	Yes	Yes
Poultry birds	Yes	No	No

This report has been prepared based on both secondary studies and primary data/information collected from the stakeholders. The following approaches and methodologies (Table 2) were undertaken to prepare this report.

Table 2. Approaches and methodologies for developing business plans

Approach for preparing this report	Methodologies adopted
Understanding current practices of slaughtering at different levels (butchers in the wet market/slaughtering facilities at the district and City corporations) in terms of daily operation (handling of large animals/small ruminants/chicken etc.), seasonal variation (festivals and other variabilities), processing and marketing of products, volume and type of waste generation, handling/disposal of waste, energy/water use, challenges involved etc.	1.Secondary study by reviewing the available literatures and resources from the DLS and other departments.
	2.Primary study through stakeholder consultations (qualitative & quantitative information), field/site visits and survey to understand the existing flow of the products and markets thereto.
	3. Analysis of the slaughtering activities and documenting the gaps and challenges both at operational and policy levels to provide viable solutions.
Prepare business plans for each type of facilities and recommendations on business models for the upgraded	1. Feasibility studies of the business models for upgrading the existing wet markets, introducing modern facilities

slaughtering facilities/ new slaughterhouses based on the collected information and global best practices and guidelines to adopt appropriate market linkages at various levels.	2. Develop long term viable-cost effective and market linked plan for each type of slaughtering facilities and appropriate waste disposal/management systems
	3. Provide a partnership model for linking the butchers/meat shop and supermarkets with the slaughtering facilities.
Prepare a long-term roadmap for capacity development: Prepare long term awareness and training programme for butchers/meat shop keepers/slaughter facility personnel) on proper evisceration, safe meat production, personnel hygiene, use of PPE, waste disposal methods, HACCP compliance for slaughtering facilities.	1. Prepare a brief guidance note on categorization of slaughtering facilities based on the best practices. This will help the reviewing and monitoring authorities in Bangladesh for renewal of registration and financial institutions in assessments of risk in lending.
	2. Linking with the specialist service providers on training need assessments (TNA) who will be developing a matrix for long term capacity building exercise for the stakeholders.
Develop a monitoring and evaluation framework for slaughtering facilities and prepare a partnership plan to expand the markets.	1. Develop tool for monitoring and to evaluate both the underlying and business performances for potential scaling up across the country.
	2. Guidance notes to establish linkage/ partnerships with the private and other on-going initiatives to expand the market of value added animal products.
Provision of due consideration to gender mainstreaming⁶ and reduced carbon footprints to make a clean and habitable environment for the dwellers around the slaughtering facilities	1. Gender mainstreaming in slaughtering facilities is important for integrating a gender approach into development efforts. The business plan will take good care to this aspect.
	2. Will prepare a guidance note on hygiene, bio-safety and environment-positive slaughtering facilities to become the regulatory compliant slaughtering projects in Bangladesh to attract export markets.

3. CONTRIBUTION OF LIVESTOCK IN ECONOMIC DEVELOPMENT

3.1 Role of livestock in rural economy of Bangladesh

Livestock is a major component in agriculture in the developing countries like Bangladesh and play an important role in its national economy. Livestock and their product provide direct cash income as animals are considered as any time money (ATM) for many farmers and are critical to agricultural production intensification through provision of manures for fertilizer and fuel to rural households. In an agriculture dependent economy, livestock plays a crucial role in production management, employment generation

⁶ In practice, gender mainstreaming means being deliberate in giving visibility and support to both women's and men's contributions individually, rather than assuming that both groups will benefit equally from gender-neutral development interventions. Policies and programme that ignore the differential impact on gender groups are often genderblind and potentially harmful for human development.

(particularly for women and youth), poverty reduction and supply of animal-based protein. In Bangladesh over 70% of the rural households are directly or indirectly engaged in livestock production which contributes a large share of the small holder and landless farmers' livelihoods.

Demand of Animal Source Food (ASF) is gradually gaining importance in developing economies like Bangladesh due to poor nutritional outcome from the food being consumed by the majority of the population. This lower level of nutritional inputs could be supplemented by consumption of milk and meat from cattle and buffalos, small ruminants and poultry products. This however, is being challenged by the low productivity in the livestock sub-sector primarily due to: (a) lack of infrastructural facilities, (b) poor technical knowledge about scientific rearing, (c) non availability of suitable animal breeds, food and medicine, (d) non- enforcement of food safety laws and (e) unfavorable market mechanism.

3.2 Contribution of Livestock in Bangladeshi GDP

A brief account of the contribution of Livestock in the National Economy of Bangladesh 2020-21 is provided in Table 3 shows that 1.44 % of the total GDP is originated from livestock at a growth rate is 3.8% which is significant keeping in view the challenges faced by the country during the global pandemic due to COVID19.

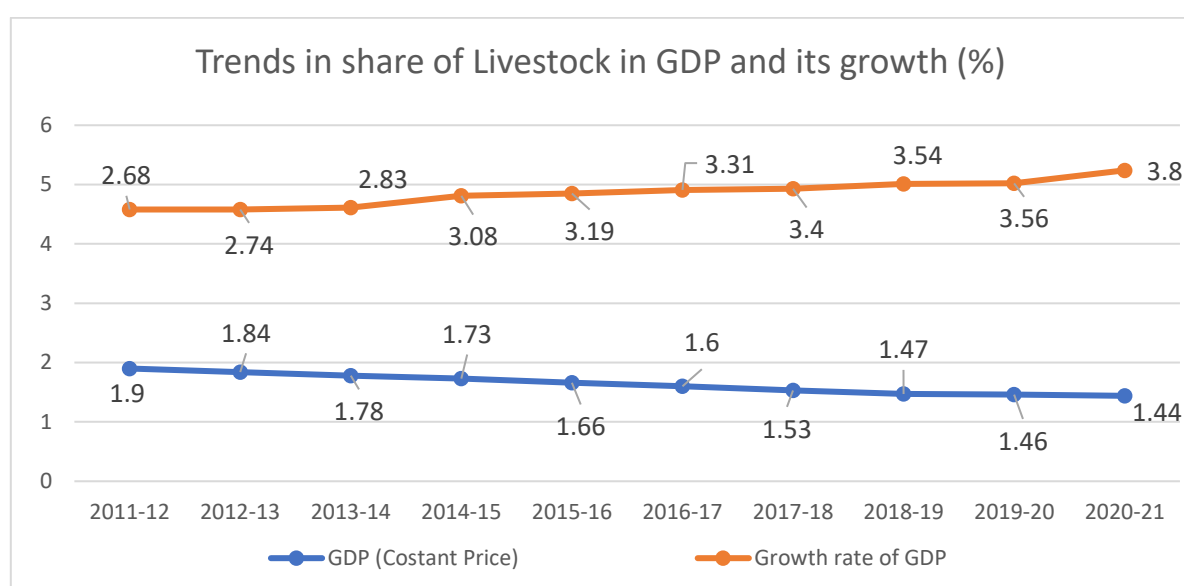
Table 3. Contribution of Livestock to Bangladesh GDP in 2020-21

Indicators	Contribution level
Contribution of Livestock in GDP (Constant Prices)	1.44%
GDP growth rate of Livestock (Constant Prices)	3.80%
GDP Volume (Current Prices) (in Crore Taka)	50,301
Share of Livestock in Agricultural GDP (Current Prices)	13.10%
Employment (Direct)	20%
Employment (Partial)	50%

(Source: DLS, 2021)

The decadal trend of contribution of livestock to country's GDP is shown in Figure 1 below provides a fair idea that the livestock is playing an important role and a constant growth was registered during the period 2011-12 to 2020-21.

Figure 1. Decadal trend in share of Livestock in National GDP



(Source: DLS and BBS 2021)

3.3 Livestock population and production

The decadal data (2011-12 to 2020-21) on total livestock population in Bangladesh (Table 4) registered a growth rate of 24% which is primarily due to higher growth in poultry production (27%) whereas the growth in ruminants (large and small) are not significant (7%). The large ruminant population (cattle and buffaloes) grown at a rate of less than 6% during the said period which provides a huge opportunity for this sector to grow at a faster rate.

Table 4. Livestock population of Bangladesh (number in lakh)

Species	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Cattle	232	233	235	236	238	239	241	242	244	245
Buffalo	14	15	15	15	15	15	15	15	15	15
Sheep	31	31	32	33	33	34	35	35	36	37
Goat	251	253	254	256	258	259	261	263	264	266
Total Ruminants	528	532	536	540	544	547	551	555	559	563
Chicken	2429	2490	2553	2618	2684	2752	2821	2893	2966	3041
Duck	457	473	489	505	522	540	559	578	597	617
Total Poultry	2886	2963	3042	3123	3206	3292	3380	3470	3563	3659
Total Livestock	3414	3495	3578	3663	3750	3839	3931	4026	4122	4222

(Source: DLS, 2021)

Production of milk and meat during the period 2011-12 to 2020-21 registered a significant growth which indicates that there was a big change in the productivity of the livestock and poultry sector (Figure 2). The milk production during the decade in the analysis

registered 246% growth whereas meat production was 262% during the same period. This substantial growth can be attributed to the breed improvement programme of the Government of Bangladesh and enabling policies to support the livestock farmers.

Figure 2. Production of Milk and Meat during 2011-12 to 2020-21

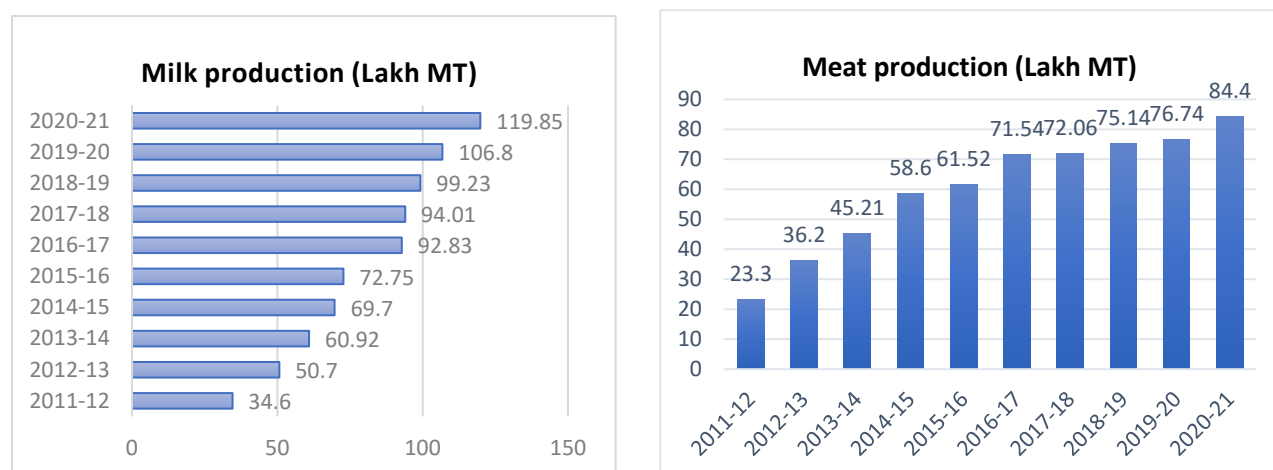
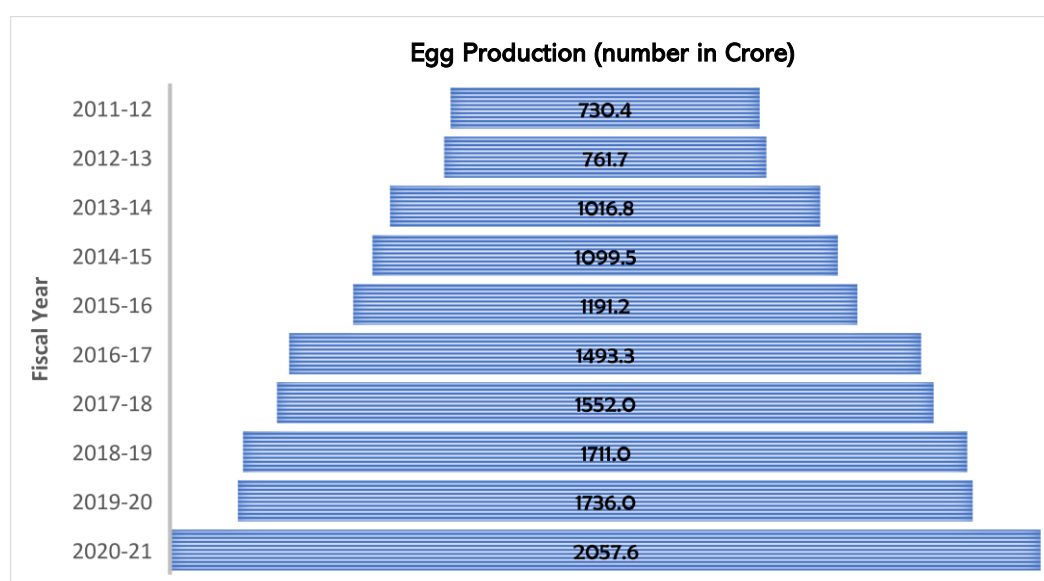


Figure 3. Production of Egg during 2011-12 to 2020-21



Egg production in the country augmented by 182% during the decade (2011-12 to 2020-21) which is significantly contributing to the food system and nutritional outcome (Figure 3).

The Department of Livestock Services (DLS), Government of Bangladesh estimated the demand and availability of milk, meat and egg for the year 2020-21 (Table 5). This estimation indicates that the availability of animal meat and egg exceeds the demand whereas, the demand for milk is more than the availability.

Table 5. Demand, production, availability of milk, meat and eggs (2020-21)

Name of the Products	Demands	Production	Availability
Milk	154.94 Lakh MT (250ml/day/head)	119.85 Lakh MT	193.38 (ml/day/head)
Meat	74.37Lakh Metric Ton (120gm/day/head)	84.40 Lakh MT	136.18 (gm/day/head)
Egg (number)	1765.92 Crore (104 number/year/head)	2057.64 Crore	121.18 (number/year/head)
# The estimated population of the country on 1 st July, 2020 was 16 crore 98 lakhs			

(Source: DLS, 2021⁷)

3.4 SWOC Analysis of livestock growth and its impact on lives and livelihoods

A brief analysis of strength, weakness, opportunities and challenges (SWOC) clearly indicates that prospects of dairy and red meat production activities are enormous, if we could able to transform the weakness and challenges as opportunity. As such, dairy and red meat production in Bangladesh most viable and it can be considered and new emerging sector and Bangladesh is already in self-sufficient in red meat production.

Strengths	Weakness
- Dairy and red meat animal farming helps directly in increasing crop production by making available draught power, manure and cash income on day-to-day basis. - Provide employment to rural population mainly women. - Regular income in the farmer. - Private dairying has increased milk and red meat production. - Irrational income improves the quality of life in rural areas.	- Lack of constant pressure group from the private sector for protecting the interest of dairy and red meat industry. - Irrational allocation of farms for dairy and red meat industry. - Lack of educate credit for Livestock development. - Artificial insemination service for breeding better cattle has limited coverage. - Inadequate research facilities and lack of transfer of technology. - Animal health care activities are not adequate. - Limited marketing support handicaps rural milk and meat producers seriously. - Lack of proper dependable statistical of Livestock sector. - Farmers access to training in modern cattle management is absent.
Opportunities	Challenges

⁷ http://dls.portal.gov.bd/sites/default/files/files/dls.portal.gov.bd/files/a7c2c046_864e_41c5_adcc_c9858ebc7887/2021-08-18-05-41-28ed36a96d0db342b627f416f5d1f97a.pdf

• A contributor to the production of food (meat, milk, eggs and blood), industrial raw materials (wool, hair, hides and skins), • Input for crop production (draught power and manure) • Export earnings (live animals, skin and hides) opportunities • Employment enhancement and earning opportunities in the rural areas	• Competency between organized and un-organized sectors resulting in unhealthy business practices/lowering values (quality/service/ethics). • In adequate Regulatory staff to monitor quality of imported and indigenous product. • Natural calamities like flood, drought, diseases that can affect to cattle population.
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Photograph 1. Food for cattle fattening



(PC: AFC-SSIL, 2022)

4. REGULATORY MECHANISMS FOR SLAUGHTERING FACILITIES

Livestock is an important component of the food supply of rural and urban areas and contributes to family nutrition, supplying animal protein. Meat is an important source of animal protein and a valuable product in resource-poor communities in many developing countries like Bangladesh. A slaughterhouse is a facility where animals are slaughtered for consumption as human food which needs robust regulatory framework for achieving safe and hygienic animal products across the country.

4.1 Regulatory and policy framework in Bangladesh on slaughtering activities

The livestock sub-sector in Bangladesh is currently governed by the following legislation:

1. Bengal Cruelty to Animals Act, 1920
2. Prevention of Cruelty to Animals Ordinance, 1962
3. Bangladesh Veterinary Practitioners Ordinance, 1982
4. Animal Disease Act, 2005
5. Bangladesh Animal and Animal Product Quarantine Act, 2005

6. National Livestock Development Policy, 2007
7. National Poultry Development Policy, 2008
8. Avian Influenza Compensation Strategy and Guidelines, 2008
9. Bangladesh Zoo Act, 2009 (Draft)
10. The Consumer's Right Protection Act 2009
11. Animals Slaughter and Meat Control Act, 2011
12. Fish Feed and Animal Feed Act, 2010
13. National Livestock extension policy, 2012
14. Bangladesh Food Safety Act 2013.

The above legislations are being amended and updated from time to time in accordance with the policy changes and the trends in production. Development of these policies demand involvement of all the key stakeholders for the guidelines to adequately address ground level problems and gaps that hinder the development of livestock sub-sector. The current policy framework in Bangladesh on slaughtering activities including responsible departments and their roles are provide in Table 6 below.

Table 6. Responsible line departments and their roles

Name of responsible departments	Specific roles
Department of Livestock Services (DLS)	Will provide & renewal of Slaughter house license for 12 months.
	Can suspend the license due to any irregularities
	Will inspect the slaughterhouse on regular basis
	Will ensure quality of slaughterhouse
City Corporation and Municipalities	Nobody is entitled to slaughter the animals out of slaughter house as specified except some religious, social or family festival will ensure.
	Will percent water and air pollution through slaughtering
	Will ensure slaughter
	Will ensure environmentally friendly waste disposal
	Ensure allotment of meat, poultry, egg shop to the traders subject to certification and recommendation of veterinary officer in issuing licence of meat, poultry and egg shop.
	Ensure drainage system of slaughter house
	Will clean the slaughter premises
	Construct the slaughter house out of residence area
	Will specify weekly 01 day as meatless day
	Anti-Mortem and Post Mortem Examination of animal for slaughtering by Veterinarian.
	Apply city corporation seal to the tested meat/ carcass of slaughtering animal after examination of veterinary officer.

	Maintaining register of the slaughtering animal and birds.
	Collect sample from meat market and send to laboratory for investigation.
Executive Magistrate in the respective Zila/Upazila	Due to any irregularities related to slaughtering and environment, the Executive Magistrate empowered to penalise the certain amount of money and prison terms.

(Source: Compiled from telephonic interviews and secondary sources)

4.2 Challenges faced by Livestock subsector in Bangladesh

There are many challenges faced by the livestock subsector in Bangladesh which are mainly systemic in nature and some of them are controllable also. Based on the study made by Bangladesh Institute of Development Studies (BIDS)⁸ identified several challenges that the sub-sector is facing. They include, among others, the following:

- Wide yields gap between the traditional and intensive and semi-intensive farming;
- Lack of availability of high-breed animals and also the lack of knowledge and technological know-how of maintaining the high-breed varieties;
- Animal Diseases are also among the most important constraints to livestock development in Bangladesh. In fact, animal disease alone constitutes half of the causes of death of all livestock population.
- Policy and institutional reforms of the Department of Livestock (DLS) and its functional arms are of critical importance to induce changes necessary to meet the new challenges caused by globalization, trade liberalization and WTO regulations;
- Quality assurance is a critical factor constraining future development of livestock;
- Lack of organized market for selling farm produce is an important problem, particularly for the smallholders in Bangladesh;
- Inadequate coverage of animal health services;
- Lack of space and physical security of animal resources; and
- low investment in livestock research and its poor management are matters of major concern also.

To maintain legal obligation for slaughtering animal and meat business the respective business units need to follow the Act 1957, amendment of which has been made in 2011⁹. The challenges of implementing slaughtering regulations and some of the possible solutions are listed in Table 7 below for immediate attention of the policy makers to popularize slaughtering as an attractive business and ensuring hygiene and food safety measures.

⁸ BIDS (2017). Barriers to Development of Livestock Sub-sector in Bangladesh. Available at <https://bids.org.bd/page/researches/?rid=36>

⁹ The amendment slaughtering act is termed as 'Animal Slaughter & Meat Quality Control Act, 2011 (Act No. 16 of 2011)'

Table 7. Challenges to implement slaughtering regulations and possible solutions

Activities/rules	Challenges	Probable solutions
Slaughtering regulation	Having no provision/ facilities of training of butchers or slaughterers from municipality/ city corporation	- Government line departments (DLS and other responsible departments) or the local authorities (city corporation / municipality) may take initiatives to arrange training course on personal hygiene, meat hygiene for persons related to slaughtering and meat business. - To obtain the overall status of slaughtering in Bangladesh. City corporation should take initiatives for establishing own laboratory. - There should have regular monitoring to slaughterhouse and butcher/ meat shops from DLS and also from local government.
	DLS, City corp./ municipality do not exercise their authority in case of mal practices, fraud performed related to animal slaughtering and meat marketing.	
	shortage of trained human resources as per standard requirements	
	No baseline survey regarding daily animal slaughtering, meat production, sale centres (meat shop, departmental stores, supermarket)	
	No organized slaughterhouse in DNCC, even Mohakhali slaughterhouse has been closed and shifted it to corona hospital in 2021.	
	In majority of the cases, butchers reluctant to get the permission from DLS for running meat business.	
	City corporation/ municipality does not have own laboratory.	
Hygiene bio safety challenges	Although approved slaughter house/ slaughtering slabs are made of brick/ concrete, but in majority of cases floor is made of permeable materials, which causes retaining of germs in the slaughterhouses/ slabs	Whatever the slaughterhouse/ slab, the floor should be of impermeable materials.
	Village meat selling corner sits on open space without having boundary and roof. Moreover, in festival animal slaughtering often done in open ground may cause pollution of environment and transmission of germs.	Local government should be pragmatic to improve slaughter and meat sale centres in villages also.
	Carrying of carcass from slaughterhouse/ slab to shop by	Carcass carrying vehicle should be hygienic

	unhygienic vehicle (Rikshaw/ van), decaying meat quality and contamination of meat	
	Inadequate sanitation facilities, absence of proper solid and liquid waste disposal system. Cleaning facilities in slaughterhouse/ slab-sometimes found insufficient causing Slabs are in bad sanitary condition	Water supply, hygiene, sanitation and waste disposal should be improved as per standard.
	Personal hygiene- Slaughterers/ butchers work without wearing protective uniform to minimize contamination from slaughtering environment/ animal/ meat.	Emphasis should be given on personal hygiene. Slaughterer and butchers should have protective uniform/gears (wearing PPE, gloves, gum boot etc.) and using hand wash and sanitization.
	Transportation of live animal causing stress to animal results spreading germs specially which were in dormant stage.	Require Bio secured vehicle.
	Insufficient water supply facilities for washing and cleaning slaughtered animal and slabs. Slaughter slabs do not possess own toilet and latrine facilities.	Water supply system should be improved but also check wastage.
	Lack of refrigeration facilities for storing meat in the slaughterhouse/ slabs	Introducing refrigeration facilities at slaughterhouse if storage is required
Marketing challenge	Lack of systematic marketing network Lack of value addition of the product Lack of adequate infrastructure Lack of credit facilities Lack of government support	For systematize meat market, meat chain market network may be developed. For business diversification, value added products like canned meat, puff meat etc may be popularized at least for export marketing. For extending business support money lender may expand credit facilities

(Source: Compilation of information received from various agencies)

4.3 Measures undertaken by national and local self-governments on enforcement

Various measures are being undertaken by the national/local government departments and the interventions by the government/non-government/private sectors hugely impacted the current slaughtering facilities and upgradation of hygiene. These are however not sufficient to streamline the system. Some of the measures undertaken ensured that no person, institution or organization shall slaughter any animal for selling commercial purposes without authorization, namely: a) Eid al-Azha, Eid al Fitr or any other religious, social programme and any other festival or event declared by the notification; b) for domestic consumption purposes based on family needs. The animal shall be slaughtered in place and in the manner mentioned in clause (a) or (b) in sub-section (a) where: a) the source of water the air or any other environment are not polluted and b) animal sacrifice and waste is prohibited as per the prescribed procedure. In addition, it specifies that no person, organization or statutory body shall, for the purpose of obtaining license establish or sell meat for commercial purpose and establish a meat processing factory. The slaughtering acts clearly described regarding duties of several stakeholders but those instructions are not followed properly.

4.4 Regulation related to meat inspection

Enforcement of meat inspection need to be designed to determine the health of animals both prior to death/ slaughter (ante mortem) and after death/ (post mortem). Isolating animals that show signs of disease, illness, or injury. Verifying animal identification records and tags. Overseeing humane treatment of animals during herding and slaughter. Animals are inspected for signs of disease before and after slaughter. The inspector relies on a veterinarian's judgement in those instances where there is a health or wholesomeness¹⁰ question. Extreme attention is paid to produce a carcass free of contamination. Injured or sick animals, requiring immediate slaughter, should be killed humanely and without delay, in accordance with the recommendations of the OIE¹¹. Animals should not be forced to move at a speed greater than their normal walking pace, in order to minimize injury through falling or slipping. In the case of slaughtering facilities for cattle/buffaloes, inspectors examine the followings:

- Head, an array of lymph nodes near the tongue, and the tongue itself.
- Esophagus and spleen.
- Lungs and heart.
- Bile duct and liver.
- Other accessible carcass lymph nodes.
- Diaphragm and kidneys.
- Carcass internal and external surfaces.

4.5 Surveillance and quarantine of imported animals

There are two methods available for importing animals from countries to countries. One is the Agricultural & Livestock Institute and the second one is private agents. Both of

¹⁰ Wholesomeness i.e., Wellness

¹¹ OIE= Office International des Epizooties/ World Organisation for Animal Health

them have different purposes to serve. For researching, new species invention, high-quality semen production, crossbreeding, survival situation, better feed development, etc. deal with government-owned research institutes. On the other hand, for trading purposes, private agents are available to arrange the animals. Although the usage of significant amounts of World Organisation for Animal Health (OIE) and World Health Organization (WHO) critically important antibiotics in livestock production is well recognised, the impact of antimicrobial usage (AMU) on antimicrobial resistance (AMR) in Bangladesh is still poorly characterized. Furthermore, no standard surveillance system is in place to monitor AMR over time. As a result, impact of changes in AMR policy and AMU practices cannot be assessed. Standard sampling methods, laboratory protocols, and participatory training modules were developed, pretested, and finalised. Extended spectrum β -lactamase (ESBL)-resistant *Escherichia coli* identified through the disk diffusion antimicrobial sensitivity testing (AST) method were selected as the indicator bacteria for AMR in the first phase of surveillance.

Bangladesh's Animal and Animal Product Quarantine Act, 2005 and Import Policy Order, 2015- 18 oversees animal quarantine issues under the Department of Livestock Services (DLS), Ministry of Fisheries and Livestock. The conditions of importing live animal, meat, day old chicks, live poultry, and eggs are included in the Import Policy Order, 2015-18. Importers must obtain Import Permit (IP) from the Department of Livestock Services (DLS) through submitting a proforma invoice and registration of the DLS. For importing meat, it is compulsory to have production and date of expiration and storing methods information on the package of imported meat. Day old chicks are importable under three conditions: a) a certificate issued by the authorized officer of the livestock department of the exporting country, to the effect that the imported chicks are free from contagious diseases; (b) a certificate issued by the World Organization of Animal Health to the effect that the exporting country is free from Avian Influenza; and (c) at the time of Letter of Credit (L/C) opening the importer must submit certificate from the director or an authorized officer of the Livestock Directorate that the importer has either a hatchery or breeding farm.

4.6 Regulations on 'Halal Certification for slaughtered meat in Bangladesh

Bangladesh authorities stipulate that all meat products must be halal, and the live animal was slaughtered with proper Islamic custom as defined by the Bangladesh government. The halal requirements for food products include that the product is free of pork products and free from alcohol. This is also applicable to non-meat products. The Bangladesh Standards and Testing Institution (BSTI) is authorized to issue 'Halal certificates' for processed goods (including meat), cosmetics, medicines or any other services¹². The halal certificates are being issued for goods and services that are acceptable according to Islamic Shariah, according to a notification issued by the Ministry of Industry,

¹² The Daily Star: BSTI to provide halal certificate for products; Star Business Report, Sep 13, 2021.
<https://www.thedailystar.net/business/export/news/bsti-provide-halal-certificate-products-2174951>

Government of Bangladesh. The certificate or renewal fee for small-scale industries is Tk 1,000, which is Tk 3,000 for medium ones and Tk 5,000 for large-scale industries. The certificate will be given for three years. After the expiry of the period, the interested company can apply for the renewal of the certificate.

To get the halal certificate or use a halal mark on a processed product or a label or in favour of a service, the interested companies will have to apply through a prescribed form by BSTI. The name and address of the organisation and factory, brand and product name should be mentioned in the application. There must have the signature of the applicant himself in the application and in the case of an organisation, the signature of the owner, partner or managing director of the organisation or the person authorised on behalf of the organisation. The Islamic Foundation Bangladesh has been given authority since 2007 for issuing Halal Certificate. Alongside, Bangladesh Standards and Testing Institution (BSTI) has been involved in issuing Halal Certificate on account of Gazette notification issued by Ministry of Industry on 09 September 2021. At present both Islamic Foundation and BSTI are issuing halal certificate.

The Bangladesh Trade and Tariff Commission¹³ recommended for the formation of a single entity on health certification of agricultural and processed food to boost and expedite relevant export appears timely. A committee that the commerce ministry set up to assess economic benefits of having such an entity had recommended a single certification body where from exporters will get all types of health certification keeping to requirements of importing countries. The commission report also says that Bangladesh, which has a huge potential in agricultural and processed food export, is unable to tap the potential for not having a single certification authority that could reduce lengthy and cumbersome processes that exporters now undergo to get certificates.

Exporters send agricultural products overseas largely using the Bangladesh Standards and Testing Institution certification that is usually issued in production stages, but exporters often need other certificates as the demand of importing countries varies. The government must, therefore, facilitate the agricultural and processed food export sector, taking the required initiative. The establishment of a single certification entity appears to be a good step to begin with. The government must also set up a testing laboratory of international standards and must have the existing laboratories accredited to ease export and to earn the confidence of the importing countries. The Bangladesh Standards and Testing Institution must also live up to its responsibilities and increase the number of products under its mandatory certification system.

¹³ <http://www.btc.gov.bd/>
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5. LANDSCAPE OF SLAUGHTERING FACILITIES IN BANGLADESH

A slaughterhouse, also called abattoir is a facility where animals are slaughtered or killed to provide food i.e. meat for humans. The noticeable reform of slaughterhouses was visible in the nineteenth century. This reform was a part of the rapid transition of industrial society from an agricultural society based on urbanization, technological development, and growing concern about public hygiene (Brantz, 2005¹⁴). In modern slaughterhouse extensive activities are performed like meat storage, processing and packaging. Byproducts and offal of slaughterhouse are also widely used on economic point of view. There exist different categories of slaughterhouses based of capacity, capital, customer, internal/ export market use of wastages etc.

5.1 Meat and meat-based products in Bangladesh

Livestock production constitutes a very important component of the agricultural economy of developing countries, a contribution that goes beyond direct food production through milk, meat and egg and also included e multipurpose uses of byproducts such as skins, fiber, bone, dung etc. Livestock helps on meat, milk and egg supply, family nutrition, family income, asset savings, soil productivity, livelihoods, transport, agricultural traction, agricultural diversification and sustainable agricultural production, family and community employment, ritual purposes and social status, Meat is the most valuable livestock product. Meat is composed of protein and amino acids, minerals, fats and fatty acids, vitamins and other bioactive components, and small quantities of carbohydrates. From the nutritional point of view, meat is the richest source of supplying protein which contains all the essential amino acids, highly bioavailable minerals and vitamins.

In Bangladesh Cattle, Goat and Chicken are the main source of supplying animal protein for the human being. Buffalo, Sheep and Ducks also supply meat in some extent. Swine is also used for meat specially for the tribe people. Turkey, Pigeon and some wild birds are also used by the people for meat purpose- but not in remarkable way. According to the DLS Economics Bangladesh is sufficient in filling demand of meat for human consumption. Instead of per capita requirement of meat 120 gram/ day, present availability is 122.10 gram. In 2018 total yearly requirement of meat calculated as 7.21 million Metric Ton, instead of that meat production calculated as 7.26 million Metric Ton, which means that 0.05 million Metric Ton was surplus.¹⁵

5.2 Red meat value chains in Bangladesh

The red meat beef value chain in Bangladesh is least developed with only two formal meat processing enterprises operating in the country. On the other hand, poultry processing value chain is the most commercially developed enterprises. The red meat

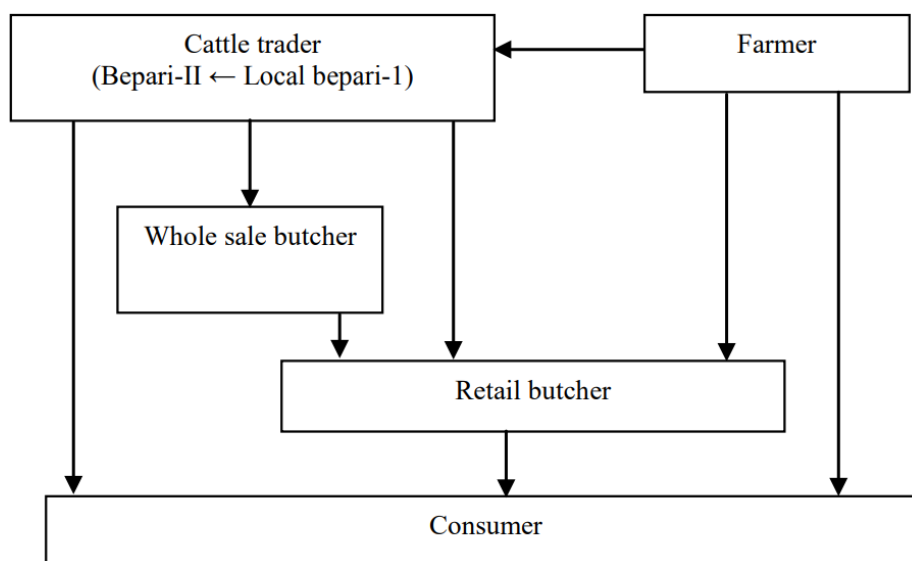
¹⁴ Dorothee Brantz (2005). Animal Bodies, Human Health and the Reform of Slaughterhouses in Nineteenth-Century Berlin. Available at

https://www.researchgate.net/publication/285145870_Animal_Bodies_Human_Health_and_the_Reform_of_Slaughterhouses_in_Nineteenth-Century_Berlin

¹⁵ DLS 2018
AFC-SSIL JV

value chain largely depends on the small producers and the intermediaries. The slaughtering facilities are available at the wet markets, city corporation/municipality shades. The supporting actors are the transporters and labourers/helpers in cleaning and processing. Marketing of slaughtered animals are majorly (90%) sold in the wet markets and local markets by the retailers and small amount are being sold at the super markets (frozen meat) which are mostly poultry products. Figure 4 below provides a generic marketing chain in Bangladesh.

Figure 4. Generic marketing channel of beef cattle in Bangladesh



Traditional channels take up the majority (approximately 90%) of beef compared to the modern channel (FAO-UNIDO, 2019)¹⁶. The major market players of industrial scale that process meat are Bengal Meat and Pabna Meat (WorldVision, 2018)¹⁷. The value chain map (Figure 5) below shows the beef value chain and two associated by-products channels. In Bangladesh, the demand for beef often increases sharply during the annual religious festival, particularly Eid-ul-Azha. Throughout the overall beef value chain, there are two main channels: traditional channel and modern channel, reflecting how cattle flows from the fattening stage to slaughtering and processing stage (in traditional and modern ways) and ultimately to end consumers. Two by-products' channels are shown on this map as well, which reflect how they link to the core beef value chain and how these by-products flow to the corresponding industry chains.

Table 8 below showing seven (7) types of marketing channel of beef in the country which shows the versatility of the beef value chain and the areas need intervention to improve the efficiency.

¹⁶ FAO-UNIDO. (2019). The dairy and beef value chain in Bangladesh: Diagnostics, investment models and action plan for development and innovation. Available at <https://www.unido.org/sites/default/files/files/2019-05/Bangladesh%20dairy%20and%20beef%20vc%20report%20%28Wei%27s%20final%20version%29%20.pdf>

¹⁷ WorldVision. (2018). Value Chain Assessment at National Level for World Vision Bangladesh. Available at <https://reliefweb.int/report/bangladesh/final-report-value-chain-assessment-national-level>

Table 8. Different marketing channels of beef value chain

Marketing Channels	
1	Producer > <i>bepari</i> > butcher > consumer
2	Producer > butcher > consumer
3	Producer > <i>bepari</i> > producer (fattening) > <i>bepari</i> > butcher > consumer
4	Producer > <i>bepari</i> > producer (fattening) > butcher > consumer
5	Producer > producer (fattening) > <i>bepari</i> > consumer
6	Producer > producer (fattening) > <i>bepari</i> > butcher > consumer
7	Producer > consumer

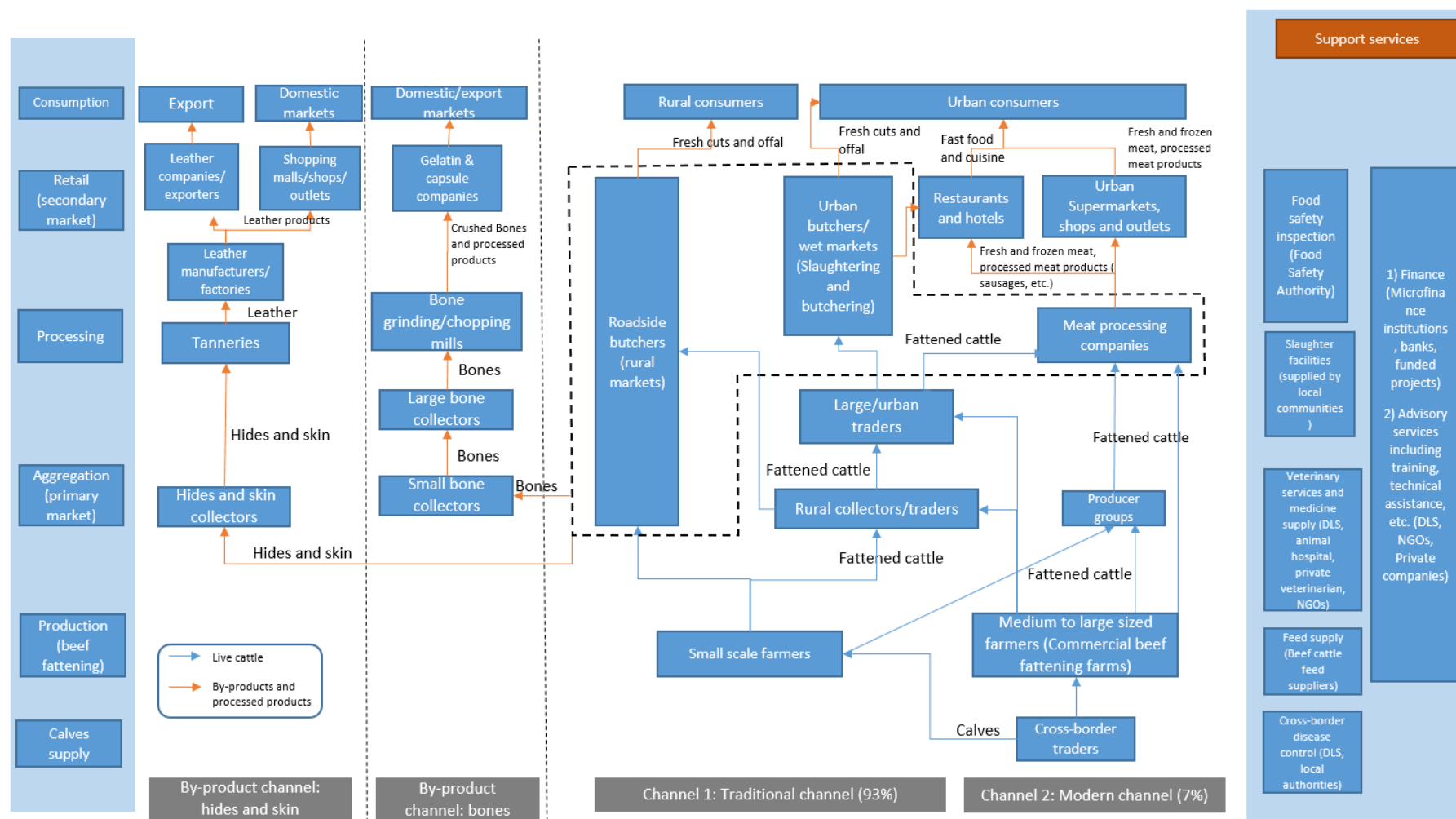
(Source: Local interviews)

Photograph 2. Bulls are more popular animal for slaughtering during the Eid-UI-Azah



(PC: AFC-SSIL, 2022)

Figure 5. Bangladesh beef value chain map



(Source: FAO-UNIDO, 2019)

The definition and brief description of the actors involved in the beef value chain is provided in Table 9 below.

Table 9. Definition of actors in Beef value chains

Actors	Brief Description
Producer	Farmers/farms who rear or fatten cattle and sell live cattle to others.
Intermediary	<i>Small traders</i> purchase live cattle from agricultural producers and sell live cattle to large traders and in the local haat¹ or market. <i>Large traders</i> purchase live cattle from small traders, fatten the cattle and sell the fattened cattle at the big market in Dhaka or other big cities. <i>Intermediaries</i> included <i>faria</i>, <i>bepari</i> and <i>aratdar</i>. • <i>Faria</i> are intermediaries who collect cattle directly from farms or haats, or from agricultural producers in the village or in the local market and sell in local markets to the <i>bepari</i>, or directly to consumers. They have no permanent shop. • <i>Bepari</i> are traders who assemble in local markets and buy from agricultural producers or <i>faria</i> and supply to urban centers. They sell to wholesalers or retailers through <i>aratdars</i> or commission agents. They have no permanent shop. • <i>Aratdar</i> are commission agents who have a fixed establishment and operate between urban <i>beparis</i> and wholesalers or retailers. (Reference: Hasan and Naim 2018; Hasan et al. 2007).
Transporters	Transport companies who supply the vehicles to carry cattle from the producers/wholesalers to Slaughtering facilities.
Wholesaler	Business entities who buy live cattle and sell beef in bulk amount and also sell live cattle occasionally to other actors or consumers.
Retailer	Business entities who buy beef or live cattle and sell beef (somewhat sell live animal) to consumers or to some other actors in small amount.
Street vendor/ mobile vendor	Small business who does not have any specific location/place to sell beef. They buy beef (meat) and sell beef on the street.
Institutional users	Organizations/Institutions that use beef for various purposes.
Slaughterhouse/ Abattoir	A specific establishment designated for slaughtering the animal. It may be either a public or private dependent on the ownerships
Abattoir's personnel	A veterinary surgeon, employee of an abattoir who are involved in the slaughtering process in an abattoir.
Butcher	A person who slaughters animals in a shop, slab or outside, and sell the carcass to other actors in the value chain

(Source: Wageningen Food & Biobased Research Wageningen (November 2021). Analysis of the beef value chain in Bangladesh. Available at <https://edepot.wur.nl/557278>)

5.3 SOWC Analysis of beef value chains

Strengths	Opportunities
- Part of the beef that did not go to the intended market was still sold on the urban food market or used for human consumption (home consumption, charity) - Actors that store beef use a temperature-controlled facility - Millions of small agricultural producers are engaged in beef fattening - Dominant systems characterized by low-cost beef fattening - Developing the sector is a national development priority - Large number of domestic consumers	- Technical support on breeding, rearing, and caring for beef cattle, including diseases, to increase the production of cattle and beef - Cooperative structures to organize actors - Market demand of fresh and processed beef has been increasing fast - Global demand of halal meat is increasing
Weakness	Challenges
- Problems with the supply of cattle and beef (not always available) - High cost of cattle feed - Lack of feed and fodder, especially in the rainy season - High transportation cost and loss of animals during transportation Lack of (timely) medicines and vaccines - Insufficient veterinary support - Poor growth and high mortality rate of cattle - High cost of storage or a lack of storage facilities - Quality decrease of beef over time (partly due to lack of (use of) cold chain facilities) - Lack of mechanical slaughtering instruments and modern cleaning and drainage systems - Lack of supply of clean water in the abattoirs - Indigenous varieties difficult to fatten - Low access to information channels	- Scarcity of land for fodder production - No slaughterhouse around the market and many slaughterhouses inactive - No specific place for slaughtering, therefore slaughtering is done at the roadside - Cattle diseases causing illness - Extortion during transportation, due to traffic jams, poor roads and police disturbances, including paying bribes - Bad road communication - Market or selling point far away - Unavailable transport - Difficulties receiving financial support or loans - Reduced sell due to endemic like Covid-19 and price fluctuations - Uncontrolled import of cattle and beef - Natural calamities such as flash floods can kill cattle and/or destroy feed

5.4 Slaughtering of animal in Bangladesh for meat consumption

In Bangladesh, animal slaughter system in Bangladesh cannot be explained in a single way. It varies depending with places, market system, slaughtering facilities, customers 'buying capacity, number of animals, butchers' profitability and so on. Slaughtering process usually governed by the Slaughtering rule of 1957, amendment of which done on 2011. The title of the amendment slaughtering rule is 'Animals Slaughter and Meat Control Act, 2011'. It is observed that in many instances, butchers/ slaughterers and even the other concerned reluctant to oblige the rule. Although the act describes to

slaughter the animal in a definite place (Slaughterhouse/ slaughtering slab) but it is ignored in many instances. Even it is seen that sometimes butchers are used to slaughter animals on busy road side, school premises, dwelling houses etc.

Slaughtering and meat market in Bangladesh are working mostly on unorganized pattern, for supplying meat majority of the Bangladeshi people depends on meat arrived from haphazard slaughters, which is poor in quality and hygiene. However, the industry trend has changed in urban cities and government has taken initiatives to set up modern slaughterhouses. Since last twenty years few private sectors have initiated to establish modern Slaughterhouse in the country. In Bangladesh slaughtering activities are overseen by Local government. In big cities and in municipality area (district and upazila head quarter) slaughtering facilities remain under jurisdiction of City Corporation and Municipality respectively. Slaughtering in Upazila/ Union level wet markets and growth centres usually oversee by the upazila/ union porishod (council) and market committee.

5.5 Present scenario of slaughtering in Bangladesh

Overall animal slaughtering scenario in Bangladesh is most unplanned, unhygienic, disorganized. Although Bangladesh Government issued a revised slaughtering act but it does not follow. Many reasons exist behind the haphazard situation in slaughtering animal. In Bangladesh due to inadequate slaughterhouses/ slaughter slabs and lack of monitoring animals are slaughtered elsewhere. If market having meat selling zone/ corner butchers themselves selected a place for slaughtering animal. This situation is prevailing in district town, upazila headquarters and even in Metropolitan area. On the occasion of Eid-ul-Azha majority of city resident premises, road adjacent to resident use as slaughtering slabs. Besides, animals are also slaughtered elsewhere for social and political purposes like marriage ceremony, independent day, winning election, birth anniversary of renowned person/ leader. Animal slaughtering places in most of the cases remain unhygienic and having not enough capacity to wash out waste and debris. Persons involved in slaughtering and meat trading process are little aware about personal hygiene and even some ignore their own hygiene.

A team of researchers from Tokyo University of Agriculture carried out a study¹⁸ in two districts (*Moymonsingh* and *Gazipur*) on '*Present Working Conditions in Slaughterhouses and Meat Selling Centers and Food Safety of Workers in Two Districts of Bangladesh*'. To carry put the study they selected 10 slaughter slabs in ten wet market of Moymonsingh and selected 10 slaughter slabs in 10 wet markets in Gazipur. Major findings of their study mentioned below:

¹⁸ Alam Mohammad Khurshed, Keiko Yoshino and Mohammad Mujaffar Hossain (2020). Available at [http://www.pertanika.upm.edu.my/resources/files/Pertanika%20PAPERS/JSSH%20Vol.%2028%20\(2\)%20Jun.%202020/09%20JSSH-4191-2018.pdf](http://www.pertanika.upm.edu.my/resources/files/Pertanika%20PAPERS/JSSH%20Vol.%2028%20(2)%20Jun.%202020/09%20JSSH-4191-2018.pdf)

- Among the twenty slaughter slabs studied, only two i.e. 10% owned by the local government and rest (90%) are under private (i.e. butchers/ meat traders) ownership.
- Out of the meat selling centers surveyed, 55% had roofs, 40% had toilets and 35% had handwashing facilities.
- Out of the 20 slaughtering facilities studied, 10% of them slaughtered sick animals.
- About 20% of the workers had health certificates, 15% of workers wore protective cloths and only 10% of workers wore rubber boots.
- In the study area, the average number of workers per slaughterhouse and meat selling center was 10.9.
- There were comparatively more workers in slaughterhouses and meat selling centers in urban than those in semi-urban areas.
- The average number of animals slaughtered per day was 20.9, where cattle were 4.3 and goat was 16.6. But the average number of goats slaughtered per day was different within the study area (Mymensingh:12 and Gazipur:21). Out of the twenty slaughterhouses and meat selling
 - ✓ Only 45% of slaughterhouses and meat selling centers had proper light facilities,
 - ✓ 35% had proper ventilation
 - ✓ 50% had drainage facilities.
 - ✓ 40% had inadequate light,
 - ✓ 40% had improper ventilation and
 - ✓ 50% of the slaughterhouses lacked drainage facilities in the Gazipur area.
 - ✓ Only 35% of slaughterhouses and meat selling centers had handwashing facilities, and tube wells were the main source of water.
 - ✓ 50% of slaughterhouses and meat selling centers had drainage facilities for bleeding,

5.6 Organized Slaughtering places

While the slaughterhouses/ slabs are given licence by the authority that is termed as organized slaughterhouse/ slaughter slab. Comparatively smaller area of slaughtering place having no boundary, smaller capacity of slaughtering animal is termed as Slaughtering slab. In city and in municipality area slaughter houses/ slabs are overseen by the city corporation and municipality. Necessary hygienic rules of slaughtering (anti mortem and post mortem) are not being obeyed. Most slaughterhouses are unhygienic and dirty. In Bangladesh, local government (city corporation, municipality, upazila council, union council) are dealt with the traditional slaughterhouses/ slabs. Among them some are under direct ownership of local government and others under the ownership of butchers/ meat shops.

Photograph 3. Slaughtering on the road side in Rangpur



(PC: AFC-SSIL, 2022)

In Dhaka City there are five animal slaughterhouses under the two city corporations. Two in the south and three in the north. According to the government system, to sell meat in market for human consumption, the animals have to be slaughtered from the slaughterhouse designated by the corporation. As the slaughterhouses under Dhaka City Corporation were conventional and older thus to meet the slaughtering mandate, government decided to modernize five slaughterhouses two under Dhaka South City Corporation (DSCC) at Kaptan Bazar and Hazaribagh and three under Dhaka North City Corporation (DNCC) at Gabtoli, Mohammadpur Krishi Market and Mohakhali.

The new design mechanized modern slaughtering facilities will be able to slaughter increase number of animals about four times than of conventional slaughterhouse. As opposed to a slaughtering capacity of 200 to 300 cattle per day at a conventional one, the capacity at Hazaribagh's mechanized slaughterhouse will reach up to 1,200 cattle each day. The blood, gut and intestinal contents and other wastages will be used for commercial purposes. Besides, each slaughterhouse will also have a biogas plant that will use. Out of the three new slaughterhouses in DNCC area, the one near Mohakhali bus terminal converted to Corona Hospital in April 2020 during the onset stage of COVID 19. As slaughterhouses in DSCC and DNCC are under renovation process, two conventional slaughterhouses presently in functioning which is located at Krishi Market, Mohammadpur and one in Mirpur under DNCC. Except meatless day (each Sunday) the slaughterhouse started functioning early dawn to till 9 a.m. Each day about 20 to 40 cattle and 100-150 goat and sheep are slaughtered.

Apart from the two conventional slaughterhouses, huge number of animals are slaughtered in different markets adjacent to the butcher shops. Slaughtering figure received from the DNCC and DSCC shows that each day on average 750 cattle, 1920 goat and 535 sheep are slaughtered. Out of which 43 No cattle (5.73%) 120 No Goat (6.25%) and 35 No Sheep (6.54%) are being slaughtered in slaughterhouse/

slaughtering slab owned by city corporation. The rest i.e., huge number of animals are slaughtered elsewhere of the city through private arrangement. From the above figure it is apparent that 94.27% cattle, 93.75% goat and 93.46% sheep are being slaughtered in private arrangement.

About 10 lakhs poultry specially broiler chickens are slaughtered for dwellers of two city corporations in Dhaka. Birds are slaughtered in live bird selling premises. Each live bird shop having facility of manual and mechanical slaughtering and hand dressing. Besides market site poultry slaughtering facilities, mobile poultry vending with slaughtering is also popular among the city dwellers. Based on information received from DNCC and DSCC Veterinary Officer over mobile phone, daily animal slaughtering figure in Dhaka city is given in Table 10 below:

Table 10. Average number of animals slaughtered on daily basis

Slaughtering place	Cattle	Goat	Sheep	Poultry
City Corporation owned slaughterhouse/ slab	43	120	35	NA
Slaughtering slab within meat shop corners	707	1,800	500	10,00,000
Total	750	1,920	535	10,00,000

Source: DNCC and DSCC (information received from the conversation with the officials)

5.7 Approximate meat production in two City Corporations of Dhaka City

From the above-mentioned slaughtering figure in Dhaka city (DNCC and DSCC), we can obtain total meat production (Beef, goat meat, mutton and poultry meat). To assess total meat production in day in Dhaka City, average live weight of cattle considered as 350 Kg, goat/sheep as 18 Kg, and average live body weight of broiler and other fowl/ duck considered as 1.5 Kg. Average estimated daily meat production in Dhaka city (DNCC and DSCC) is provided in Table 11 below.

Table 11. Estimated meat production in Dhaka City on daily basis

Particulars	Cattle	Goat	Sheep	Poultry	Remarks
Number of species	750	1,920	535	10,00,000	Average number
Average live weight (Kg)	350	18	18	1.5	Changes during the festival seasons
Total live weight (Kg)	262,500	34,560	9,630	15,00,000	
Total weight of dressed meat **	1,57,500	17,280	4,815	9,00,000	Total Meat 10,79,595 Kg.
Meat supply sharing by species (%)	14.59%	1.60%	0.47%	83.36%	Poultry birds lead the demand

** dressed weight is 60% of body weight for cattle, 50% for goat and 60% for poultry
(Source: DNCC and DSCC (information received from the conversation with the officials))

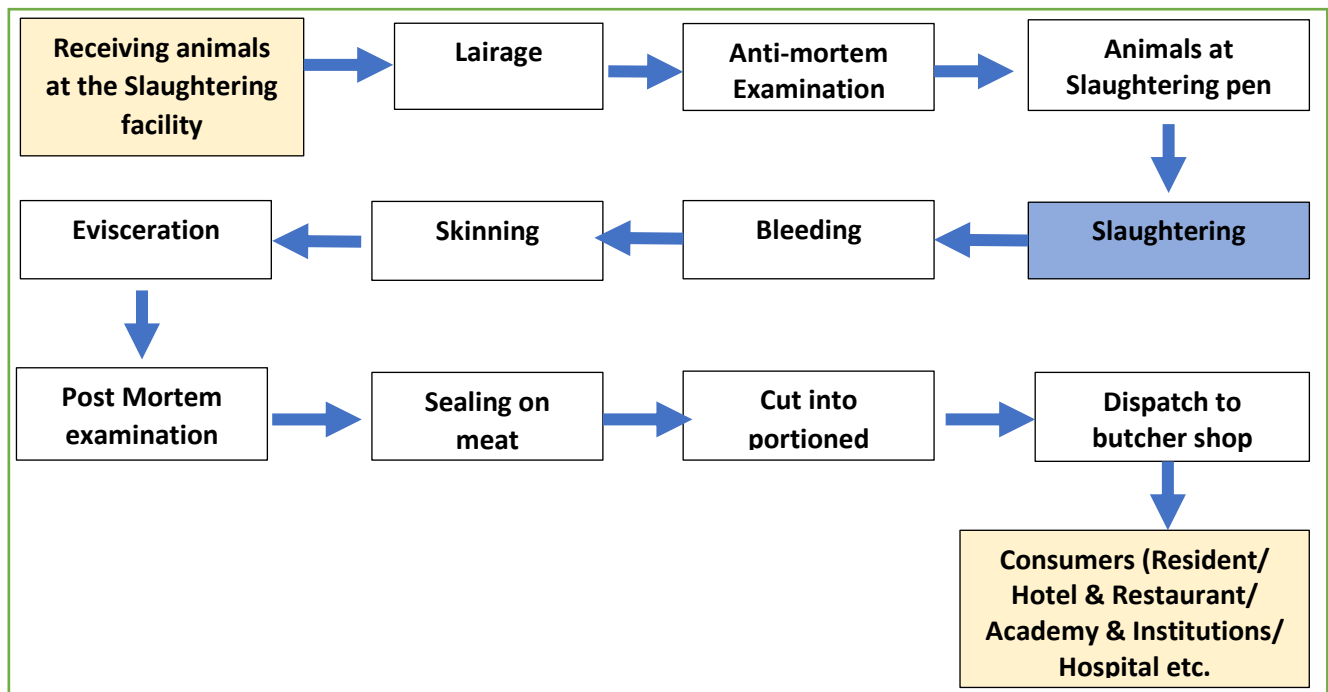
From the slaughtering figure in Dhaka city, it is revealed that out of total meat supply 83% come from poultry (mainly broiler), followed by beef, goat meat and mutton those

shared by 14.59%, 1.60% and 0.47% respectively. Persons related to slaughtering and meat trading could not give idea regarding number of butcher/ meat shop/ in Dhaka city. But Mr. Rony, a meat trader at Krishi market informed me that about 20,000 persons have enrolled as General member of Meat Traders Association in Dhaka city both DNCC and DSCC. He also said that many of them are irregular some are inactive in their profession.

5.8 Present status of slaughtering facilities

A brief report of the slaughtering facilities (slaughter slabs) in *Krishi Market*, Mohammadpur under DNCC and another *Saheb bazar* under Rajshahi City Corporation (RCC) has been narrated below for better understanding on the status of the operating facilities. Mohammadpur slaughter slab is relatively organized and better operational procedure followed, where drainage facility found better than Saheb bazar slaughter slab under RCC. No separate lairage facilities observed both the visited slaughterhouses in DNCC and RCC. But as having more space in Krishi Market Slaughterhouse animals bring relatively earlier avail some rest before slaughtering. In both the cases owner of the animal (butcher/ meat trader) involved in skinning and evisceration process. Both the slaughtering slabs having facilities of water supply and electricity. Slaughtering wastages use to dispose by the city corporation waste disposal department. Wastages are disposed in specific landfill. Blood used to wash out with water. Animal slaughtering activities are roughly similar in both Krishi market, DNCC and Saheb bazar, Rajsahi City Corporation (RCC) as stated in Figure 6 below:

Figure 6. Slaughtering facilities in Krishi Market, Mohammadpur, Dhaka



In Krishi market production process starts with 6 to 8 hours¹⁹ rest of animal before slaughtering. This process is known as lairage. During lairage only drinking water is served to the animal. While in lairage, veterinary doctor conducts an anti-mortem in which animal is thoroughly checked.

Photograph 4. Slaughtered animals at Krishi Market at Mohammadpur, Dhaka



(PC: AFC-SSIL, 2022)

Once anti mortem and lairage are completed slaughtering process starts by carrying the animal into the slaughtering pen. Slaughterer (butcher himself or Moulana) use to slaughter animal in Halal method²⁰. After completion of bleeding, helper hang the animal through rope or chain for skinning and evisceration. In the evisceration process animal body is used to open to remove the contents of the carcass. After evisceration, veterinary doctor used to conduct post mortem, in which meat quality and hygiene examination. After post mortem, meat inspector impressed a seal mark on the meat and finally whole carcass or portion of carcass dispatch to the butcher shop for selling. For slaughtering of animal in Saheb bazar slaughtering slab (RCC) animals are used to brought at early morning just before slaughtering, thus animals can't give rest before slaughter.

5.9 Modern slaughterhouse

Establishing The modern slaughterhouse Five modern slaughterhouses are under process of renovation/ construction in Dhaka city (both in DSCC and DNCC). The Department of Livestock Services (DLS) with the assistance from World Bank funded Livestock and Dairy Development Project (LDDP) has undertaken an initiative to construct the three modern slaughterhouse in three metropolitan cities like Rajshahi, Khulna and Chottagram. For establishment of modern slaughterhouses each of the Rajshahi City Corporation (RCC) and Khulna City Corporation (KCC) allocated 100 decimal (one acre) land and Chottagram City Corporation (CCC) allocate 88 decimals land. Land available for construction of modern slaughterhouses in three metropolitan cities is given in Table 12 below.

¹⁹ In ideal slaughtering process 12-18-hour rest is necessary before slaughtering animal.

²⁰ Stunning process is not followed before slaughtering animal.

Table 12. Availability of land and other conditions in three city corporation

SI #	City Corporations	Land Allocated	Other conditions
1	Rajshahi City Corporation (RCC)	Up to 100 decimals	No dwelling house nearby
2	Khulna City Corporation (KCC)	>100 decimals	Adjacent to main road, no adjacent resident
3	Chottagram City Corporation (CCC)	Up to 88 decimals	The land is adjacent to a School ²¹ .

(Source: collected information from DLS, 2022)

A modern slaughterhouse facility includes: lairage, ante-mortem examination, a slaughtering section, flaying, carcass dressing and washing, a post-mortem inspection section, a meat processing plant, chilling plant, an animal isolation point, by-product processing sheds, and an effluent treatment plant. As per the global standard, the land area earmarked for the proposed modern slaughterhouses are not sufficient and keeping in view the legal complications to acquire more lands, it seems that the facilities will not be keeping much space for the lairage. The other important co-benefits of these modern facilities may be used for providing training facilities for cattle farmers, cattle traders, butchers and veterinarians for improving the efficiency ecosystem. Besides, three (3) modern slaughterhouses (Rajshahi, Khulna and Chattagram), the LDDP will also be supporting establishment of 17 slaughterhouses in identified districts and upgrade 192 wet market slaughter slabs in upazila wet markets or other identified growth centers²².

5.10 Privately owned modern slaughterhouses in Bangladesh

The private companies in Bangladesh have not shown much of interest in establishing modern slaughtering facilities for cattle/buffalo and goats. However, there are many private enterprises who are running chicken meat processing plants successfully across the country. This reiterate the fact that the prospects are not much brighter in establishing slaughtering facilities for beef meat as an independent business line. In Bangladesh, one industrial meat processing company (Bengal meat in Pabna) with modern slaughtering facilities are currently operating successfully and offering their products for export market and high net worth domestic customers (Box 1).

Box 1. Bengal Meat Processing Industries Ltd.

With the aim to export completely halal meat products of Bangladesh to middle east countries and high net worth domestic customers, a private entrepreneur established the Bengal Meat Processing Industries Limited (BMPIL) at Kashinathpur of Pabna district in 2007. The BMPIL

²¹ School authority and local people are reluctant and not in favour of establishing slaughterhouse near the school which might have an environmental effect. Awareness campaign need to be done in the locality about the facility.

²² Identification of locations for District level slaughtering facilities and wet markets are under process.

and its pasture land consisting of 30 acres of land. As of mandate Bengal meat ensures 100 percent safe meat for consumption. The processing capacity of Bengal Meat is 6000-8000 cattle, 50,000 to 70,000 goats and 1,800,000 to 2,000,000 chickens per year. They do, however, process meat into ready-to-cook nuggets, sausages, and other prepared products. Bengal Meat used to export meat but since 2014 the export failed due to its low-price competitiveness. The company then shifted its attention to the domestic market and currently only keeps 10% of total sales targeting oversea markets, such as Maldives, Qatar and UAE. Cattle slaughtered in modern slaughterhouses, then processed and packed directly in factories, is finally marketed through fast food shops, superstores and convenience stores. Regarding the geographical dispersion, Bengal Meat targets 70% in urban and 30% in rural areas. The company is now been negotiating with some Western and Southeast Asian countries like the USA, Canada, Australia, Malaysia and Singapore to export the processed meat. At the domestic front, some star hotels, resorts and clubs are the main customers of Bengal meat (*Lakeshore hotel, The Palace Resort and Spa, Officers Club, Dhaka, Radisson, Pan Pacific Sonargaon Hotel, La Meridian, Gulshan Club, Sayaman beach, Grand Sultan and The Westin, Hotel Serina etc.*). Bengal meat also marketing their products in Dhaka city through their different outlets and supermarkets which are however not affordable by the common people due to premium price tag.

(Source: Bengal Meat <https://bengalmeat.com/>)

Another privately owned slaughterhouse (*Premium Slaughterhouse*) at Baliadangi upazila of Thakurgaon is now under reopened which was established in 2003 and was in operation till 2006. Some entrepreneurs from Bangladesh received support from the USAID project Agro-based Industries and Technologies Development Project (ATDP) under its entrepreneurship development programme for capacity building. The ADTP also facilitated low-cost financial support from Bangladesh bank and Prime bank to reopen the abundant slaughtering facility after renovating constructions, purchase of machineries, equipment, vehicles etc. The slaughterhouse established with a capacity of slaughtering 20 cattle/ buffalo or 60 goat/ sheep per day. After started operation they could able to slaughter 20 cattle per week. In the processing plant they used to package and chilling the meat and transported to nearby cities like Thakurgaon, Dinajpur, Rangpur and Bogura and Dhaka. The slaughterhouse consisted with biogas plant using slaughterhouse wastages and debris as raw materials.

5.11 Mapping the role of existing BDS

The business development services (BDS) to support slaughterhouses in Bangladesh are cold chains, freezers at the market level, transportation, marketing, branding etc. Slaughtering facilities mapping for beef, mutton and goat meat production Slaughtering facilities mapping for beef, mutton and goat meat production is consisted with several tiers. In inclusion of all of the segments those have directly or indirectly related with slaughtering facilities will create a complex mapping. Considering with the major segments of slaughtering tires here schematic diagram on slaughterhouse market mapping is described through the Figure 6 below. From the slaughterhouse market mapping, following notable points are could be arrived:

Animal source: Slaughterhouses get live animals from traders/ animal brokers. Animal trader/ broker procure animal from Primary producers.

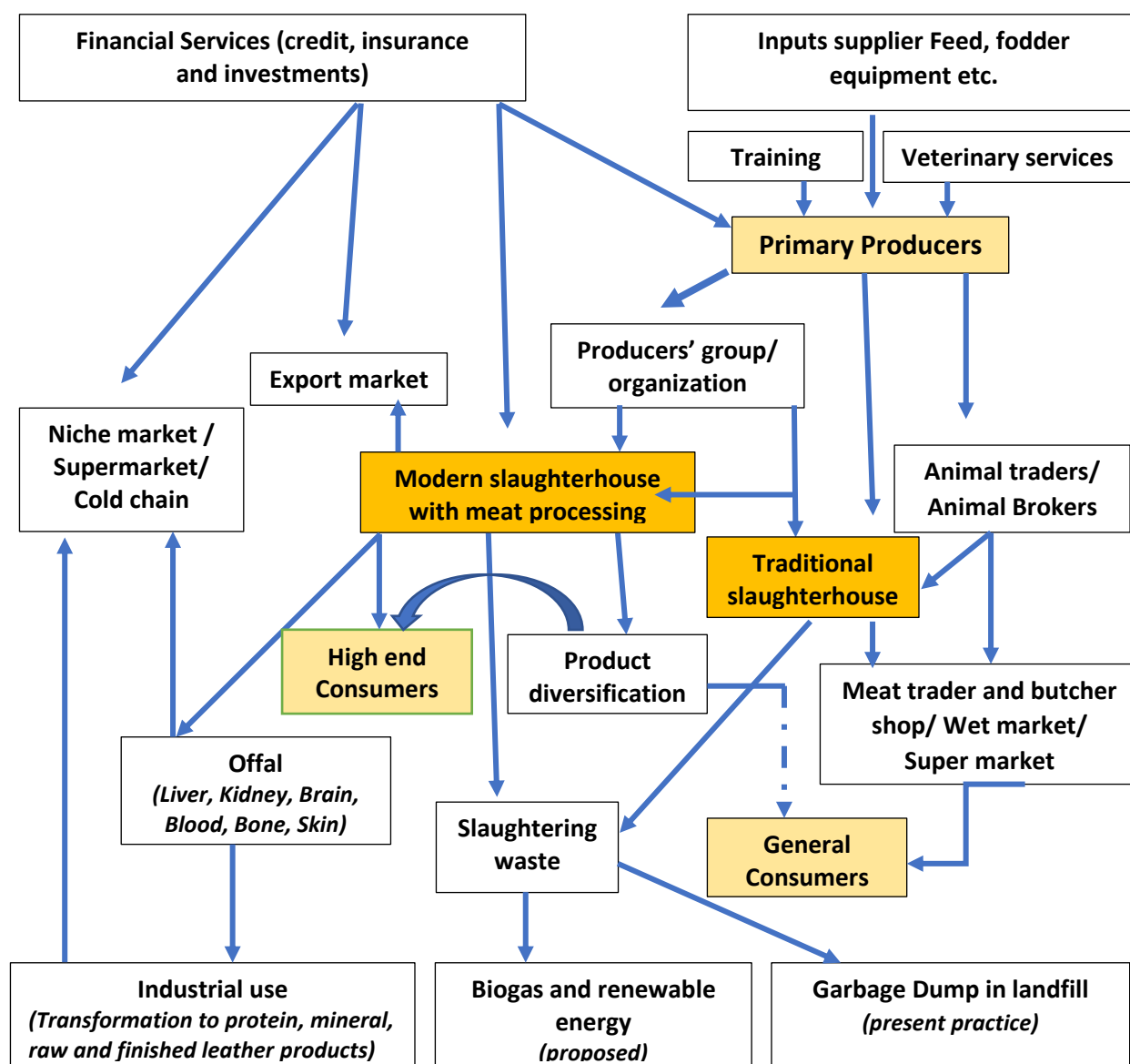
Primary producers: Primary producers are the different categories of farmers like landless and marginal to large farmers and small to big entrepreneurs. Primary producers in some instances creating producers' organization. Input suppliers, Training providers, health service providers and fund providers are the backyard linkage of the primary producers. Fund providers also associated with funding slaughterhouse, meat traders, markets and exporters.

Supply chain: After slaughtering animals, slaughterhouses supply meat to butcher/ meat traders of local market and super market. Different consumers (individual or institution) get meat from meat traders. Meat obtained from modern slaughterhouse goes to the niche market for specific customers and a big portion of meat produced is intended for exporting.

Waste Management: As present practice slaughter wastages (dung and intestinal contents) carried by the city corporation or musical authority for dumping in landfill. It is intended for converting slaughterhouse wastages (traditional and modern slaughterhouse) in to Bio gas and converting the product (biogas) into renewable energy. Offal like bone, blood and hide (Skin) used for industrial purpose and export market. Offal like liver, kidney, spleen is used for human consumption.

Cooling facility: Conventional slaughterhouses do not possess Refrigerator of cooling system. Super market and departmental stores maintain refrigerator for their own interested. They use to store unsold meat for selling them in next. Modern slaughterhouse has meat cooling facilities with having Refrigerator and Cooling Chamber. Modern slaughter also possesses Cooling van for transporting meat and diversified meat products from plant to outlets.

Figure 7. Schematic diagram on Slaughterhouse Market Mapping



(Source: AFC-SSIL Agribusiness Consultants)

6. BUSINESS FEASIBILITY OF SLAUGHTERING FACILITIES

The beef value chain in Bangladesh primarily depends on the dairy value chain, as essentially most of the beef cattle in the country comes from local animals. Very few farmers/farms focus on rearing bulls for consumption purposes. Additionally, just under half of the animals slaughtered for beef are old cows, which are no longer productive in milk production. Bulls are mostly slaughtered during the Eid al-Adha, when about 40% of the cattle consumed are slaughtered on one day. Those farmers who do focus on bull fattening are generally either medium- to large-scale farmers who could afford feed for fattening, or subsistence “kitchen farmers” who raise the bulls by feeding them crop residues. Bull fattening poses financial challenges for small-scale farmers who

approach livestock rearing as a business, as feeding bulls for fattening requires a daily expenditure of around BDT300 per day, while the cash inflow occurs only when the bull is sold. The other important challenge faced by the most small-scale farmers are management as the women faces difficulty in manipulating the larger animals. Managing goats and poultry by the small-scale farmers are rather easy as the women members in the family generally support the rearing which might be one of the reasons that goat and poultry meat are becoming more popular among the last mile farm families in the country.

6.1 Market size and characteristics of the market for beef

The total supply of meat to Bangladeshi consumers is approximately 2.2 million tons (2020-21), including all types of commonly consumed animals: cattle, buffalo, sheep, goats, and poultry. As the Table 13 below shows, about 66% of the meat supply is cattle beef, considering about 40% of the national cattle herd slaughtered annually. Poultry makes up the largest number of animals slaughtered (16.5%) although due to their smaller size, chickens and ducks represent the second largest category of meat supply to the nation.

Table 13. Breakdown of meat supply to the consumer market in Bangladesh (2020-21)

Species	National livestock population (A)	Annual Average (%) Slaughtered (B)	Number slaughtered (C=A * B)	Av. Weight of Carcass (Kg) (D)	Meat supply (Kg) (E=B*D)	Share of meat supply (%)
Cattle	24,545,000	40.00%	9,818,000	150	1,472,700	66.46
Buffalo	1,500,000	40.00%	600,000	220	132,000	5.96
Sheep	3,679,000	35.00%	1,287,650	20	25,753	1.16
Goats	26,604,000	55.00%	14,632,200	15	219,483	9.91
Poultry	365,852,000	100.00%	365,852,000	1	365,852	16.51
Total	422,180,000	-	392,189,850	-	2,215,788	100.00

(Source: Extrapolated from DLS data 2021)

The weight of the animals used to estimate meat supply leaves a margin for estimation. The following Table 14 provides assumptions for animal weights, using a 270 Kg for the typical cow or bull slaughtered, as the local breed cattle range from 250 to 300 Kg live weight. Full grown male Pabna cattle, in comparison, weigh 350 to 400 Kg each, with females weighing less. Holstein-Frisian crossbreed cattle with 50% exotic blood weigh around a half ton, and a 100% Holstein-Frisian pure-breed weighs over one ton.

Table 14. Live weight of animals slaughtered and of total herd (2020-21)

Species	Livestock population (A)	Average live weight (kg) of animals (B)	Average (%) Slaughtered (C)	Live weight of animals slaughtered (Kg) (D=A*B*C)	Live weight of total herds (Kg) (E=A*B)
Cattle	24,545,000	270	40.00%	2,650,860	6,627,150

Buffalo	1,500,000	400	40.00%	240,000	600,000
Sheep	3,679,000	25	35.00%	36,790	91,975
Goats	26,604,000	20	55.00%	212,832	532,080
Poultry	365,852,000	1.5	100.00%	219,511	548,778
Total	422,180,000	-	-	3,359,993	8,399,983

(Source: Extrapolated DLS data 2021)

The data available from DLS shows that the national meat supply was 8.4 million tons during 2020-21, which equates to a per capita consumption of 136.18 gm/day. This per capita consumption would indicate that the country is self-sufficient in meat production on a theoretical level, as the WHO's recommended per capita intake is 120 gm/day. The figures seem to be calculated based on the total live weight of the population in Bangladesh which was 8.44 million MT during the year 2020-21. The table 14 shows that in comparison to the 2.2 million tons of meat actually supplied to consumers (Ref. table 13), the total live weights of the animals slaughtered is 3.4 million tons, and the total weight of the live herds in the country is 8.4 million tons (similar to the DLS estimate). Therefore, the DLS estimation of meat supply is more likely representative of the total live weight of the herds available for slaughter, but not on the actual meat available to consumers. The actual per capita consumption of meat (including all types) in Bangladesh is 35.87 gram/day.

6.2 Retail market of beef and other meats

With half of the cattle slaughtered for Eid al-Adha, the other half are slaughtered during the rest of the year. Considering only the beef consumed during the rest of the year, the proportion of beef in national meat consumption remains high, at 52%, while poultry consumption increases to 27%. Chicken is less expensive per kilogram than beef and small ruminants (goat/sheep) are the most expensive meat (Table 15). Many consumers, particularly in rural and peri-urban areas, report consuming no beef except during the festival. Beef consumption is higher and more consistent in urban areas.

Table 15. Retail prices of all category of meats

Category	Sold by wet market butchers (BDT)	
	Rural markets	Urban markets
1. Cattle/Buffalo		
1.1 Meat with bone (per kg)	500-520	550-600
1.2 Offal (per kg)	350-400	220-500
1.3 Stomach (per kg)	200-250	250
1.4 Skin and hides (per animal)	300-350	200-250
2. Goat/Sheep		
2.1 Meat (per kg)	700-750	800-900
2.2 Offal (per kg)	100-150	100-120
2.3 Skin (per animal)	100-120	75-100
3. Poultry birds		
3.1 Dressed meat (per kg)	100-120	125-150
3.2 Skin and stomach (per bird)	30-40	20-30

(Source: Field survey and personal interviews)

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6.3. Beef market segments, products, and customer preferences

Approximately 95% of the meat consumed in Bangladesh is purchased as fresh cuts at wet markets²³. Meat with pieces of bone is the most popular among the rural and urban customers, while the stomach and other offal are also used for consumption and other purposes. Our field study revealed that only about 30% of the cattle are slaughtered in Dhaka are killed in official slaughtering facilities (DNCC and DSCC), and only about 20% in the other major cities²⁴, with few to none being slaughtered in official facilities in the peri-urban and rural areas. The municipalities in smaller townships are monitoring animal slaughtering through their staff members posted in the markets to collect the rent but they do not have any official slaughtering facilities. The other slaughtering occurs in unofficial and unregulated sites, without veterinarian supervision (Box 2).

Box 2. Private slaughtering facilities in Dhaka

A study to private slaughtering facilities and meat selling centers in Dhaka City among 130 meat shops and 10 meat selling centers showed that a total of 182 live cattle were slaughtered per day (66,430/year) in the 10 meat selling centers. The average weight of the slaughtered cattle was 137.5 kg (data collection from June 2018 to February 2019), going for a price of BDT482 per kg. This average weight is comparable to the live animal weight in high season of the abattoir that only purchased bulls.

(Source: Jafor, 2019)

As per the information collected from the public in general and the meat shop owners, it may be concluded that less than 1% of the beef consumed in the country is purchased at the organized market/shops, supermarkets and restaurants²⁵. Private sector companies attempted to compete in the high-net-worth consumer segment, but failed due to limited market demand. Bengal Meat, as well as other companies, also produce processed meat products, although the majority is chicken, supplied to fast food outlets. Select cuts of meat without bone, as well as meat with bone, are available at the few supermarkets in Dhaka. As there is no complete distribution cold chain in the country, Bengal Meat rents space in supermarkets, and has its own shops, to ensure control of its entire supply chain and they sell the popular cut and processed meat for which a list is provided in Box 3 below.

Box 3. List of processed beef products available in supermarkets

The complete list of cut and processed beef products available includes beef bacon, boneless, bone-in, brain, chilli fritz, chilli salami, beef crumble pizza topping, flank steak, frankfurter sausage, beefham, head meat, heart, hump, Italian sausage, keema, kidney, knuckle, liver, meat ball, mince, mortadella, neck, osso-bucco, pastrami, pepperoni, prime rib, rib eye, rib set, rib steak, rump, salami, salami loaf, sausage, shank, brisket, butt fillet, Canadian beef bacon,

²³ There is no confirmation about this share as the national level data as such not available. This estimation is from field interviews and secondary research.

²⁴ For example, Khulna City Corporation manage 2 slaughtering facilities with capacity of 120 animals per day which is around 18-22% of the total number of animals slaughtered in the city markets. Apart from large animals, all other animals are being slaughtered at the wet markets and they have no control over those.

²⁵ The one industrial meat processing company, Bengal Meat, operates one modern slaughterhouse in the country, which reportedly slaughters about 40 cattle per day, for a total of less than 14600 cattle annually which serves only the elite customer segment.

cooked corn beef, eye of silverside, gravy beef, pepper roast beef, smoked roast beef, spleen, T-bone steak, tail, tenderloin, tongue, and topside.

(Source: Bengal Meat website)

In general, the ordinary consumer does not trust the products in supermarkets as they report not knowing when the animals were slaughtered, or whether the meat is safe. This needs a robust campaign to disseminate the knowledge on the criteria which define safety in meat products. The price of meat in supermarkets also dissuades the majority of the population from purchasing.

6.4 Current trends and expected future market growth

As per the report of DLS (reported in Table 4), out of the different livestock species, the buffalo herd is expanding at the slowest rate, while poultry is the fastest. Average CAGRs show the cattle herd growing at 0.59%, buffalo at 0.42%, sheep at 1.87%, goat at 0.62%, and poultry at 2.72%. The low growth rates reflect the high cull rates, with animals sent to slaughter. The poultry growth rate is highest due to the rapid production cycle (8 -10 weeks) and the high demand for chicken meat. However, due to the high cost of poultry feeds, compounded by the market demand for chicken meat reaching a saturation point, has led to economic sustainability challenges for poultry farmers. These small growth rates, coupled with the human population growth rate of approximately 1.02%²⁶ means that the meat supply to the nation will remain relatively unchanged. In fact, as the human growth rate is slightly higher than the cattle growth rate, the meat supply may decrease which may be not so significant but the requirement for hygienic beef meat demand will increase with the increased middle-income population in the country

Photograph 5. Slaughtering facilities at Gollamari, Khulna City Corporation



(PC: AFC_SSIL, 2022)

Although prices for beef range from BDT 500 to 550 per Kg across districts, the variation is related more to the difference between urban and rural locations, rather than any regional deficits. The beef prices at the butcher level vary by about 20-25%

²⁶ The growth rate of the human population in Bangladesh is gradually declining, falling from 1.19% in 2010, to 1.02% in 2021.

between the regions which is quite acceptable keeping in view the high level of variation other animal products. The average wet market beef price (in the district level) according to our survey is BDT500-520 per Kg which is little higher in larger cities like Dhaka.

6.5 Existing slaughtering facilities and their business prospects

Most of the slaughterhouses are lacking basic amenities such as light, ventilation and water. Due to the scarcity of water, butchers cannot wash carcasses and clean slaughterhouses properly. They often clean carcasses manually carrying water in a bucket. They clean the stomach in the pond resulting in huge water contamination. The slaughtering and carcass-dressing processes are performed in open areas in highly unhygienic conditions and the meat is sold with little or no veterinary inspection. Carcasses are prepared in unhygienic conditions in local slaughterhouses. In rural and urban areas, towns and even in cities, the slaughtering of animals is still done by unauthorized butchers in fields, bushes, backyards or roads, where killed animals are eviscerated and dressed. In the case of goats, it is usually performed by hanging. Blood, ruminal and intestinal contents are either left where the slaughter has taken place or washed down to drain which eventually ends up in a pond or a watercourse. In Bangladesh, there is no organized system of animal slaughter facilities in terms of lairage, flaying of carcasses, carcass washing, meat inspection, etc. Inside Dhaka, there are only 3-4 slaughterhouses in operation²⁷, managed by the City Corporation. Some are mainly served for Qurbani and some are now under construction to be upgraded. However, in general, these slaughterhouses are largely far beyond the demand. During the normal day, around 500-700 cows are slaughtered in Dhaka city²⁸ but only 200-300 are slaughtered inside an abattoir. In a few slaughterhouses, the city corporation is mainly in charge of the waste treatment. Due to a lack of enforcement of the Slaughtering Act, animals of different ages are killed indiscriminately without giving due consideration to the microbiology or the hygienic quality status of meat supply to consumers which may lead to potential health hazards. Butchers are not trained to manage by products in the slaughterhouses. They flay hides in a traditional method with a sharp knife which causes damage to the hide during the operation. Thus, the price of hides decreases by up to 15%.

The biggest challenge for industrial processing is the difficulty in reducing production cost. High duty fees constrain the company to invest more capital to purchase modern facilities like sausage filler, smoke houses, ice flake machines, modified atmosphere packaging (MAP) systems, etc. Meanwhile the high rates for electricity creates additional costs. Due to its high production costs, the sale price is much higher compared to the raw meat in wet markets. Therefore, the targeted consumers are often limited to the middle and upper classes, those with higher income. Keeping in view the foregoing, the Department of Livestock (DLS) through the LDDP project aiming to achieve the objectives of the Government of Bangladesh (GOB) to strengthen the institutional capacity, resilient food systems and provisioning safe food to the people of the country. The current intervention to develop modern environment friendly

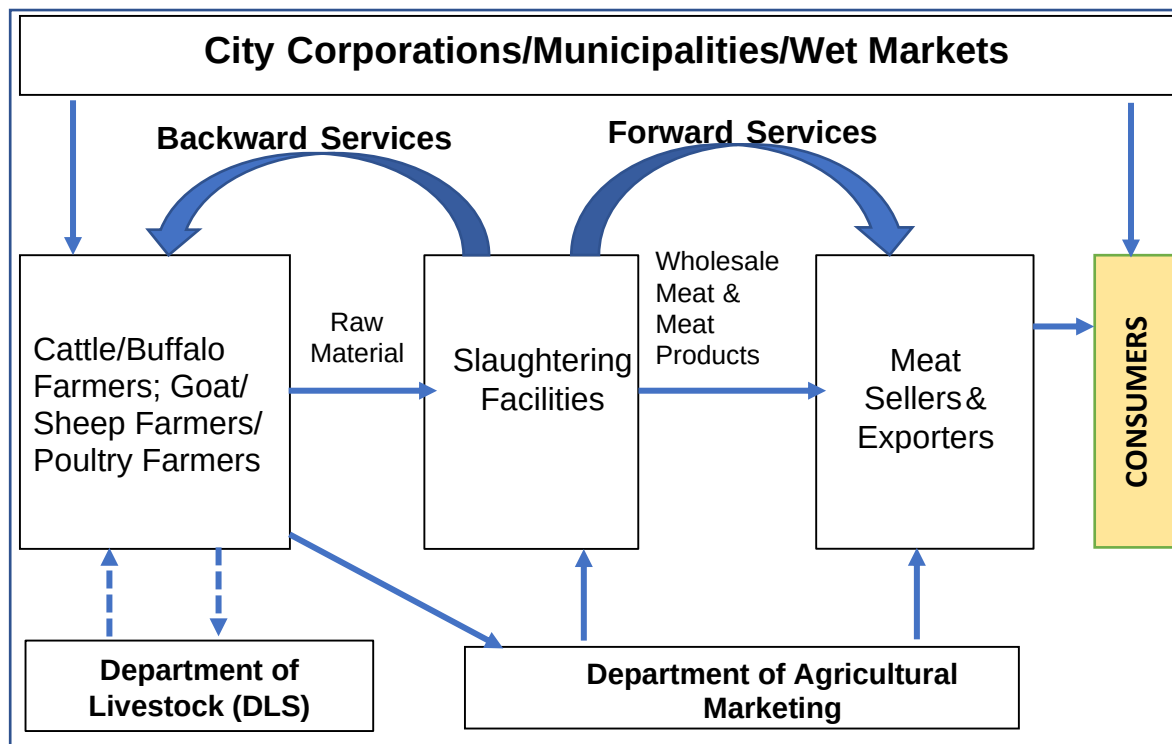
²⁷ One of the slaughtering facilities is now converted as COVID hospital.

slaughtering facilities and upgrading the existing wet markets need a robust business plan with the support of all stakeholders.

6.6 Backward and Forward Linkages

Under the proposed scheme, the modern slaughterhouse (including upgraded wet markets) will establish strong backward (with producers of the animals) and forward linkages (market and consumers). The backward linkage will ensure the quality and hygiene of raw material availability by encouraging and promote livestock owners to produce the animals by providing easy access for sale and better prices for their animals. The forward linkage will guarantee the slaughtering facilities to reach to the right market players/entities and as per the preferences of the consumers. Majority of the livestock owners (about 80 percent) in Bangladesh²⁹ normally raise 1 or 2 cattle/buffaloes (for slaughtering during the festival time), 5 to 10 goats/sheep (for commercial purpose) and 50-100 poultry birds (chicken and duck for periodic sales) as the backyard system. These smallholders are the major customers to the local slaughtering slabs/facilities which are mainly available at the road side unorganized markets. However, the medium sized producers (5-10 cattle/buffaloes) generally visit the organized slaughtering facilities at the wet markets which are under the proposed upgradation. The medium-large categories of producers or traders (more than 10 cattle/buffaloes) are generally relying on the medium sized slaughtering facilities available at the Municipality/Upazila level. Figure 7 below provides a detailed idea on the actors and how the services will work on the ground.

Figure 8. Backward and forward linkages



(Source: Drawn based on information from the field)

²⁹Alam, M K; Keiko, Y and Hossain, M M (2020). Present Working Conditions in Slaughterhouses and Meat Selling Centres and Food Safety of Workers in Two Districts of Bangladesh; *Pertanika J. Soc. Sci. & Hum.* Vol 28, No.2; pp 867 – 881.

6.7 Slaughtering facilities and process flow in the modern facilities

The current project is designed to address the concerns of public health, environment and animal welfare, as the slaughtering facilities of 3 city corporations (Rajsahi, Khulna and Chattagram) have embarked to modernize the facilities. The new design of the facilities will not only provide sanitary protection but will increase daily slaughtering capacity by nearly four times that of a conventional slaughterhouse. As opposed to a slaughtering capacity of 200 to 300 cattle per day at a conventional one, the capacity at mechanized slaughterhouse will reach upto 1,200 cattle each day. As a means to protect public health, each slaughterhouse will have in-house veterinary professionals who will screen each animal before slaughtering. Once a sick animal is identified, it will be sent to a quarantine zone, built at a safe location away from the shed for healthy animals waiting in queue.

Photograph 6. Slaughtering slabs maintained by Rangpur City Corporation



(PC: AFC-SSIL, 2022)

In the modern slaughtering process, an animal will be first taken into an enclosed chamber, which is then turned upside down. A traditional method (Halal) is then followed to slaughter it. The blood, collected in a tank through a drainage system, is later used for commercial purposes. The carcass is then hung onto an overhead conveyor belt. After deskinning the carcass, chainsaws are used to split it into sizeable portions. The meat trader then takes the portions to the butcher shop and processes the meat according to customer's requirement. With regard to the pro-environment features, the slaughtering facilities reduce the risk of biohazard by ensuring that the animal waste is not released in the environment without getting treated in an on-site effluent treatment plant (ETP). Besides, it is proposed that each slaughterhouse will also have a biogas plant that will use animal faeces collected there. Humane treatment of animals was not possible at conventional slaughterhouses where animals were

slaughtered in front of other animals in queue. The modern slaughterhouses will have separate enclosures from where the slaughtering process will not be visible. However, an observation enclosure for the owner of the animals may be constructed. At a conventional slaughterhouse, even an expert butcher would take around an hour to complete the entire process of slaughtering, deskinning and sizing up of a cow, while it will be around 20 to 30 minutes at the modern facility.

6.8 Business models in slaughtering facilities

As described in the meat value chain section, the condition of the existing slaughter facilities, (or lack of facilities) prevents to provide safe, quality meat for the population. In major urban areas, only 20% of cattle are slaughtered in designated slaughterhouses, which are usually overseen by veterinarians employed by the city corporations/municipalities and most of them are in bad condition. A larger proportion of cattle are slaughtered in the wet markets, with 40% of all cattle slaughtered in Dhaka, slaughtered in the market lanes in front of the butchers' retail stands which clearly indicated that there is a need of intervention to this direction. As noted, while Bangladesh has a Slaughter Act (2011), it lacks the subsequent legal guidelines to make the Act enforceable, as well as the human and financial resources to adequately monitor slaughtering. Particularly out of the major cities, the butchers and slaughters are not aware of any government requirement to slaughter animals in an officially designated facility. The policy makers in the country are well aware of this situation and the LDDP project has allocated a sizable amount of funds for improvement of the existing condition and move forward to new era. To support this endeavour, a robust business model exploring all aspects of business process has been prepared. While developing the business models for climate resilient public infrastructure in the form of proving safe slaughtering facilities, we propose three (3) types business process which may be accepted based on their merits and context:

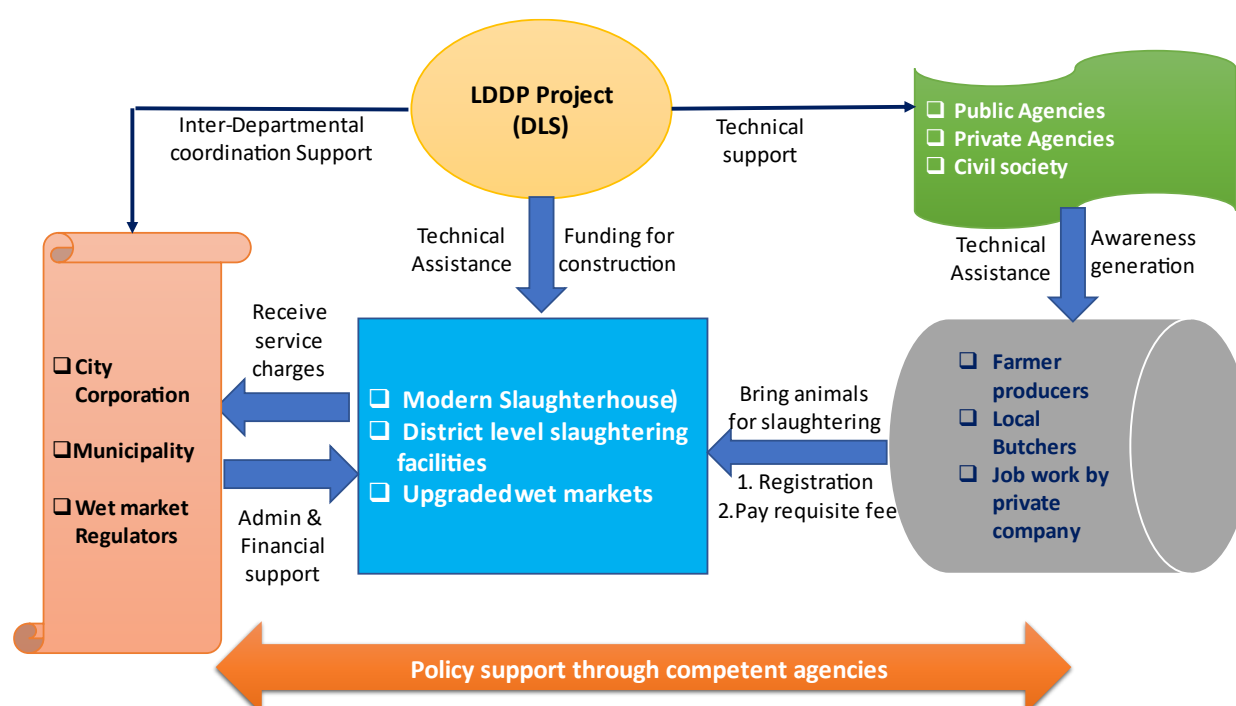
- a) **Business Model 1:** Public infrastructure run by the public institutions (specialized government agencies, city corporations, municipalities or other local governing bodies),
- b) **Business Model 2:** Public infrastructure operating under public-private-partnership (PPP) mode (joint operation by the local authorities and private entities under an agreed standard operating procedure) and
- c) **Business Model 3:** Public infrastructure run by private entities under a long-term agreement/lease (with continuous monitoring and evaluation of the performance in terms of food safety and hygiene).

Success of all the three business models generally depending on the central competencies which are defined as the capacity of the organization/agency holds in which its competitors cannot match or imitate. Furthermore, an intensive integration

(both vertical and horizontal³⁰) is a prerequisite for achieving the objectives. A detailed narration is provided below:

In case of **Business Model 1 (BM 1)** wherein the slaughtering facilities will be operated by the public agency (city corporation/municipality/other public agency) with the help of the professionals recruited by them for this purpose (Figure 8). This operational model may be termed as Build Operate and Transfer (BOT) in case on new constructions (city corporation and District level facilities) whereas in case of wet markets we may term this as Rehabilitate Own Operate Transfer (ROOT) which creates the opportunities of delivering public services are much higher as it may ensure delivering safe food without hampering the environment which in fact will fulfil the major objectives of sustainable social business and public services.

Figure 9. Business Model 1: Slaughtering facility run by public agency



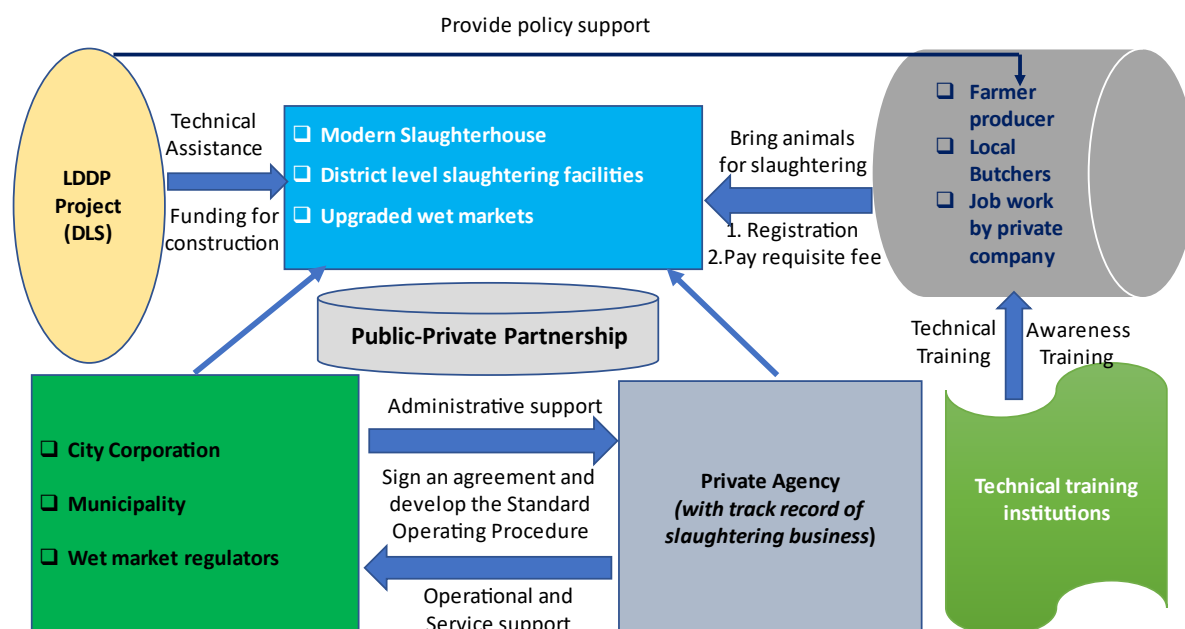
(Source: AFC-SSIL, 2022)

The **Business Model 2 (BM 2)** is proposed to consider that slaughtering facilities will be operated under Public-Private-Partnerships. In this operational Business model, the public agency will be selecting the interested private partners purely based on merits and experiences in the same filed (Figure 9). In this operational business model, under the generic BOT it is possible to extend PPP further considering that the services of the private entity will be sought during the operational stage through a service or operation and maintenance (O&M) contract awarded to a private company (Table 16).

³⁰ *Vertical integration* is the incorporation of various actors in the supply chain which can be of two types: (a) downwards vertical integration and (b) forward vertical integration. *Horizontal integration* defined as the expansion/replication of the productive capacity in different geographical locations.

Both the public and private entities will be bringing their core competence to run the facility efficiently and achieve the three-fold bottom line of sustainability: financial, environmental and social.

Figure 10. Business Model 2: Slaughtering facility run under PPP mode



(Source: AFC-SSIL, 2022)

Table 16. Characteristics of PPP modalities in operating Slaughtering facilities

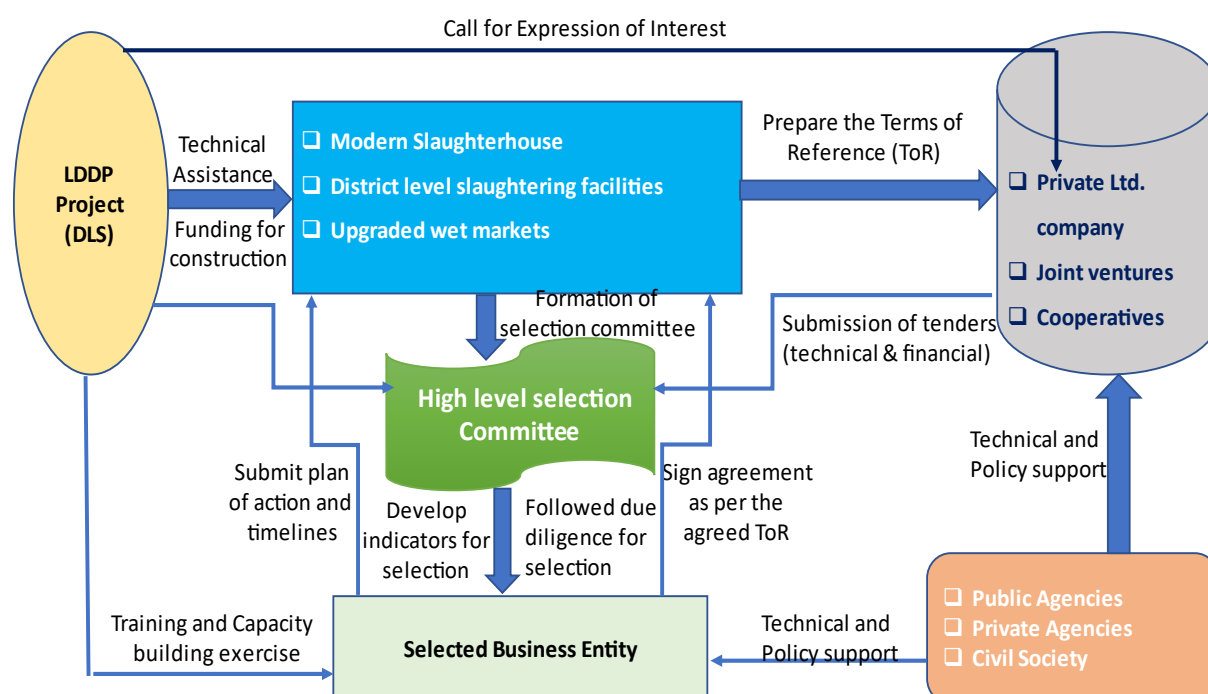
Types of PPP modality	Main features	Risk transfer	Ownership	Comments
1. Service Contract	- Certain services are out-sourced to a private company. - Private company provides agreed services to the Public Agency - Public agency retains general control and supervision.	- Service contracts provide a relatively low-risk option for expanding the role of the private sector. - No equity risk borne by the private company	Government Agency/Public entity	- This type of PPP has limited benefits. - Service contracts can be a competitive form of operational type PPPs, and require a well-developed service industry. - Suitable for initial years of establishment of public infrastructures.
2. Operation and maintenance contract (O&M)	- Management and operation of a public infrastructure is out-sourced to a private company. - Similar to a service contract but the	Similar to the service contract with additional risk of keeping the facility up to certain technical standards.	Government Agency/Public entity	- Suitable for projects like slaughtering facilities with a significant operating content. - O&M could be applied to a BOT, BOOT, BOO, ROOT and ROO project. - A method to import

Types of PPP modality	Main features	Risk transfer	Ownership	Comments
	scope of services is wider with greater control passed to the private company	No equity risk borne by the private company		private sector efficiencies and technical know-how. Suitable for initial years of operation.

(Source: AFC, SSIL, 2022)

In case of **Business Model 3 (BM 3)** of the slaughtering facility infrastructure developed by the local authorities (with the funding from LDDP) and run by private entities under a long-term lease agreement with the local authority/public agency. In this operational business model (Figure 10), the public authority will follow the government approved standard operating procedures to complete the due diligence in selecting the right private entities to run the slaughtering facilities at an agreed fees which may be reviewed from time to time with the consent of both the parties. This agreement needs to be long-term (generally 5-10 years) with the clause of termination from both side as this business need a gestation period of 3-5 years for awareness generation in the field to use the hygienic system of slaughtering and the importance of safe food for public health.

Figure 11. Business Model 3: Slaughtering facility run under PPP mode



(Source: AFC-SSIL, 2022)

*A detailed format for Expression of Interest (Eoi) for the private entities to participate as private operator/participant in PPP of the modern slaughtering facilities has been provided as **Annexure 1** of this report.*

6.9 Revenue streams for the business models

The public infrastructure projects need to consider the issue of revenue streams, to determine how investment costs can be defray/repaid over time notwithstanding the fact that these facilities are being built to provide specific public goods and services. Because many “public” assets (e.g., road, school, hospital) lack any kind of typical revenue model, many infrastructure assets build by the government must receive revenues to cover the operational costs directly from the receivers of the services. These revenues are generally linked to the service being provided. Across the globe wherever government was involved in providing services at a cost, the efficiency is being challenged due to many of the dynamic factors which creates a different types of revenue risk. For government/public agency, the benefit of creating this revenue model (whether supplemented by third-party income) is that payments can be deferred over time. This allows a greater level of immediate development utilizing scarce cash resources as well as matching the costs to the benefits generated over time. Keeping in view the above proven hypothesis and the proposed business models, we propose the following revenue stream for the slaughtering facilities under the LDDP project.

Both the *business models 1 and 2* may rely on four (4) categories of income streams: (a) Registration fee (annual) for the butchers/meat sellers to avail the slaughtering services, (b) Slaughtering fees from the customers, (c) Fee collected for other services (medical certification, HACCP certification, animal food, animal parking space, cleaning of slaughtered animals, cutting, deskinning, separating the waste materials, freezing services, etc.) and (d) Job work from private companies with a standard fee to be decided by the respective regulating authorities. In case of *business model 3*, the public slaughtering facilities are eligible for two types of income: (a) Annual income from leasing the facilities which may be paid on quarterly basis and (b) Service fee for the regular inspection (preferably monthly basis) and certification by the public agency appointed veterinary doctors and food safety officials.

6.10 Co-benefits of the proposed facilities and business models

Apart from the production of quality meat to meet domestic demand, substitute imports, modernizing the slaughtering facilities across Bangladesh under the ongoing LDDP provides many of the of co-benefits to the consumers and business entities which are as follows:

Food safety and hygiene: In the modern slaughtering facilities, there are opportunities for inspection and evaluation of fitness of the animals being slaughtered for human consumption as it allows checking the live animals on arrival (antemortem inspection) as well as the carcasses and other parts such as organs of slaughtered animals (postmortem inspection). This process will reduce the risk of public health which is

currently compromised due to unhygienic system.

Employment opportunity: The modernization of slaughterhouses will create employment opportunities. Livestock is one of the key drivers of sustainable economic growth and a major source of income and employment for many Bangladeshis. The modern slaughtering facilities will provide a welcome boost to the industry, improve economic growth, empower the private sector, as well as create jobs.

Management of hides and wastes: The modern public infrastructures being constructed to boost slaughtering system in the country will also include facilities for holding livestock and for management of by-products such as hides and waste.

Demonstration effect: The public infrastructure for scientific slaughtering will boost the business line and may encourage the enterprises (including SMEs) to develop more new slaughtering facilities across the cities and townships.

*A complete guideline for hygiene and sanitation-based categorization of slaughtering facilities for incentivizing has been provided in **Annex 2** of this report.*

6.11 Social and gender safeguards in developing public slaughtering facilities

Safeguarding the social impacts and provisioning gender mainstreaming are the two major outcome of upgrading the slaughtering system under the LDDP.

Social safeguards: As the project is being implemented by the Department of Livestock Services (DLS), Government of Bangladesh, it is expected that the due diligence has been undertaken during pre-project phase to address the grievances on land acquisition procedures, entitlements, eligibility etc. The provision of information needs to be continued during both the detailed design phase and the construction phase including further public meetings during mobilization of contractors, and others. The feedback from the local residents which includes their acceptance of this project should be given due importance. However, their concerns relate mainly to environmental items, such as: (i) waste water, (ii) air pollution, and (iii) noise, which must be addressed in the Environmental Management Plan (EMP). In case any adverse social concerns or issues were raised by them need to be addressed on priority basis. The expectation of employment opportunities for the local residents should be handled with passion. The executing and implementing agencies are mainly the local authorities (city corporation/municipalities/Upazila authority) and there is no acquisition of private assets required (land, structures, others), and no loss of income expected. There are no impacts expected from physical or economic displacement to households in this subproject. Table 17 below provides excerpts of the discussions on the four (4) issues related to the perception of the local people near the slaughtering facility construction sites.

Table 17. Reaction of the stakeholders

Project Beneficiaries	Expectations from the Slaughtering facilities	Perceived Socio-Economic Benefits	Perceived Negative Impacts	Mitigating Measures to minimize negative impacts
Men and women farmers/producers	• Convenience to supply animals to Slaughterhouse • Clean Place and hygienic	• Reduce the transportation if the Slaughterhouse near-by; • Take a short time to wait for the products	• Increased of diseases; • Have Bad environment because increased of fry, smelly and waste • water	• All animal which will bring in Slaughterhouse have to check up by veterinary doctors. • Eliminate the waste; • Construction of the wastewater treatment pool before send water into the river

(Source: AFC-SSIL, 2022 Field visits and discussions with the people)

Gender mainstreaming: The LDDP provides much emphasis to women's participation in livestock production and commercialization because it is recognized that women are mostly engaged in livestock production particularly raising cattle and goats which are raised in backyards or in nearby places near the homes. With the completion of the project, it is envisaged that women alongside men will enjoy immense socio-economic benefits not just along production but also towards engagement in livestock commercialization following the value chain concept that will redound to a sustained increase in household income; the project is a response to poverty alleviation/reduction. The main gender gaps in livestock are related to decision making, social barriers, and access to economic opportunities. The recent silver lining of improvement in gender equality of Bangladesh has been acknowledged by the Global Gender Gap Index (2017) as the country ranked 44 out of 144 countries climbing several spots.

In this regard, it is important to mention that the slaughtering activities are male dominated and women play almost insignificant role in the whole process. To ensure that women's needs, concerns and preferences are considered in project design and implementation, however, a Gender Action Plan (GAP) need to be prepared indicating gender action targets and activities concerning gender mainstreaming as regards the design and operation and maintenance (O&M) of the slaughtering facilities. A few indicative action points are identified by the consulting team which may be considered by LDDP to address the gender mainstreaming issue:

- Provide equal opportunity for employment preferably in the areas of cleaning and maintenance of the slaughtering facilities;
- Ensure that the design of slaughter houses include provisions for adequate number of separate male and female toilets with adequate lighting and reliable water supply system facilities;

- Establish the socio-economic situation of the local population in project implementation areas who are envisaged to benefit from the O&M of the slaughterhouse;
- Gather the needs, concerns and preferences including positive and negative impacts and mitigating measures to address the negative impacts of the slaughterhouse.

6.12 Environmental safeguards and benefits

Environmental risks are mainly associated with nearby surface water and groundwater and community use of those waters. Solutions could be engineered, however from an environmental-protection perspective the recommendation is to keep the design of the slaughterhouse simple. The operation should be run up from a “pilot” scale until any installed effluent-treatment measures prove themselves and are performing as planned. Performance monitoring can be used to make refinements to effluent treatment/training before scaling-up

Modern slaughterhouses are beneficial to the environment and surrounding ecology in multiple ways like efficient waste management and disposal, energy recovery from waste, renewable energy use, efficient use of resources, wastewater treatment, public health and safety, etc., apart from financial benefits to the implementers. The key environmental benefits emanated from modern slaughtering facilities are as below:

- **Efficient and hygienic waste disposal:** Disposing of solid and liquid wastes from slaughtering facilities through open dumps and nearby water bodies pose severe threat to the environment and public health. Improper disposal of untreated slaughterhouse waste is one of the main sources of infectious diseases. Anaerobic treatment of these organic wastes not only reduces such disease risks but also help in aligning with the environmental and pollution control norms of the country.
- **Reduced air pollution:** Burning of biomass for hot water generation, use of diesel generator for electricity supply and open burning of solid animal wastes can cause serious air pollution in and around the slaughtering facility. These can lead to increased generation of fumes and particulate matter that are suspended and carried away in the air³¹. Improved electrification, use of clean fuels for heating and source segregated waste handling in modern slaughtering facilities can reduce such air pollution impacts to a greater extent. The biogas generation along with heat/electricity application can help address all these problems.
- **Reduced land pollution and regeneration of soil fertility:** Dumping and burning of slaughtering wastes can lead to disintegration of local soil characteristics over time. However, the sludge obtained from the bio-digester can be used as organic manure which can help improve the fertility of the soil. Segregation of useful meat by-products (edible organs other than muscles) in a modern process line minimises volume of solid wastes to be handled and disposed-off at the dump sites. For

³¹ <https://www.sciencedirect.com/science/article/pii/S2405844020312093>
AFC-SSIL JV

example, bones and other meat wastes can be utilised for value added materials as animal nutrients³². Cold chain in modern slaughtering facility retains meat quality and minimises wastages.

- **Reduced water pollution:** Slaughterhouse wastewater is composed of a complex mixture of fats, proteins, organic compounds and suspended solids like pieces of fat, grease, hair, manure, grit and undigested feed. Blood drained from slaughtering animals is the major biological component of the liquid waste. A modern slaughtering facility utilises the blood which would rather be wasted as a nutrient rich feed for poultry³³. In absence of treatment facilities, the wastewater will be discharged in near ponds, river and sewers causing water pollution. Such discharge of high concentration of nutrients can cause algal blooms and “dead zones” in water bodies that are fatal to aquatic life and dangerous to human health³⁴. Reduced freshwater use, wastewater recycling, etc., can reduce the water footprint of the modern slaughterhouse and also avoid contamination of surface water as well as ground water.
- **Public health and safety:** Slaughterhouse wastes are a potential reservoir of bacterial, viral, prion and parasitic pathogens, capable of infecting both animals and humans. Modernising slaughtering facilities ensures hygienic operations and protective gears which ensures safe work environment for the staff. The local population also reaps the environmental benefits of reduced damage to the water, air and land as discussed above.
- **Odour control** Treatment of the slaughterhouse wastes with modern methods ensures odour control. Odour decreases the level of discomfort by those in the vicinity and affects the working conditions. Resolving the odour emission problem will regain the community relations and increase the acceptance of such facilities in urban spaces. These measures indirectly improve the quality of the facility and promote business development activities.
- **Reduced greenhouse gas (GHG) emissions:** Unlike fossil fuel combustion, biogas production from waste is considered CO₂ neutral and therefore, does not emit additional greenhouse gases (GHG) into the atmosphere. Also, combustion of biogas in an internal combustion engine is the cleanest form of electricity generation without any particulate and other fugitive emissions as diesel combustion does. Use of solar energy at the facility decreases the dependence on fossil fuel derived electricity and thereby reduces GHG emissions.

6.13 Waste management and disposal system

All livestock can be a potential source of hazardous farm waste, whether they have been affected by a disease or not. Safe and efficient carcass waste disposal is a major challenge that those working in the sector must face. Carcasses are the products of

³² <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3614052/>

³³ <https://www.researchgate.net/publication/344188863> International Journal of Agriculture and Biosciences Some Selected Animal Wastes and By-Products for Poultry Feed Review

³⁴ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8694297/>

slaughterhouse. Other offals are by-products or wastes. Generally, the terms byproducts and offal are used to denote every part which is not included in a dressed carcass. By-products can be divided into two groups namely, edible and inedible. Organs such as kidneys brain, liver, heart, gullet are examples of edible by-products. Hooves, horns, hair, bristles, gall bladder, ears, skin etc. are among the inedible by-products. Byproducts can form a part of edible meat or can be converted to produce items for various commercial usages. The components left unrecovered simply form solid wastes. It has been observed

that waste generation is largely influenced by the facility for recovery of by-products. It also depends on customs of consumer community. As such, quantity of wastes varies from place to place.

Ruminal, stomach and intestinal contents essentially form solid waste. Besides this, stomach and large intestine are also disposed of as waste in most of the slaughter houses. Soft meat parts such as lungs and pancreas are collected in large slaughter houses for sale to poultry feed processing units, whereas these offal are disposed as waste in medium and small slaughter houses. Horns and hooves are generally collected for sale. Almost every by-product of slaughterhouse can be utilized. However, various circumstances do not always permit byproduct recovery. The reasons may be inadequate quantity of materials, lack of markets, cost of processing etc. In such instances, they simply form part of waste lot for which different methods of processing and disposal have to be considered. For the slaughter house wastes composting, biomethanation and rendering systems (Box 4) are suggested. Selection of appropriate method, however, depends mainly on type of wastes and its quantity. Incineration is also an option for treatment of slaughter house waste.

Box 4. Rendering method of waste disposal in slaughterhouse

Rendering method of carcass disposal deserves a special mention for many reasons. In the past, the by-products of slaughterhouses were simply regarded as waste and nothing else, and were removed through incineration or other methods. However, more modern methods like the rendering of slaughterhouse waste not only provides a more sustainable method of treating animal waste, but also allows to consider factors such as profitability and productivity, by processing and recycling certain parts of carcasses that can serve other purposes, such as being used as quality animal feed. Rendering facilities usually use steam to sterilize the waste and eliminate risks associated with animal diseases, and use powerful shredder blades and different sub-systems to produce feed that is rich in protein. The advantages of this method are: (a) Cost-efficiency: saving money on carcass disposal costs, (b) Recycling: obtaining useful materials instead of completely destroying the waste and (c) Profitability: reducing other operating costs with an efficient animal waste disposal solution.

Source: Celitron (2020). Available at <https://celitron.com/en/blog/slaughterhouse-rendering-the-best-way-to-dispose-of-carcass-waste>

Of course, all carcass disposal methods have disadvantages as well, since the waste still has to get to the rendering facility. Picking up and transporting hazardous farm and slaughterhouse waste to their final disposal place can pose serious biosecurity risks until the remains are rendered sterile.

6.14 Clean energy intervention in modern slaughtering facilities

In general, the electricity and the fuels such as diesel (for power generators), biomass, charcoal and liquefied petroleum gas (LPG) (for heating needs) are the commonly used energy sources in the slaughtering facilities. The electricity consumption may widely vary based on the animals slaughtered. For example, the electricity consumption in modern slaughterhouses is reported to be in the range of 20-310 kWh/cattle and 0.4-1.2 kWh/poultry³⁵. In particular, the refrigeration system consumes around 45% of the total electricity consumption in the slaughterhouses. Pumps are used for water supply in the facility and motors are used in operation of conveyors/hangers. Other small loads include handheld equipment, hoists, etc. The fuels are mainly used for hot water generation required for cleaning the carcass and sanitizing equipment & facility³⁶.

*A detailed note on clean energy intervention is provided in **Annex 3** of this report.*

7. FINANCIAL FEASIBILITY STUDY

As envisaged in LDDP, a sum of US\$94.3 million has been earmarked for developing modern slaughterhouses in city corporations and meat processing facilities at the municipality and Zila/Upzila level wet markets with a focus on improvement of hygiene and provisioning for freezing the products for upmarket customers. The sub-grant allocations are as under:

- Improvement of wet markets by moving animals slaughtering out of the wet markets (allocation of US\$51.6 million for 192 units with an average unit cost of US\$256,000);
- Slaughtering facilities at the district level (allocation of US\$12.7 million for 20 units with an average unit cost of US\$635,000);
- Developing modern slaughterhouse and cold chains and rendering facilities in the metropolitan areas (allocation of US\$30.0 million for 3 units with an average unit cost of US\$10.0 million).

7.1 Key Assumptions

During the financial calculation, we had to consider certain assumptions and the most critical assumption is consideration of the investment made through LDDP as a **sunk cost**. Financial feasibility of all three types of slaughtering facilities were studied based on the field visits and key assumptions:

- Slaughtering Capacity:* As the slaughtering capacities are different for different categories of slaughtering facilities and based on the animals being slaughtered, Table 18 and 19 below provides the assumptions considered for the financial calculations:

³⁵ <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/slaughterhouses>

³⁶ https://www.deswater.com/DWT_articles/vol_190_papers/190_2020_98.pdf

Table 18. Slaughtering Capacity (Large Ruminants)

Description	Modern Slaughterhouse (City Corporations)	Municipality/ Zila level medium size facilities	Upgraded Wet market facility at Upazila level
Maximum daily capacity	200	100	50
Working days in a week	6	6	6
Weeks in a year	52	52	52
Capacity Year 1	60%	60%	60%
Total numbers/year	37440	18720	9360
Capacity Year 2	70%	70%	70%
Total numbers/year	43680	21840	10920
Capacity Year 3	80%	80%	80%
Total numbers/year	49920	24960	12480
Capacity Year 4	85%	85%	85%
Total numbers/year	53040	26520	13260
Capacity Year 5	90%	90%	90%
Total numbers/year	56160	28080	14040

Table 19. Slaughtering Capacity (Small Ruminants)

Description	Modern Slaughterhouse (City Corporations)	Municipality/ Zila level medium size facilities	Upgraded Wet market facility at Upazila level
Maximum daily capacity	300	200	100
Working days in a week	6	6	6
Weeks in a year	52	52	52
Capacity Year 1	60%	60%	60%
Total numbers/year	56160	37440	18720
Capacity Year 2	70%	70%	70%
Total numbers/year	65520	43680	21840
Capacity Year 3	80%	80%	80%
Total numbers/year	74880	49920	24960
Capacity Year 4	85%	85%	85%
Total numbers/year	79560	53040	26520
Capacity Year 5	90%	90%	90%
Total numbers/year	84240	56160	28080

- b) *Operating Cost of the Running the facilities:* The operating cost of running all types of facilities are considered based on the estimation and local price of the services which is provided in Table 20 below.

Table 20. Annual Cost of Services provided by the Slaughterhouse (in BDT)

Items of operating costs	Unit description	Modern Slaughterhouse (City Corporations)	Municipality/ Zila level medium size facilities	Upgraded Wet market facility at Upazila level
Cost of keeping animals in slaughterhouse for check up	Average 1 day @BDT100 per day	43,68,000 (average 60% efficiency level)	0 (same day slaughtering after checkup)	0 (same day slaughtering after checkup)
Labour Services	Labour charges @BDT500 per day	62,40,000 (40 labour work for 312 days)	31,20,000 (20 labour work for 312 days)	15,60,000 (10 labour work for 312 days)
Employee services	Average 40,000 per month	48,00,000 (for 10 employees)	24,00,000 (for 5 employees)	14,40,000 (3 employee)
Electricity cost	Lumpsum (estimation)	24,00,000	6,00,000	4,00,000
Direct Water Cost	Lumpsum (estimation)	3,00,000	1,50,000	50,000
Maintatnce of Shed & building	Lumpsum (estimation)	15,00,000	5,00,000	2,00,000
Misc cost items	Lumpsum (estimation)	5,00,000	3,00,000	1,00,000
TOTAL Annual Cost		20108000	7070000	3775000

- c) *Economic assumptions:* The inflation rate in Bangladesh is covering around 5-6% during the last 5 years. In our calculation, we considered the inflation at a flat rate of 10% for easy calculations (Table 21).

Table 21. Assumptions* on economics and price escalation

Description of Items	Annual increase
Feed cost growth Rate	10%
Electricity Price Growth Rate	10%
Water Price Growth Rate	10%
Salary Growth Rate (labour and employee)	10%
Operational & Maintenance costs	10%
Revenue stream (all possible fee-based income)	5%

*AFC-SSIL assumption are based on stakeholders' consultations, 2022

- d) *Revenue stream:* The revenue stream of the slaughtering facilities being constructed under the LDDP are generally based on receipt of fees for the services provided. The revenues are based on the government rates and the local market rates. Details on the income streams are provided in Table 22 below.

Table 22. Assumptions* on Revenue Streams (in BDT)

Description	Unit description	Modern Slaughterhouse (City Corporations)	Municipality/ Zila level medium size facilities	Upgraded Wet market facility at Upazila level
Collection of slaughtering fees	BDT100 for each large ruminant and BDT30 for small ruminants	48,00,000 Large Ruminant (Annual average #30,000) Small Ruminant (Annual Average#60000)	27,00,000 Large Ruminant (Annual average #15,000) Small Ruminant (Annual Average#40,000)	12,50,000 Large Ruminant (Annual average #8,000) Small Ruminant (Annual Average#15,000)
Collection of fees for cleaning and deskinning	BDT200 for each large ruminant and BDT50 for each small ruminant	96,00,000 Large Ruminant (Annual average #30,000) Small Ruminant (Annual Average#60000)	50,00,000 Large Ruminant (Annual average #15,000) Small Ruminant (Annual Average#40,000)	23,50,000 Large Ruminant (Annual average #8,000) Small Ruminant (Annual Average#15,000)
Collection of Annual Registration Fee	BDT1000 annual fee for each butcher	2,00,000 (Lumpsum)	2,00,000 (Lumpsum)	50,000 (Lumpsum)
Rent for the slabs at the Wet market	BDT500 per month	Not Applicable	Not Applicable	1,50,00 (considering 25 meat sellers)
Fee for Refrigeration services	Fee of BDT5 per kg meat for 24 hours (capacity of the freezer depends on size of the facilities)	6,00,000 (on an average 400 Kg. meat for 300 days)	3,00,000 (on an average 200Kg. meat for 300 days)	1,50,000 (on an average 100Kg. meat for 300 days)
Fee for certification of good health	BDT30 for each large ruminant and BDT10 for each small ruminant	15,00,000 Large Ruminant (Annual average #30,000) Small Ruminant (Annual Average#60000)	8,50,000 Large Ruminant (Annual average #15,000) Small Ruminant (Annual Average#40,000)	3,90,000 Large Ruminant (Annual average #8,000) Small Ruminant (Annual Average#15,000)
Job Work from other private companies	Lumpsum (estimation)	20,00,000	5,00,000	Not Applicable
Misc Fees	BDT100 annually for each butchers/meat processors and sellers	2,00,000	1,00,000	Not Applicable
TOTAL		18900000	9650000	4340000

*AFC-SSIL assumption/estimations are extrapolated based on stakeholders' consultations, 2022

Note: All calculations are based on cash basis and have not considered the depreciation of the machines as we considered a substantial amount of money for annual cost of maintenance of the public infrastructures developed under the project.

7.2 Projected income expenditure statement

The projected income and expenditure statements provided in this sub-section based on the assumptions mentioned above.

- a) *Construction of modern slaughterhouses:* The projected income and expenditure and gross profit for the proposed modern slaughterhouse in 3 city corporations is provided in Table 23 below.

Table 23. Projected Income & Expenditure of Modern Slaughterhouse (City Corporations)

(Amount in BDT)

Sl. #	Description of Items	Projected Year of operation				
		Year 1	Year 2	Year 3	Year 4	Year 5
		(60% efficiency)	(70% efficiency)	(80% efficiency)	(85% efficiency)	(90% efficiency)
1	Revenue	18900000	19835000	20816750	21847588	22929967
1.1	Collection of slaughtering fees	4800000	5040000	5292000	5556600	5834430
1.2	Collection of fees for cleaning and deskinning	9600000	10080000	10584000	11113200	11668860
1.3	Collection of Annual Registration Fee & renewal charges	200000	200000	200000	200000	200000
1.4	Fee for refrigeration services	600000	630000	661500	694575	729304
1.5	Fee for certification of good health	1500000	1575000	1653750	1736438	1823259
1.6	Job Work from other private companies	2000000	2100000	2205000	2315250	2431013
1.7	Misc Fee-based income	200000	210000	220500	231525	243101
2	Expenditure	20108000	22118800	24330680	26763748	29440123
2.1	Cost of keeping animals in slaughterhouse for check up	4368000	4804800	5285280	5813808	6395189
2.2	Payment for labour Services	6240000	6864000	7550400	8305440	9135984
2.3	Payment to Employees	4800000	5280000	5808000	6388800	7027680
2.4	Electricity cost	2400000	2640000	2904000	3194400	3513840
2.5	Direct Water Cost	300000	330000	363000	399300	439230
2.6	Maintatnce of Shed & building	1500000	1650000	1815000	1996500	2196150
2.6	Misc. cost items	500000	550000	605000	665500	732050

3	Gross Profit (+)/ Loss (-) (Item #1-Item #2)	-1208000	-2283800	-3513930	-4916161	-6510156
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(Source; AFC-SSIL, 2022)

The above table indicates that the modern slaughterhouse proposed in 3 city corporation if operated by the city corporations will not be able to cover the operational costs (considering the assumptions are right while calculating the financials of this business). The above-mentioned situation strengthens our recommendations to improve the efficiency by adopting the Business Model 2 (PPP model on operational and maintenance partnership) and Business Model 3 (Invite the private sector for operating the facilities with regular monitoring and certain restrictions).

b) *Slaughtering facilities at the Municipality/District level*: The projected income and expenditure and gross profit for the proposed slaughtering facilities at the Municipalities/Districts level in 17 potential locations is provided in Table 24 below.

Table 24. Projected Income & Expenditure of slaughtering facilities at Municipality/District level

(Amount in BDT)

Sl. #	Description of Items	Projected Year of operation				
		Year 1	Year 2	Year 3	Year 4	Year 5
		(60% efficiency)	(70% efficiency)	(80% efficiency)	(85% efficiency)	(90% efficiency)
1	Revenue	9650000	10122500	10618625	11139556	11686534
1.1	Collection of slaughtering fees	2700000	2835000	2976750	3125588	3281867
1.2	Collection of fees for cleaning and skinning	5000000	5250000	5512500	5788125	6077531
1.3	Collection of Annual Registration Fee & renewal charges	200000	200000	200000	200000	200000
1.4	Fee for refrigeration services	300000	315000	330750	347288	364652
1.5	Fee for certification of good health	850000	892500	937125	983981	1033180
1.6	Job Work from other private companies	500000	525000	551250	578813	607753
1.7	Misc Fee-based income	100000	105000	110250	115763	121551
2	Expenditure	7070000	7777000	8554700	9410170	10351187

Sl. #	Description of Items	Projected Year of operation				
		Year 1	Year 2	Year 3	Year 4	Year 5
		(60% efficiency)	(70% efficiency)	(80% efficiency)	(85% efficiency)	(90% efficiency)
2.1	Payment for labour Services	3120000	3432000	3775200	4152720	4567992
2.2	Payment to Employees	2400000	2640000	2904000	3194400	3513840
2.3	Electricity cost	600000	660000	726000	798600	878460
2.4	Direct Water Cost	150000	165000	181500	199650	219615
2.5	Maintatnce of Shed & building	500000	550000	605000	665500	732050
2.6	Misc cost items	300000	330000	363000	399300	439230
3	Gross Profit (+) /Loss (-) (Item #1-Item #2)	2580000	2345500	2063925	1729386	1335347

(Source; AFC-SSIL, 2022)

The slaughtering facilities at the identified municipality/district level is showing a better opportunity as it is showing a profitable proposition to follow the Business Model 1 which anchoring on the public agencies running the public slaughtering facilities. The only important areas need to be monitored the efficiency of the facilities.

c) *Improvement of wet markets at Upazila level:* The projected income and expenditure and gross profit for the proposed improvements slaughtering facilities in wet markets in 192 identified growth centres is provided in Table 25 below.

Table 25. Projected Income & Expenditure of improved wet markets with slaughtering facilities

(Amount in BDT)

Sl. #	Description of Items	Projected Year of operation				
		Year 1	Year 2	Year 3	Year 4	Year 5
		(60% efficiency)	(70% efficiency)	(80% efficiency)	(85% efficiency)	(90% efficiency)
1	Revenue	4340000	4599500	4819475	5050449	5292971
1.1	Collection of slaughtering fee	1250000	1312500	1378125	1447031	1519383
1.2	Collection of fees for cleaning and deskinning	2350000	2467500	2590875	2720419	2856440
1.3	Rent for hiring space in wet market	50000	52500	55125	57881	60775

Sl. #	Description of Items	Projected Year of operation				
		Year 1	Year 2	Year 3	Year 4	Year 5
		(60% efficiency)	(70% efficiency)	(80% efficiency)	(85% efficiency)	(90% efficiency)
1	Revenue	4340000	4599500	4819475	5050449	5292971
1.3	Collection of Annual Registration Fee & renewal charges	150000	200000	200000	200000	200000
1.4	Fee for refrigeration services	150000	157500	165375	173644	182326
1.5	Fee for certification of good health	390000	409500	429975	451474	474047
2	Expenditure	3750000	4125000	4537500	4991250	5490375
2.1	Payment for labour Services	1560000	1716000	1887600	2076360	2283996
2.2	Payment to Employees	1440000	1584000	1742400	1916640	2108304
2.3	Electricity cost	400000	440000	484000	532400	585640
2.4	Direct Water Cost	50000	55000	60500	66550	73205
2.5	Maintatnce of Shed & building	200000	220000	242000	266200	292820
2.6	Misc cost items	100000	110000	121000	133100	146410
3	Gross Profit (+) /Loss (-) (Item #1- Item #2)	590000	474500	281975	59199	-197404

(Source; AFC-SSIL, 2022)

The above table clearly indicates that the improved wet markets provide more opportunities to cover the operational cost of running the facility which however is showing lower profits and at the end of fifth year it is in loss. Under this situation, it is advised that the governing body of the wet markets need to explore opportunities of other services which could defray the operating cost and keep the market in running condition and efficiently serve the requirements as envisaged in the project.

8. MONITORING AND EVALUATION OF SLAUGHTERING FACILITIES

The scale of adaptation of the new climate smart technology by slaughterers and butchers, impact on the slaughterers and butchers' productivity with the new technologies and impact on the consumers behavior with the new slaughtering technologies

SI	Indicator	Frequency	Data source	Methodology of data collection	Responsibility for data collection
1	Slaughtering facilities renovated and made climate smart (Number) (City Corporation)	Annually	MIS and Progress report	MIS and Progress report	DLS/Implementation Agency
	Slaughtering facilities renovated and made climate smart (Number) (Districts)	Annually	MIS and Progress report	MIS and Progress report	DLS/Implementation Agency
	Slaughtering facilities renovated and made climate smart (Number) (Upazila/Growth center)	Annually	MIS and Progress report	MIS and Progress report	DLS/Implementation Agency
2.	Butchers have received business development skills training, inputs, marketing support and financial services (Number) (Male)	Annually	MIS and Progress report	Focus Group discussion, Key informant interview	DLS/Implementation Agency
	Butchers have received business development skills training, inputs, marketing support and financial services (Number) (Female)	Annually	MIS and Progress report	Focus Group discussion, Key informant interview	DLS/Implementation Agency
3.	Butchers adopting improved slaughtering technology (Number)	Annually	MIS and Progress report	Focus Group discussion, Key informant interview	DLS/Implementation Agency
4.	Butchers implement food safety measures (Number)	Annually	MIS and Progress report	Focus Group discussion, Key informant interview	DLS/Implementation Agency

9. WAY FORWARD

The following are the broad recommendations for upgrading the slaughtering facilities in Bangladesh to achieve high quality meat for domestic consumption and forward-looking export quality meat for international trade.

A. Adopt an official definition for Slaughtering Facilities

At present there are no official norms for classification of slaughter houses in Bangladesh. However, depending upon the type of animals slaughtered, the slaughter houses are classified into: ·

- Large animal (i.e., cattle, buffalo etc.) slaughter house
- Goat and sheep slaughter house
- Poultry slaughter house

In order to assess the variations in pollution load with respect to number of animals slaughtered, it is recommended that Government of Bangladesh adopt suitable definition for slaughter houses. The bovines and small ruminant slaughter houses may be further classified into following categories (Table 26):

Table 26. Proposed categorization of slaughtering facilities

Sl.	Category of Slaughtering facilities	Criterion
1	Large	<i>Annual Slaughtering Capacity:</i> Large Animals > 30,000 and Goats/Sheep > 5,00,000 Or <i>Daily Live Weight Killed</i> > 50 Metric Tonnes
2	Medium	<i>Annual Slaughtering Capacity:</i> Large Animals 10,001 – 30,000 and Goats/Sheep 1,00,001 – 5,00,000 Or <i>Daily Live Weight Killed</i> 10 – 50 Metric Tonnes
3	Small	<i>Annual Slaughtering Capacity:</i> Large Animals Up to 10,000 and Goats/Sheep Up to 1,00,000 Or <i>Daily Live Weight Killed</i> Up to 10 Metric Tonnes

Large scale slaughter houses shall be located in big cities, medium slaughter houses in district/towns while the small-scale slaughter houses are in Upazilas, and villages with wet market facilities and distributed all over the country.

B. Validity of license period for longer term

All animal slaughter in Bangladesh is regulated by Animal Slaughter & Meat Quality Control Act, 2011 (Act No. 16 of 2011). Under article 9 (1) of the Act, the Director General of DLS issues license for one year to slaughter houses, butchers, meat shops, and meat processing units. It is suggested that the license validity period is increased to ten (10) years so that the licensees is able to recover investments made in the venture. The date of issue and expiry period of all licenses may be published in DLS website or any App based software. For this purpose, article 9 (1) of the Animal Slaughter & Meat Quality Control Act, 2011 may be suitably modified.

C. Introduce Additional licensing and registration of Slaughter Houses and Meat Shops with Bangladesh Food Safety Authority

As of date slaughter houses and meat shops are operating under license of DLS and civic bodies. It is suggested that in order to improve standards of meat food business, that all slaughter houses be licensed and registered with Bangladesh Food Safety Authority (BFSA). No slaughter house or meat shop– irrespective of their size – be permitted to conduct their operations unless they have a registration or mandatory license from the BFSA. Meat shops must be prohibited from slaughtering animals

particularly large animals and small ruminants if they do not possess the required infrastructure for handling and maintaining hygiene. The BFSA may ensure that meat and slaughter houses to run their operations in

- Compliance with legal provisions under *Food Safety Act, 2013*,
- Enhance animal welfare measures, and
- Weed out food handling practices other than those allowed by the food safety regulations.

D. Issue Guidelines for Setting Slaughter house Environmental and Quality Standards under the Animal Slaughter & Meat Quality Control Act, 2011.

Article 6 of the said Act commits to formulation of environmental and quality for all slaughter houses. Such guidelines may be issued at the earliest by DLS. The guidelines may cover basic amenities in slaughter house, operations including humane slaughtering, in plant phytosanitary measures, by-product recovery and waste management systems. The overall objective of the proposed guidelines is to promote good hygiene and sanitation in slaughter house and to reduce environmental problems.

E. License and Train all Meat Workers in Slaughterhouses on Zoonotic diseases

Handling meat poses occupational risks which trained and qualified are better able to appreciate. Most workers are not knowledgeable about zoonotic diseases, and do not have adequate protective equipment (Khurshed et al., 2020). Better facilities and hygiene practices will go a long way to advance worker safety and to reduce the possibility of meat contamination. Training in food safety, basic hygiene, and protection from zoonotic diseases will equip slaughter house and meat shop workers to do their job better. After necessary training, and passing of examination, qualifying candidates should be issued trade licenses to conduct their occupations.

F. Train slaughters/butchers on safe/hygienic methods of slaughtering and butchering:

Training need analysis (TNA) exercise need to be organized on how to use the improved machines and facilities, and on designing meat distribution routes using the delivery vehicles. Once the equipment is set up, training and coaching need to be provided to operate the slaughtering facility efficiently and as well as to build the necessary skills among slaughters and butchers to provide safe meat to consumers. Slaughters and butchers will be trained on aspects of food safety, how to prepare safe meat, foodborne illnesses, sources of contamination, and on how to use the new equipment correctly to prepare meat in accordance with food safety standards.

G. Hand-holding of support stakeholders (local governments, facility/market management committees, butchers).

Handholding of the stakeholders to implement usage of the new facilities, and undertake monitoring and evaluation of safer practices. The Agricultural

Universities/specialized training institutions/NGOs will play a facilitating and convening role to ensure that the usage procedures, costs and business model changes are clearly understood by the entities responsible for the different aspects of the facilities use and management. The training programme will support the institutions to adjust their mode of operations and expectations, in order to smoothly adapt to using the new facilities. The identified training organization may be entrusted to design and implement a monitoring and evaluation system which will on the one hand analyze the impact of the upgrade in terms of socio-economic impact on actors, and on the other inspect and monitor the facilities to ensure correct usage and the output of a quality, safe product.

H. Developing mobile slaughtering facilities

In general, the evolution of a mobile slaughter facility requires a great deal of creative thinking and problem solving because the current Regulations in Bangladesh are based on fixed slaughter facilities. Apart from the regulatory challenges, the mobile slaughtering facilities mounted on a van trailer may face many challenges in the big cities like Dhaka: (a) Inspection by the regulators (b) Parking facilities, (c) Water and drainage systems, (d) Bleeding and Inedible Control, (e) Sanitary dressing, (f) Pests and Rodents, (g) Waste management etc. Currently there is no suitable location for mobile slaughtering facilities with the convenience that could operate utilizing all food safety protocols and provides a quality product for the meat industry. However, being a forward-looking project, the LDDP may think about developing business plan for mobile slaughtering facilities for the hilly tract and the island where the producer have to travel long distance to sell their cattle or else the middlemen pay lower price to them and take the advantage of situation.

I. Develop strategies for improving the investment in slaughtering facilities

A long-term strategy needs to be developed to promote private sector enterprises in modernizing slaughtering facilities by leveraging the public investments. All actors in the sector should be consulted during the planning process. A brief outline of the framework is provided below:

- **Develop Sectoral development plans, considering different components of value chain:** Sectoral development plans need to be developed in various upazilas in consultation with stakeholders
- **Locate the infrastructure gaps specific to the area and sub sector:** Upazila-wise infrastructure gaps need to be identified by DLOs and the same were discussed with the concerned departments of the national Government and presented in the high-power committee meetings.
- **Monitoring and convergence of financing plans and growth centre development** plans to facilitate investments for traditional as well as diversified activities to improve scientific slaughtering facilities and also development of adequate backward and forward linkages.

- **Facilitate execution of critical interventions required for the flow of private investments** to scale up slaughtering facilities: Regularly facilitating convergence by involving private investors, developmental agencies, banking network, service providers and marketing agencies in the growth centres.
- **Periodic updating/revision of unit costs for different types of slaughtering facilities:** Need to revise unit costs at Upazila/District level to provide updated investment requirements.
- **Popularize scientific slaughtering facilities with the governmental support:** The DLS may develop mobile/computer App or software for online information on the available schemes for developing slaughtering facilities.

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ANNEX 1

SAMPLE EXPRESSION OF INTEREST (EOI) DOCUMENT FOR OPERATING SLAUGHTERHOUSE

Ministry/Division	Ministry of Fisheries & Livestock
Agency	Department of Livestock Services (DLS)
Procuring Entity Name	Project Director, Livestock and Dairy Development Project (LDDP)
Procuring Entity Code	IDA-630-BD/xxxx
Procurement Entity District	Dhaka
Expression of Interest for Selection of	Private enterprises interested to operate slaughterhouses in selected cities and districts Bangladesh.
Title of Service	Sub-grants for livestock and dairy business
EOI Ref. No.	DLS/LDDP/SD-2xxx
Date	1/0x/202x
KEY INFORMATION	
Procurement of Sub-Method	Sub Grants
FUNDING INFORMATION	
Budget and Source of Funds	Development Budget Grant/Credit

Development Partners	The World Bank			
PARTICULAR INFORMATION				
Project/Program Name	Livestock and Dairy Development Project			
EOI Closing Date and Time	31/0x/202x 12.00 PM			
Publication Date	15/0x/202x			
INFORMATION FOR APPLICANT				
Brief Description of Assignment	This EOI document has been advertised for use in preparing and submitting applications to avail sub grants to promote private sector investment in slaughterhouses in Bangladesh. The slaughterhouses will be run on public private partnership mode where in the public sector will build the slaughterhouse on its own land and lease out the slaughtering facility to private sector to profitably operate them. A small leasing fees will be charged by the public sector.			
Experience, Resources and Delivery Capacity Required	Both new and existing businesses duly registered and operating in Bangladesh can apply for sub grants. The sub grants would be equal or preferably lower than that of the project proponent's financial contribution.			
Other Details, if applicable				
Association with foreign firms is	Permitted			
EOI INFORMATION FOR APPLICANT				
Ref No.	Phasing of Services	Location	Start Date	Completion Date
DLS/LDDP/SD-xx	NA	Dhaka	March 202x	xx/xx/ 202x
PROCURING ENTITY DETAILS				
Name of Official Inviting EOI	Mr. Abdur Rahim			
Designation of Official Inviting EOI	Project Director			
Address of Official Inviting EOI	Livestock and Dairy Development Project Pranisampad Bhaban-2 (6th Floor), DLS, Dhaka-1215			
Contact Details of Official Inviting EOI	Phone : 02-58154913, Email : lddp@dls.gov.bd			
The procuring entity reserves the right to accept or reject all tenders				

PROJECT BUSINESS PROPOSAL

FOR PROPOSED SLAUGHTERHOUSE IN.....
DISTRICT CITY.

PROJECT PROPONENT:

NAME OF ORGANISATION

CONTACT PERSON:

DESIGNATION:

EMAIL ID:

MOBILE:

ADDRESS:

TABLE OF CONTENTS

EXECUTIVE SUMMARY

PROJECT BUSINESS PROPOSAL

FOR PROPOSED SLAUGHTERHOUSE IN³⁷

.....DISTRICT CITY

1.0 INTRODUCTION

- 1.1 General description of the project area
- 1.2 General description of the project proponent organisation including prior experience relevant to the proposed project.

2.0 PROJECT JUSTIFICATION

Why is the project being important? Which gaps is it addressing?

3.0 PROJECT DESCRIPTION

- 3.1 General description of the project proponent organisation
- 3.2 Project ownership – what is the stake of the project proponents?
- 3.3 Project locality/Site Selection Details of project area and why it was selected.
- 3.4 Capacity: hat is the slaughterhouse throughput? Which species and where it will be sourced.
- 3.5 Land Size: What is the size of land for the proposed project site? Is the land owned by the project proponent? If not, what rights the proponents have over the land? Is additional land available if need be? Which ownership documents are availed? Is the land prone to water logging or floods? Attach a map of the land with GPS coordinates.
- 3.6 Civic amenities: What are the civic amenities currently available at the proposed site?
- 3.7 Project Objectives: What does the project aim to achieve?
- 3.8 Source of Slaughter Stock Where will the slaughter stock be sourced?
- 3.9 Human Resource Requirement: Skilled and semi-skilled

³⁷ The slaughterhouses are proposed in Rajsahi, Khulna and Chittangong city corporations, and the following 61 districts xxxx,xxxx,xxxx, xxxx.

slaughterhouse personnel.

- 3.10 Target market for the products and by products: Which is the target market for the meat products, meat by products and non-meat by products?

4.0 SOCIO-ECONOMIC IMPACT OF THE PROJECT

Which are the positive and negative impacts of the project to the project area and Bangladesh in general?

Proposed mitigation measures to the negative impacts. How will the negative project impacts be addressed?

5.0 PROJECT BUDGET AND RETURNS

- 5.1 Project Balance Sheet, Income and Expenditure, and Cash flow statement for ten years.
- 5.2 Significant Operational and Financial Ratios
- 5.3 How much lease amount will be paid to the public sector per year.
- 5.4 Means of Financing project's expenditure
- 5.5 What is the viability gap funding requested from LDDP?

6.0 REGULATIONS and LICENSES

Details of licenses, and permissions already obtained and proposed to be obtained for the establishment and operation of the slaughter house.

7.0 CONCLUSION

Justify if the project is worthwhile to undertake on the basis of profitability, NPV and IRR calculations and socio-economic benefits generated viz employment generated, contribution to GDP, taxes paid to the Government etc.

Name of the Project Proponent	
Name of Director/Authorised Representative	
Signature	
Date	

Place	
Official seal	

REFERENCE

Literature cited.

ANNEX 2

Draft guidelines for hygiene and sanitation in slaughterhouse

PREAMBLE

The standards for hygiene and sanitation in slaughter houses are being issued in accordance with Article 9 (1) of the Animal Slaughter & Meat Quality Control Act, 2011 (Act No. 16 of 2011).

Many of the slaughter houses in Bangladesh are more than six decades old, yet they lack basic amenities like proper flooring, water supply, and ventilation. At present, their condition is far from satisfactory. The guidelines are intended to support ongoing improvements in existing slaughter houses and establishing new slaughter houses on scientific lines with emphasis on higher levels of hygiene and sanitation and by products recovery.

SCOPE

The guidelines cover the general requirements for bovines, large animals, and small ruminants. The guidelines shall cover

- Location of slaughter houses
- Space requirement of slaughter house
- Classification of slaughter houses
- The general flow of goods in slaughter house
- Features of modern slaughter houses
- Checklist for periodic audit of conditions of slaughterhouse
- Ways for by-product recovery and waste management systems.

APPLICATION

The guidelines shall apply to every local authority (District, Subdistrict, Union Councils, Municipalities, City Corporation, Villages, Wards, Cantonment Board) or person(s) operating a slaughter house. These guidelines shall be applicable to all cities/towns/villages where slaughter houses exist.

DEFINITIONS

- Carcass – Any part of animal body that is used for human consumption.
- Composting – A natural process of recycling organic matter involving microbial degradation.
- Dissolved Air Floatation is a water treatment process to remove suspended matter such as oil or solids.
- Evisceration – is a surgical technique by which inner organs of the body, particularly organs of thorax and abdomen such as the intestines, heart, lung, liver, and kidneys are removed.
- Gambrelling is suspending the carcass for particular operation.
- Lairage – a place where animals are rested prior to slaughtering.
- Pithing insertion of a rod or coiled wire through the hole in the skull of cattle made by the captive bolt to physically disrupting the brain and rostral part of the spinal cord. The animal loses consciousness so as to kill or immobilize it.
- Offal part of internal organs such as digestive tract of a slaughtered ruminant.
- Phyto-sanitary measures are laws, regulations, standards, and procedures that governments employ as necessary to protect human, or animal life or health from the risks associated with the spread of pests, diseases, or disease-carrying and causing organisms, or from additives, toxins, or contaminants in food, beverages, or feedstuffs.
- Rendering is the process that converts animal fatty tissue into the purified fats like lard or tallow. All slaughtering wastes (35% of animal weight) can be converted to compound feed.
- Rumen – The first stomach of ruminants, which receives food or cud from the oesophagus, partly digests it with the aid of bacteria, and passes it to the reticulum.
- Scalding is lowering of animal into boiling water or steam to prepare skin for dehairing.
- Singeing is cleaning the carcass by burning the hair.
- Slaughter House – Any building, premises or place which is used for killing of animals for human consumption.
- Stunning pen compartment are used to render animals immobile or unconscious. The pens are narrow preventing any substantial movement of the animal forward, backward, or sideways
- Tallow is a rendered form of beef or mutton fat containing lard.
- Viscera – Internal organs which are removed after slaughtering.

LOCATION OF SLAUGHTER HOUSE

- The site should be located outside or on the periphery of a city or town and away from any factory, public road, or public place (at least 200 meters).
- The site should be free from dust, odour, smoke, and other contaminants.
- Care should, however, be taken to see that these are easily accessible to the patrons and do not adversely affect the transport of meat to the market place.

- The slope, terrain, foundation, and soil conditions on the site shall be suitable for the construction of multi-floor permanent buildings.
- The site shall be free of waterlogging or flooding. The site shall be dry and well drained, preferably situate at a higher level than its surroundings.
- If located near a river, stream, or lake, the slaughterhouse shall be at least 10 meters away from the bank.
- The site shall have assured potable water, electricity, and proper hygienic waste disposal facilities.
- Transport to and from the slaughterhouse shall be accessible.
- The site shall be fenced.
- The area immediately surrounding the slaughterhouse shall be brick lined, or concreted or covered with asphalt or a similar material. The access road shall be similarly treated.
- There shall be sufficient space for probable future expansion.

SPACE REQUIRED FOR SLAUGHTER HOUSE

As a thumb rule, we suggest that 20 metre is provided for each large animal and 5 metre per small ruminant. Thus, the land requirement

Table 27. A2.1: Land required for Slaughter houses

Size of Slaughter house	Bovines		Small Ruminant		Total land required sq. mtr
	Capacity (Number of kills per day)	Total Land reqd.in sq. mtr	Capacity (Number of kills per day)	Total Land reqd in sq meter	
Mini	20	400	200	1000	1400
Small	50	1000	300	1500	2500
Medium	200	4000	450	2250	6200
Large	400	8000	900	4500	12500

Utmost consideration is to be given to the size and location. For future expansion, double the land required should be acquired. Thus, at the minimum, the land needed for mini, small, medium, and large units is 1.4 ha, 2.5 ha, 6.2 ha, and 12.5 ha, respectively.

CLASSIFICATION OF SLAUGHTER HOUSES

At present there are no official standards for classification of slaughter houses in Bangladesh. However, slaughter house can be classified depending upon the type of processes of slaughtering animals, type of animal slaughtered, and capacity of the slaughter house where animals are slaughtered.

Classification of slaughter house based on type of process adopted for slaughtering are:

- a) Manual slaughtering, found in wet markets
- b) Semi mechanized, found in municipalities and large towns

c) Mechanized, found in export oriented modern slaughter houses.

Some slaughter houses keep a count of number of small and large animals being slaughtered every day. Counting is a more reliable and convenient way tracking slaughtering performance, rather than weighing each animal to estimate live weight of animals killed per day (TLWK/day). Based on the number of animals slaughtered, the slaughter houses are classified into mini, small, medium, and large. The basis of classification is given below:

- Mini: Less than 20 bovines per day, and 200 goats and sheep per day (any day in a week)
- Small: More than 20 and up to 50 bovines and 300 goats per day (any day in a week)
- Medium: More than 50 and up to 200 large animals or more than 300 up to 450 goat and sheep per day (any day in a week)
- Large: More than 200 bovines per day, or more than 900 goat and sheep per day (any day in a week).

ASSESSING SLAUGHTERING FACILITIES

There is paucity of data on the present conditions of slaughter houses in cities, municipalities, towns, and villages. DLS issues licenses with one year validity to slaughter houses and meat shops. However, there are substantial number of slaughtering facilities without any license from DLS, or permission to operate shops from local authorities. It is proposed that a country wide audit is undertaken by DLS officers of all facilities that have been licensed in the last three years. Thereafter, DLS will arrange biannual audits of all licensed and unlicensed slaughter houses. Each facility will be scored using the Audit Check list available in Schedule I. Those which are non-compliant will have their licenses cancelled.

The audit will be conducted against six parameters, namely

- Status of business licenses
- Condition of physical facilities
- Phytosanitary controls available
- Sanitation, maintenance, and waste disposal
- Personal hygiene of workers
- Internal audit, training, and documentation

Each of the parameters will be scored. Those scoring above 90% would be deemed “outstanding”, those with 71-90% scores “satisfactory”, those with 51-70% identified for improvement, and those scoring below 50% are considered “non-compliant”. The non-compliant units will invite disciplinary actions, and cancellation of license, unless further improvements within a period of three months is undertaken.

The advantage of the scoring sheet depicted in Schedule I is that it pinpoints where improvement is needed. Financial and non-financial incentives can be designed to encourage business units to upgrade themselves.

SECTIONS IN SLAUGHTER HOUSE

The typical sections of slaughter houses are:

- Reception – A dedicated area to offload animals
- Lairage: Lairage Cattle, goats, and sheep shall be penned separately. Depending on the size of the animals and the duration of time that the animals will be penned, the penning space shall not be less than: a) For each adult cow – 1.74 square metres floor area. b) For each sheep and goats – 0.56 square metres floor space. d) For poultry- 10 to 15 birds per square metre
- Slaughter hall The slaughter halls and ancillary accommodation thus provided shall be separated, keeping in view the economic and local requirements, by solid walls depending upon the site. The slaughter hall shall have the following facilities:
 - Halal area
 - Bleeding area
 - Hoisting area
- Flaying section
- Evisceration section
- Carcass splitting
- Carcass washing area
- Inspection facilities
- Carcass chilling area
- Carcass freezing area
- Changing room with shower facilities, toilets, and access to drinking water.

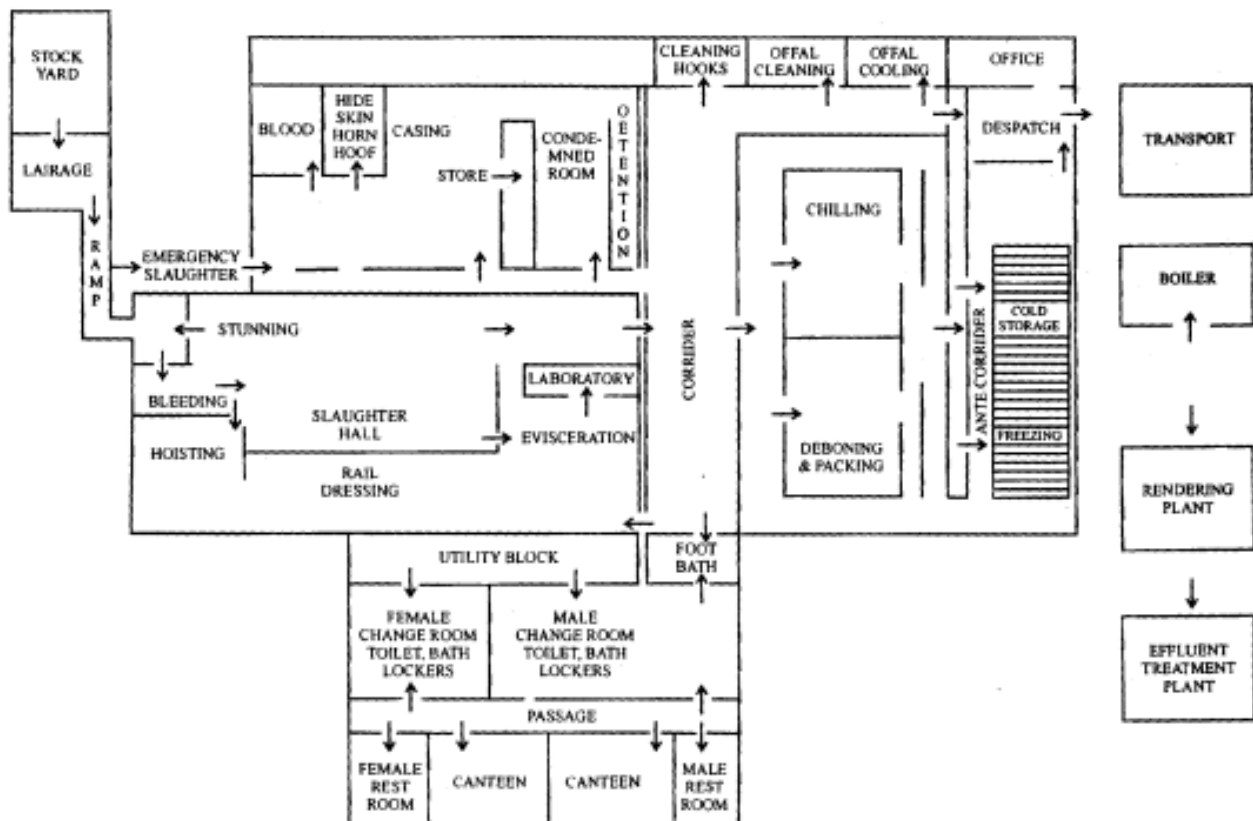
Modern slaughter houses boast of additional facilities for the convenience of customers, employees, ensure higher degree of quality assurance, and discharge responsibility towards natural environment.

- Hides/Skins room to temporarily store the hides/skins.
- Offal room for emptying and cleaning of stomachs and intestines.
- Retention room for the retention of all meat condemned as unfit for human consumption and shall be locked up separately. The condemned meat is disposed off in appropriately designed condemnation pit or appropriately designed incineration facilities or other approved means of disposal.
- A laboratory within the premises of the slaughter house may be provided. Meat is examined for standard plate count, coli form count, psychotrophs, staphylococcal counts and the presence of pathogens such as Salmonella spp.

- Distribution room to conduct sales or collection of products and or by products to avoid customers or outsiders from accessing prohibited areas in the slaughterhouse.
- Composting³⁸ pits. Non edible parts of body and manure are either dumped in pits for composting or used as biogas.

The below figure (A2.1) depicts various sections found in a modern slaughter house

Figure 12. A2.1 Sections in a modern slaughter house



(Source: <http://meattechnologyblog.blogspot.com/2013/>)

ESSENTIAL FACILITIES

The slaughter house shall have the critical conveniences for the following activities:

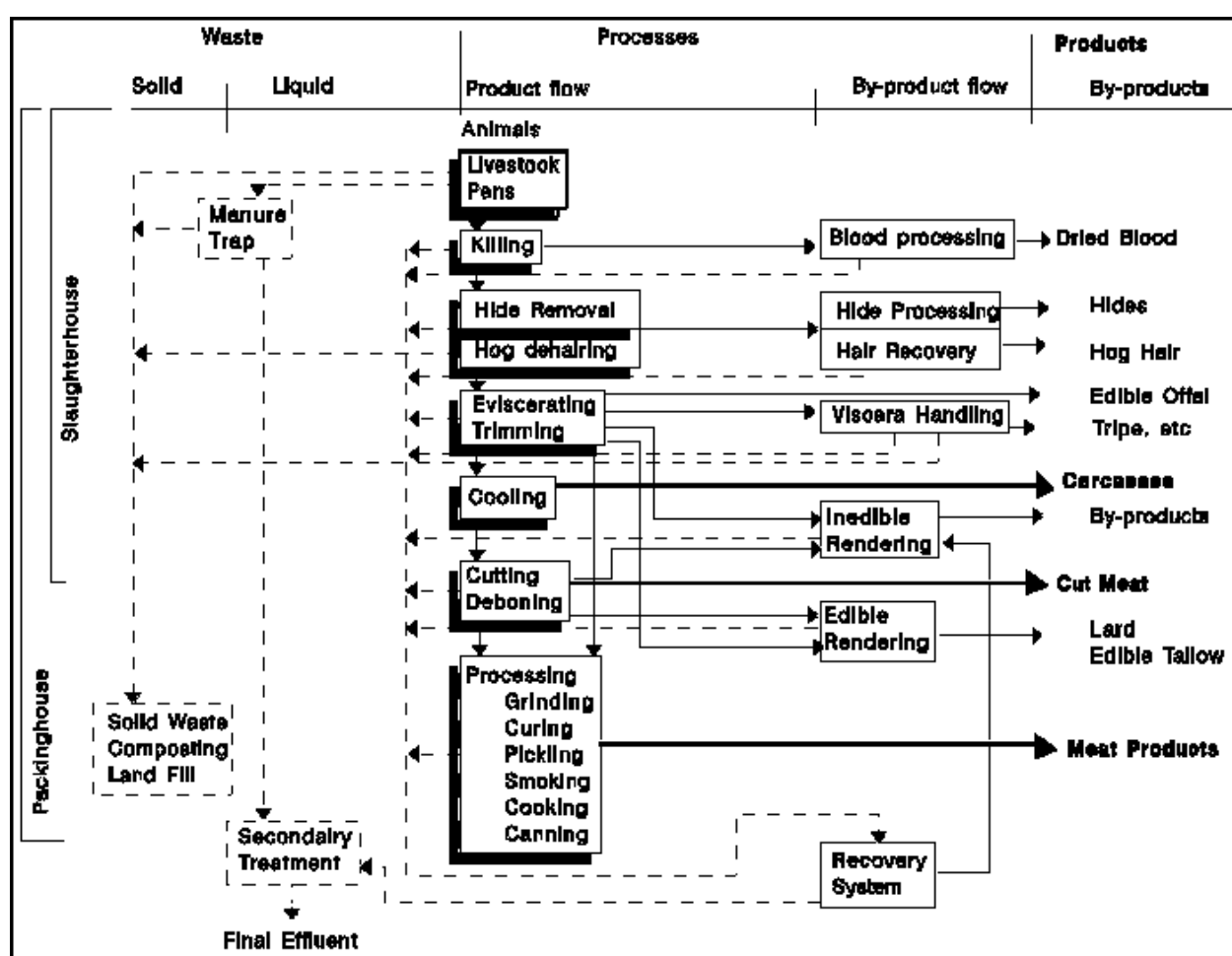
- I. Receiving the animal.
- II. ante-mortem inspection
- III. isolation of sick/diseased animals
- IV. Resting place for animals before slaughter
- V. Conducting humane slaughter – stunning box
- VI. Flaying, dressing, and washing of the carcasses
- VII. Hanging carcasses and edible offal
- VIII. Handling by-products

³⁸ In densely populated Bangladesh, composting suffers from many disadvantages. This method demands large amount of dry land free from inundation during monsoon, relies on manual labour for collection of wastes, long wait time for decomposing, and the fertiliser value of compost is moderate.

- IX. Managing solid and liquid wastes
- X. Inspection of meat
- XI. Chilling and Freezing facilities
- XII. Emergency slaughter
- XIII. Office
- XIV. Staff room
- XV. Supply of hot and cold of potable water
- XVI. Changing room and toilets

Figure 2 illustrates typical work processes in a slaughter house. The layout of entire slaughter house, as far as possible, shall follow forward flow principle.

Figure 13. A2.2 Work process flow in a slaughter house



(Source: Verheijen L. A. H. M. (1996) Management of Waste from Animal Product Processing, International Agriculture Centre, Wageningen, The Netherlands.
<https://www.fao.org/3/X6114E/x6114e00.gif>)

GENERAL PROVISIONS

Slaughter houses are food factories. Food business operators must ensure that the construction, layout, and equipment of slaughterhouses in which bovines, and small ruminants are slaughtered have:

- Properly built, and hygienic lairage facilities erected not less than ten meters from the slaughter house and equipped with adequate facilities for ante-mortem inspection and isolation pens for diseased or injured animals.
- Fenced cattle races from the lairages to the slaughterhouse, properly drained and in a suitable place equipped with facilities for washing and watering the animals.
- Floors of slaughter hall and dressing area are constructed of dense, acid-resistant, waterproof concrete and have appropriate non slip finish.
- Base slab shall be made of concrete (150 mm thick) reinforced with 10 mm rods both ways with spacing of 200 mm or it shall be reinforced with equivalent welded mesh.
- It should be made of strong concrete topping (40 mm minimum thickness), or granolithic concrete, or unglazed tiles (ceramic, quarry, cast iron or polymers) resistant to cracking, chipping, flaking and moisture proof.
- The minimum floor slope shall be one degree. Floor shall slope uniformly to drain inlets with no low spots.
- Internal wall surfaces shall be Impervious, easy to clean and resistant to wear, rust, and impact. Walls up to 1.5 to 2 meters from floor should be surfaced with approved quality white glazed tiles or other equivalent material. Both exterior and internal wall shall be smoothly finished and impervious to liquids (up to 1.8 m), not readily subjected to chipping or flaking, and sealed at joints. Internal walls where carcasses are processed shall not be painted.
- All ventilation machines such as AC, exhaust fans or air coolers should be fitted with silencers and all ducts shall be lined with sound-absorbent materials.
- Concave arches with sufficient radii to promote good sanitation shall be fixed at the juncture of floors and walls in all rooms.
- Ceilings of adequate head room be smooth and flat and be cement plastered or other acceptable impervious material that allow for easy cleaning
- Provisions for adequate natural lighting and ventilation shall be made. Doorways at least 150 centimetres wide and the doors must be made of rust resistant metal having tight soldered or welded seams. Door jambs shall be covered with rust resistant metal.
- Pest proofing to prevent the entry of insects and rodents, expanded metal or wire with a mesh not exceeding 127 mm shall be embedded in the walls and floor at their junctions. All windows and other exterior openings that could admit insects, pigeons, or bats, shall be equipped with screens. “Fly chaser” fans shall be provided over outside doorways where screening is not practicable.
- Exposed interior wood work shall be painted with nontoxic water-based acrylic wood dyes or fire-resistant wood sealer.
- The floors shall be well drained, with at least one drainage inlet, placed under the dressing rails, for each thirty-five square meters of floor space.
- Drains for paunch and stomach contents at least 20 centimetres in diameter.

- Waste disposal system of adequate size and must comply with the Bangladesh Environment Conservation Act 1995 (ECA 1995). No industrial unit can function without obtaining an Environmental Clearance Certificate (ECC) from the DOE.
- The slaughter house should have an adequate separation between clean and dirty sections, which shall be arranged in such a way that from introduction of a live animal into the slaughter house up to the emergence of meat and offal classed as fit for human consumption there shall be a continuous process; without any possibilities of reversal, inter-section or overlapping between the live animals and meat, and between meat and by-products or waste.
- There should be rails with hooks of suitable rust proof metal for bleeding, dressing, and hanging of carcasses in slaughter house.

To avoid the contamination of meat, FBOs must have the followings:

(a) A sufficient number of rooms, for handling hides and skins, the cleaning and treatment of intestines and ovals, and the storage, disposal and treatment of inedible and condemned animals, carcass, and meat and

(b) Need to ensure separation in space or time of the following operations:

- Stunning: Arrangement should be provided in slaughter house for humane slaughtering. Large animals may be stunned mechanically by captive pistol or gun. In case of goat, sheep and pig, electric stunner may be used. An animal should not be stunned and slaughtered in sight of other animals.
- Bleeding: The bleeding area should be so located that the blood should not be splashed on other animals being slaughtered or on carcasses being skinned. Blood drains and collection should be immediate and proper.
- Dressing: Dressing of carcasses should not be done on floor. At no point raw meat may come with the floors, walls, and fixtures.
- Adequate means and tools for de-hiding or belting of the animals should be provided. Hides and skins should be immediately transported either in a closed wheel barrow or by chute provided with self-closing door. In no case, the hides or skins should be spread on floor for inspection. Means for immediate disposal of legs, horns, and hooves should be provided through spring load floor chutes or side wall door or closed wheel barrows.
- Evisceration: There should be adequate contrivances for immediate separation and disposal of condemned material. Care should be taken too not to puncture intestine during evisceration to avoid contamination of carcass.
- Slaughter lines are designed to allow constant progress of the slaughter process and to avoid cross-contamination between the various parts of the slaughter line. Where more than one slaughter line is operated in the same establishment, there must be adequate separation of the lines to prevent cross-contamination

c) Possess lockable facilities for the refrigerated storage of detained meat and separate lockable facilities for the storage of meat declared unfit for human consumption

d) A separate place with appropriate facilities for the cleaning, washing and disinfection of means of transport for livestock. However, slaughterhouses need not have these places and facilities if the competent authority so permits, and official authorised places and facilities exist nearby.

e) Need to have lockable facilities reserved for the slaughter of sick and suspect animals. This is not essential if this slaughter takes place in other establishments authorised by the competent authority for this purpose, or at the end of the normal slaughter period.

f) Ensure specific area or place for storing of manure or digestive tract content;

g) Confirm that the facility is equipped with locks as and where needed, room for the exclusive use of the veterinary service.

h) Need the sterilizers to be provided for the disinfection of knives, steels, cleavers, saws, and other similar implements. The slaughterhouse shall have provision for the cleaning and disinfection of trucks, trolleys, trays, gambrels, hooks, inspection tables, and similar equipment and implements at the end of each working day. Sterilizers shall be connected to a hot water in adequate amount at temperature of not less than 82° C.

WATER

Water is a critical utility required for abattoir and meat producing units. Water is consumed in following areas

- Washing and showering animals in lairage
- Hot water to wash slaughter hall and work rooms during working hours
- Washing of equipment, utensils, knives, and tong. regularly
- Washing of carcass
- Hot water is required at elevated temperature (82°C) for frequent sterilizing of equipment and tools.
- The equipment for washing hands used by the staff engaged in handling exposed meat must have taps designed to prevent the spread of contamination
- Sufficient, safe, and constant supply of fresh water for drinking and potable purpose
- Water for washing of hands (including adequate supply of hot and coldwater, nail brushes, soap, or detergent) should be provided for persons working in slaughter house.

Water of various quality can be used to suit purpose. Raw water without any treatment is used for animal's shower in lairage. Filtered shall be used for washing of equipment, plant floor, aprons, and water for hand and foot washing of plant staff. Filtered and UV sterilised water is meant for utensil/knives/appliances washing and potable purposes.

WORKFORCE

The workers engaged in slaughtering, dressing and meat packing should be well educated and trained in their respective operations. Workers should have regular medical check-up and should be medically fit to manage meat (food). They should be

provided with necessary uniform and protective clothing, and they should always use and maintain them in a clean and sanitary condition throughout their working period. At the minimum, the workforce requirement for a small slaughter house has been provided in Table A2.2 below.

Table 28. A2.2. Human resources requirements

Sl. No.	Designation	Number required
1	Manager cum Vet. Officer	1
2	Documentation Officer cum Record Keeper	1
3	Accountant	1
4	Vet. Inspector	2
5	ETP & Blood Processing Plant Operator	3
6	Mechanic cum Electrician	3
7	Master Butcher/ Molla	2
8	Butchers	8
9	Sweepers	2
10	Guard	2
	Total	25

INPLANT MEASURES

- i) High efficiency spray nozzles with quick shot off in carcass washing, evisceration line and all cleaning purposes should be installed for effective cleaning and to reduce water consumption.
- ii) Dry cleaning step for all clean-up operations followed by controlled and efficient wet cleaning should be introduced to reduce pollution load in wastewater.
- iii) Proper segregation and collection of blood should be practiced in every slaughter house.
- iv) The dry procedures for collection of stomach and intestinal contents should be adopted. In no case, discharge of stomach and intestinal contents be allowed to discharge into drains.
- v) Hairs/feathers and other screenable solids should be removed from the wastewater as close to the place of generation/discharge as possible.

RECOVERY FROM WASTE

- i) Blood should be collected by pharmaceutical companies for manufacturing of haemotonic preparations. Alternatively, blood plasma could be used in sausage preparations. Blood can also be converted to blood meal which, after mixing and drying with rumen digesta can be used as animal feed.
- ii) Rumen digesta contains 10-20% proteins, vitamins, and essential minerals which, after processing/drying is an ideal animal feed. Alternatively, rumen digesta can be used as manure after composting.
- iii) Fat should be collected separately and rendered into tallow or lard by using wet or dry rendering processes. Indirect heat is used to melt fat and

evaporate moisture from animal tissue. Tallow and lard are a valuable raw material for several chemical industries.

- iv) Dissolved Air Floatation (DAF) is a proven method not only for pre-treatment of wastewater but also for fat and protein recovery. Prior to floatation, coagulation and flocculation are required. The collected float with solid content of 8 16-18% consists of proteins and fats. Coagulation of proteins and melting of fats is conducted in the subsequent protein recovery system consisting of a heat exchanger and dryer. The dried product, with a protein content of approximately 98% can be used as animal feed.

WASTE MANAGEMENT

Slaughter houses generate both liquid (effluent) and solid waste. Wastewater discharged from slaughterhouse contains high BOD, COD and TSS concentrations and treated fully or partially in effluent treatment plant depending upon the location, capacity and type of slaughterhouses and the treated effluent is disposed into sewer system. The sources of effluent generated are

- Animal holding area – floor washing and urine
- Carcass dressing -blood, floor, and machine washings
- Cleaning internal organs – wash liquor
- Rendering – glue water
- By products – floor and machine washing

The components left unrecovered simply form the solid wastes. Sources of solid waste generated from slaughter house are (CPCB 2017, p. 13):

- Animal holding – fodder wastes/dungs
- Abattoir – blood
- Hide removed – hair and dirt
- Internal organ cleaning area – Paunch content
- Carcass dressing – flesh, grease
- By products plant – grease and offal

It has been observed that waste generation is dependent on the extent of recovery of by-products. Modern plants have superior efficiency in extracting economic value from by-products and waste. Rumen, stomach and intestinal are disposed of as waste in smaller slaughter houses in wet markets. Soft meat parts such as lungs and pancreas are collected in large slaughter houses for sale to poultry feed processing units, whereas offal are disposed as waste in medium and small slaughter houses. Horns and hooves are used for the manufacture of plates and buttons. These body parts are rich in calcium with good potential for production of poultry feed and pet food.

Regulations are necessary to mitigate environmental impact of slaughterhouses, and the treatment methods used as the main regulatory requirement. The compliance with current environmental legislation and the state of art technologies may also provide

economic relief via resource recovery from biogas generation using high-rate anaerobic treatment.

A comparison of current regulations and discharge limits for organics and nutrients in slaughterhouse waste water (SWW) show that Canadian standards are stricter than that of USA, Australia, and USA (Bustillo-Lecompte, and Mehrvar, 2017). Emerging economies such as India and China have less strict standards. Table A2.3 below narrates the standards adopted for the chemical contents in the Slaughter House effluents for developed and developing countries.

Table 29. A2.3: Standards for Content of Chemical in Slaughter House Effluent

Parameter	Canada	USA	EU	China	India
pH	6-9	6-9	n. a	6-9	5-9
BOD (mg/L)	5-30	16-26	25	20-100	30-100
TSS (mg/L)	5-30	20-30	35-60	20-30	100
COD (mg/L)	n. a	250	125-250	100	n. a
Oils, fat, and grease (mg/L)		10	10-15		10

NB: pH, BOD, COD, TSS figures are adopted from Bustillo-Lecompte, and Mehrvar, 2017. COD and oils, fat, and grease figures are quoted in CPCB (2017) and Bajaj and Ranjhan (2020)

Bangladesh does not specific standards for regulating waste water in slaughter houses. However, the Bangladesh Standards and Guidelines for Sludge Management (DOE, 2017) provides a framework for establishing specific benchmarks for industrial pollution. The current DOE standards (Table A2.4) for waste from industrial water discharge into an inland surface body could be examined for adoption for the slaughter houses.

Table 30. A2.4: DOE Standards for Waste from Industrial Water Discharge in Bangladesh

Parameter	Values
pH	6-9
BOD (mg/L)	50
TSS (mg/L)	150
COD (mg/L)	200
Oils, fat, and grease (mg/L)	10

Source: Amin, A S M Tareq (2015) Textile effluents, their treatment and discharge in Bangladesh, Textile Today, July 2015. <https://www.textiletoday.com.bd/textile-effluents-treatment-discharge-bangladesh/>

The selection of specific treatment method depends on the characteristics of the SWW being treated, the best available technology economically achievable (BAT), the strength of administration to enforce regulations, and the preparedness of the industry to embrace suitable standards.

All wastewater of slaughter houses must be treated in accordance with statutory standards before it is discharged. The treatment methods are likely to vary according to the size of the slaughter house. Large units may opt for self-cleaning type screening, anaerobic treatment, aerobic treatment, and filter press for dewatering of sludge. The medium and small units may find two stage screening (bar type), anaerobic pond and polishing pond. The mini units dispose wastewater into specially dug pits. Mini units shall install screen and oil and grease separators in case waste is disposed into municipal sewer lines.

All solid wastes arising in the slaughter house shall be properly treated and disposed of by methods specified below. Rendering, and burial is suitable for wastes consisting of inedible offal, animal tissue, organs, body parts, and carcasses. Stomach/intestinal contents, dungs, and sludge could be directed for composting.

SPECIFICATIONS FOR CIVIL WORKS AND EQUIPMENTS

The bare minimum requirement for civil work and equipment for a small slaughter house is available in schedule 2 and 3. Larger units will require more sophisticated equipment and elaborate civil works which may be specified in business plan.

SLAUGHTERHOUSE AUDIT SCORE SHEET

There is an urgent need to institutionalize the slaughtering facilities in Bangladesh. The Department of Livestock (DLS) may use the tool of audit scoring sheet (Table A2.5) for annual physical auditing of the facilities which may serve the purposes of (a) assessment of current state of affairs on compliance to the regulatory requirement on health and hygiene, (b) taking decisions more objectively on renewing the licenses of slaughtering facilities and (c) provisioning of incentives to compliant facilities.

Table 31. A2.5. Compliance Audit Score Sheet for Slaughtering facilities

Date			
Inspector's name			
Establishment Name			
Establishment representative			
Address of the unit			
Mobile no.			
Email ID			
S. No.	Audit Questions	Score	
		Maximum	Achieved
I	Status of Business licenses		
1	<i>Business establishment has a valid and updated DLS License.*</i>	4	
2	<i>Business establishment has a valid NOC from local authority.*</i>	4	

II	Condition of Physical Infrastructure		
3	The premises have separate provision for the slaughter of varied species of animals.	2	
4	There is a lairage, duly fenced and secured, with facility for watering and examination of animals.	2	
5	The layout of the slaughter house is such that there is no possibility of overlap/intersection between live animals and the emergence of meat and offals from slaughtered animals.	2	
6	Internal structure & fittings are made of non-toxic, impermeable materials which minimises entry of dirt, dust, pest, and rodents.	2	
7	Floors are impervious, epoxy coated and non-slippery.	2	
8	Walls are epoxy coated, paved with imperious glazed tiles upto 1 meter height for poultry or small ruminant animals and upto 5 metre for large animals.	2	
9	Windows & other openings are free from accumulated dirt, and have insect- proof screen guards.	2	
10	Doors are smooth, non-absorbent surface, close fitted & self closing (where appropriate).	2	
11	Premises have sufficient lighting i.e.540 lux (inspection points), 220 lux (work room) & 110 lux (other areas).	2	
12	Adequate ventilation is provided within the premises.	2	
13	Personnel hygiene facilities are available including adequate number of toilets, change rooms and hand washing facilities with warm or hot and coldwater, and hand drying close to toilets.		
14	<i>Clean potable cold water (meeting standards of ISO 24512:2007) with pressure hose pipes and supply of hot water is available in slaughter hall.*</i>	4	
15	An equipped laboratory is available with qualified chemist/analyst or veterinary microbiologist.	2	
16	The equipment & containers (except for chopping blocks, cutting boards & brooms) are durable, made of corrosion resistant material which facilitates cleaning.	2	
III	Quality Assurance		
17	Animals suspected of infectious diseases are segregated and kept in separation.	2	
18	<i>Humane methods are used for slaughtering. Animals are rested before slaughter to reduce stress. Slaughtering of animals is not done in sight of other animals. Stunning of animals is done before slaughtering.*</i>	4	
19	Finished food products are duly labelled for traceability.	2	
20	The dressing of the carcasses is not done on floor. Suitable hoists are provided to hang the carcasses before evisceration	2	

21	Meat cleaver and knives are of stainless steel and sterilized/ sanitized before use.	2	
22	<i>All animals are subjected to ante-mortem examination and post mortem inspection by the authorised veterinarian.*</i>	4	
23	When dressed meat has to be stored without further immediate processing, such storage is maintained at 0°C to 2°C.	2	
24	Carcasses, parts and the organs thereof found to be healthy and fit for human consumption are marked as “ <i>Inspected & passed</i> ”. Carcass or parts thereof which is unfit for human consumption is marked as “ <i>Inspected & condemned</i> ”.	2	
IV	Sanitation, maintenance & waste disposal		
25	Cleaning of equipment, food premises, and floors are done everyday. Lime washing, colour washing or paint washing is done at least once in 12 months.	2	
26	Preventive maintenance of all equipment is conducted regularly as per the manufacturer’s instructions.	2	
27	<i>Blood, manure, rubbish, filth or other refuse from any animal slaughtered and the hide, viscera and offals are removed from the slaughter house within 8 hours after completion of slaughtering in a manner not to cause contamination. The container or receptacle used for these wastes is thoroughly cleaned and disinfected immediately after use.*</i>	4	
28	<i>Pest control programme is available and pest control activities are conducted by trained and experienced personnel.</i>	4	
29	No signs of pest activity or infestation in premises (viz eggs, larvae, faeces)	2	
30	There is an efficient drainage system and all drains and gutters are properly and permanently installed fitted with traps and screens. The drainage system for blood is either underground with facility for easy cleaning or a portable receptacle with lid.	2	
31	Sufficient space is there for separation and storage of condemned carcasses. Destruction of condemned carcasses, organs or parts thereof shall be conducted under the direct supervision of the authorised veterinarian.	2	
32	Slaughter house refuse and waste material is suitably processed to prepare animal by product or dumped in pits that are suitably covered.	2	
33	<i>For large slaughter house, ETP is required. Disposal of sewage and effluents is done in conformity with standards laid down under The Environmental Conservation Act, 1995, The Environmental Conservation rules, 1997 and Bangladesh Water Act 2013 (BWA).*</i>	4	
V	Personal Hygiene of workers		

34	Annual medical examination & inoculation of food handlers against the enteric group of diseases as per recommended schedule of the vaccine is done. Check for records.	2	
35	No person suffering from a disease or illness or with open wounds or burns participates in handling of food or materials which come in contact with food.	2	
36	<i>Food handlers maintain personal cleanliness (clean clothes, trimmed nails & water proof bandage) and personal behaviour (hand washing, no loose jewellery, no smoking, no spitting etc).</i>	4	
37	Food handlers are equipped with suitable aprons, gloves, headgear, shoe cover etc.	2	
VI	Internal audit, training & documentation		
38	Internal / External audit of the operation system is done periodically. Check for records.	2	
39	There is an active consumer complaints redressal mechanism.	2	
40	Food handlers are trained in any FSSC 22000, GMP, or HACCP, or any other training in risk management, traceability, hygiene, and regulations so that food is managed safely. Check for training records.	2	
41	<i>Appropriate documentation & records are available and retained for a period of one year or the shelf-life of the product, whichever is more*.</i>	4	
	Total Points	100	
	Grade Achieved (tick mark)	A/ B/ C/ D	

Asterisk mark (*) questions may significantly impact food safety & therefore must be addressed as a priority. Failure in any of the asterisk mark questions, will lead to Non-compliance

Grade	Compliance	Score
A	Outstanding	91 - 100
B	Satisfactory	71-90
C	Laggard. Needs Improvement	51-70
D	Non compliance	<50

ANNEX 3

Economic evaluation of clean energy interventions in slaughtering facilities

Introduction

The meat production in Bangladesh has increased to 7.6 million tons in the fiscal year (FY) 2019-20 from 1.9 million tons in FY 2010-11³⁹. Beef contributes to around 60% of the total annual meat consumption and the remaining 40% is from goat, poultry, etc. The per capita consumption of meat was 126.20 gm/day/head in FY 2019-20⁴⁰ which is more than the World Health Organization (WHO) recommended minimum consumption (120 gm/day/head⁴¹) indicating that the country is self-sufficient in meat production. However, there is no organized system of slaughtering facilities in the country in terms of lairage, flaying of carcasses, carcass washing, meat inspection, etc.

There are public slaughterhouses managed by the city administration with capacity ranging from 25-100 cattle per day. But majority of cattle slaughtering and marketing of meat products are still carried out in a traditional way in Bangladesh and wet markets are the most preferred place for people to purchase beef as it is considered to be fresh. Because of the traditional way of slaughtering, food safety has been a major concern. Bengal Meat, a private enterprise is the only company operating a modern slaughterhouse in the country. With about 10 million cattle slaughtered annually, over half of these or about 6 million are slaughtered on a single day for the Eid al-Adha festival and this far exceeds the capacity of all of the slaughtering facilities in the country⁴². The existing waste management practices in slaughterhouses are also inadequate. The carcass removal is unsystematic and the waste is dumped in local bins, sewerage and drainage system leading to water contamination and greenhouse gas (GHG) emissions.

Thus, there is a need for introducing modern and quality slaughtering practices in the country. As one of the sustainable developments linked modernization approach, this Annex 2 discusses on the potential of integrating energy efficiency (EE) & renewable energy (RE) interventions for efficient slaughtering facility operations.

Slaughterhouses and energy requirements

In general, the electricity and the fuels such as diesel (for power generators), biomass, charcoal and liquefied petroleum gas (LPG) (for heating needs) are the commonly used energy sources in the slaughtering facilities. The electricity consumption may widely vary based on the animals slaughtered. For example, the electricity consumption in

³⁹http://dls.portal.gov.bd/sites/default/files/files/dls.portal.gov.bd/page/ee5f4621_fa3a_40ac_8bd9_898fb8ee4700/2020-07-22-19-34-e4cd5ed65f45419ee038e00b8939c1a0.pdf

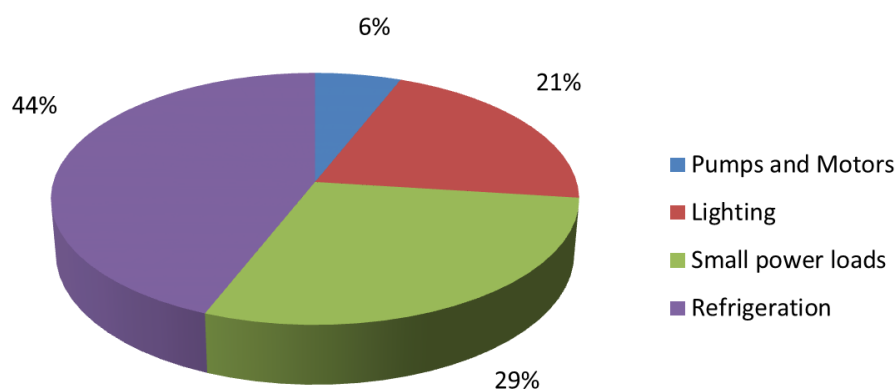
⁴⁰http://dls.portal.gov.bd/sites/default/files/files/dls.portal.gov.bd/page/ee5f4621_fa3a_40ac_8bd9_898fb8ee4700/2020-07-22-19-34-e4cd5ed65f45419ee038e00b8939c1a0.pdf

⁴¹<https://www.unido.org/sites/default/files/files/2019-05/Bangladesh%20dairy%20and%20beef%20vc%20report%20%28Wei%27s%20final%20version%29%20.pdf>

⁴²<https://www.unido.org/sites/default/files/files/2019-05/Bangladesh%20dairy%20and%20beef%20vc%20report%20%28Wei%27s%20final%20version%29%20.pdf>

modern slaughterhouses is reported to be in the range of 20-310 kWh/cattle and 0.4-1.2 kWh/poultry⁴³. In particular, the refrigeration system consumes around 45% of the total electricity consumption in the slaughterhouses. Pumps are used for water supply in the facility and motors are used in operation of conveyors/hangers. Other small loads include handheld equipment, hoists, etc. The fuels are mainly used for hot water generation required for cleaning the carcass and sanitizing equipment & facility⁴⁴. Use of biomass fuel such as wood and charcoal for hot water generation also leads to air pollution around the slaughterhouse facility. Figure A3.1 shows the contribution to different electrical loads to total electricity consumption in typical slaughtering facilities.

Figure 14. A3.1 Contribution of electrical loads in typical slaughterhouse



Operational pattern of slaughterhouse (major type of livestock handled, daily hours of service, use of cold storage) also impacts the energy requirements.

Public slaughterhouses:

In case of public slaughterhouses managed by city administration/local government authorities, the cattle are slaughtered in the early morning hours (2 am - 6 am) and at late evening hours (6 pm – 10 pm). The traders bring their cattle to the slaughterhouse to get them butchered for a service fee during this time and then the meat product are distributed across the city for retail sale to consumers. Thus, the operation of public facility can be intermittent 8 hours per day. Given this operation pattern, need for a chilling or refrigeration unit to store meat products is relatively low. Electricity is sourced from the grid connection and the diesel generator is used in case of emergency purpose only.

Private slaughterhouses:

In case of private enterprises, the operation can be different where the facility may be operating all through the day continuously delivering meat products to their clients/consumers. Therefore, the energy load of chilling or refrigeration unit will be high

⁴³ <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/slaughterhouses>

⁴⁴ https://www.deswater.com/DWT_articles/vol_190_papers/190_2020_98.pdf

here requiring higher electricity consumption. Electricity is sourced from the grid connection and diesel generator may be used for emergency power supply. This note mainly deals with the public sector slaughtering facilities. However, the interventions discussed and recommendations made may be applicable for the private enterprises as well. Most of the slaughterhouses in Bangladesh are lacking basic amenities such as sufficient lighting, proper ventilation, adequate water/hot water supply and environment friendly waste disposal for safe and hygienic work environment. Adopting EE and RE systems can help overcome some of these challenges.

Potential EE and RE technologies

Slaughterhouses are one of the major sources of water pollution and GHG emissions, especially in the developing countries. Although it is not an energy intensive sector compared to other industrial sectors, improving energy efficiency & generating clean energy from slaughtering wastes can be the potential interventions for lowering the dependence on fossil fuels & its costs. In addition, this can support slaughterhouses to abide by the health & safety regulations and other environmental norms set by national and local policies. Many studies show that it is possible to reduce the energy costs in meat industries by applying adequate energy conservation strategies or use of clean alternate energy sources.

Following are the most widely used EE and RE measures which can help in achieving efficient slaughterhouse operation:

- Efficient lighting
- Solar water heaters
- Solar PhotoVoltaic (PV) power generation
- Waste-to-Energy (WTE)
- Energy efficient appliances

Efficient lighting

Bangladesh's residential, commercial and public buildings represent about 35% of the total electricity consumption. Thus, there is a huge potential for electricity savings in the commercial area including slaughterhouses. Particularly, the replacement of conventional lamps & compact florescent lamps (CFLs) with the energy efficient lighting systems such as Light Emitting Diode (LED) lamps will reduce the electricity consumption and also improve comfort of slaughterhouse staff by offering good quality ambient lighting. Switching from CLFs to LEDs can offer around 25% reduction in energy consumption. There are different types of LED lighting and the most appropriate ones can be chosen as per different floors/operational areas of slaughterhouses. Figure A2.2 shows sample LED lamp applications available. This will give improved vision to the butchers for efficient cutting and cleaning operation. Where there is unreliable grid supply and early morning slaughtering is practised, the use of solar PV in conjunction with batteries and LEDs can be considered for reliable lighting.



Figure 15. A2.2 Different LED lighting applications

Solar water heaters

In slaughtering operations, hot water at a temperature of 60°C – 80°C is required to clean the carcass and also in cleaning & sanitizing the equipment/facilities. Traditional way of heating water in tanks requires manually operation of burning of wood or charcoal or LPG using burners/stoves as per requirement. This can be a limitation where there is no adequate staff or space to install stoves/tanks. Burning of biomass will also lead to smoke generation affecting nearby communities. But solar water heater does not need manual operation and does not generate smoke. It does not need additional ground space as it can be mounted on roof top of slaughterhouse. To achieve hot water supply of desired temperature levels, either flat plate or evacuated tube solar water heaters can be used.

(i) Flat plate solar water heater

In this technology, the solar radiation is absorbed by flat plate collectors which consist of an insulated outer metallic box covered on the top with glass sheet. Inside there is blackened metallic absorber sheets with built in channels or riser tubes to carry water. The absorber absorbs the solar radiation and transfers the heat to the flowing water. The maximum hot water temperature achieved by flat plate solar water heater is 90 °C. The flat plate solar water heater system is given in figure A2.3.



Figure 16. A2.3 Flat plate solar water heating system

(ii) Evacuated tube solar water heater

Evacuated tube collector is made of double layer borosilicate glass tubes evacuated for providing insulation. The outer wall of the inner tube is coated with selective absorbing material. This helps absorption of solar radiation and transfers the heat to the water which flows through the inner tube. The average hot water temperature achieved by the evacuated tube solar water heater is 140°C. The evacuated tube solar water heater system is given in figure A2.4.



Figure 17. A2.4 Evacuated tube solar water heating system

Solar PV power generation

Solar PV power generation can be best solution in remote slaughtering facilities where there is dependence on diesel generator due to remote location or unreliable power supply from the national grid. The technology also has a well established market in Bangladesh with number of market players. Solar PV power generation can be implemented together with various applications such as lighting, water pumping, refrigeration, etc., based on space available for installation (roof top or ground mounted) and financial resources.

(i) Off grid system

The Solar PV system which is not connected to the national/local electrical grid is termed as off-grid PV system or standalone system. Following are the key components of the off-grid solar PV system:

- **PV Panel:** This is used to convert solar energy to electrical energy. Whenever sunlight falls upon these panels, these generate electricity which is supplied to the loads/batteries.
- **Charge Controller:** It determines how much current should be injected into the batteries for its most optimum performance. As it determines the efficiency of the entire solar system as well as the operating life of the batteries, it is a critical component. The charge controller protects the battery from overcharging.
- **Battery Bank:** Any excess energy generated during day is stored in the battery banks and is used to power loads whenever required.
- **DC-AC Inverter:** A DC-AC solar inverter (or just a 'solar inverter') is used to convert direct current to alternating current for use by AC loads. DC loads can be directly fed from the solar system and do not require an inverter.

It is also possible that the excess power from off-grid solar PV system can be supplied to the nearby communities if they do not have grid access. Such sale of power to nearby households/enterprises/schools can serve as additional revenue for the slaughterhouse administration.

(ii) Grid-tied system

The grid connected solar PV system is similar to the off-grid system except that there will be no battery storage and any excess power will be exported to the grid. However, this may require approval from the electricity utility authorities and alignment with net metering regulations in the country. The sale of power to grid can serve as additional revenue for the slaughterhouse administration.

Waste to Energy (WtE)

In Bangladesh, around 10 million livestock are slaughtered annually producing 7.6 million tons of meat for consumption each year. As a consequence, the slaughterhouses produce large amount of solid wastes and wastewater and if directly disposed, these would result in environmental & ecological problems and risk of clogging the wastewater drainage systems. Anaerobic treatment of these wastes in a biogas digester can be an effective solution to handle these wastes and prevent environmental damages. The biogas generated can be captured and used for heating water or generating electricity. The final sludge can be used as fertilizer in agriculture farms.

There are on-going biogas generation projects (from slaughterhouse waste) in Bangladesh. For example, the World Bank through the "Bangladesh Scaling-up Renewable Energy Project", aims to generate the biogas from slaughterhouse waste in Rajshahi city. Similarly, the GIZ is also providing technical assistance for the implementation of biogas facility at Tongi, Gazipur city. The lessons learnt from these projects can be considered while implementing the biogas facility through this project. Approximately 7,915 tons of slaughterhouse waste are generated annually from the

slaughterhouses in Dhaka city alone and has the potential to generate 2.15 million m³ of biogas.

In general, the biogas digesters are of three type namely, (i) fixed dome, (ii) floating drums and (iii) flexible balloons.

(i) Fixed dome digester

Fixed dome digester is robust, reliable and requires only little maintenance. The size of these plants can range anywhere from 2 – 16 m³. The biogas system is made up of several interconnected parts. The schematic of fixed dome digester is given in figure A2.5. The specific role of each component is summarised below:

Inlet - The main purpose of the inlet is to mix organic material and water into a semi solid state. This mixture is fed into the digester via an inlet pipe.

Digester - The digester holds the mixture of manure and water, creating a conducive environment for anaerobic digestion where microorganisms produce biogas. The digester is cylindrical in shape and is usually made of brick masonry with a concave concrete cover or dome. Typically, the digester is built underground with only the plumbing, inlet and outlets visible.

Dome - The purpose of the dome is to collect the gas produced in the digester. This is typically plastered in several layers and painted with a special paint in order to minimise gas leakage. Gas accumulates under the dome creating pressure and pushing down the level of the slurry and consequently increasing the slurry level in the connected slurry tank. It is the difference in slurry levels between the slurry tank and the inside of the dome that maintains the pressure to push the gas into the outlet pipe.

Outlet - The outlet valve releases the collected gas under the dome to biogas appliances such as stoves or lamps.

Slurry tank - The slurry tank holds the slurry that the gas pressure from under the dome displaces. This slurry overflows into a composting tank as more manure is fed into the digester. This slurry can then be used as a fertiliser.

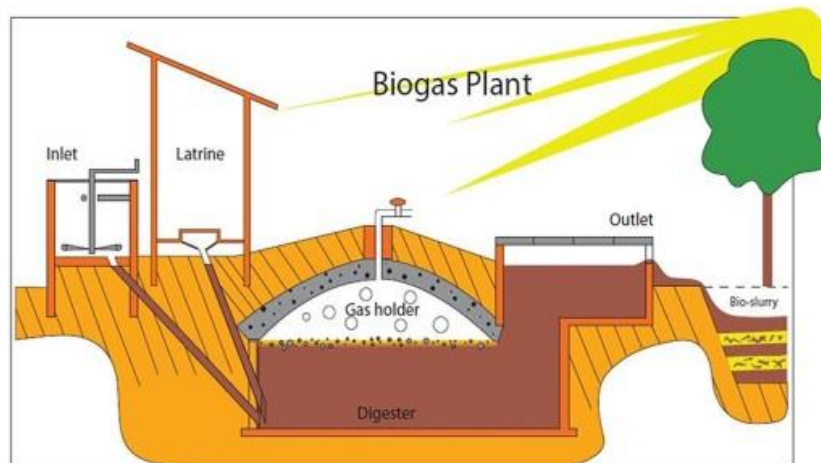


Figure 18. A2.5 Schematic of fixed dome digester

(ii) Floating drum technology

Figure A2.6 shows the schematic of floating drum technology. The basic functioning of the floating drum digester is similar to the fixed dome. The key difference of this technology is a cylindrical or dome-shaped digester with a moving, floating gas-holder or drum that floats depending on the amount of gas in the digester. The gas-holder either floats directly in the digester slurry or in a separate water jacket. The drum in which the biogas collects will usually have an internal or external guide frame that provides stability and keeps the drum upright.

As biogas is produced and more gas is released, the drum is pushed up, indicating a rise in the amount of gas. When the gas is used up, the drum sinks. This provides a useful visual indicator of how much gas is available to users. Costs of building/installing the floating drum type obviously depend upon the size, the materials used and the model of the digester. Floating drum digesters need some maintenance depending on how well they are managed. Maintenance involves cleaning, painting and fixing leaks.

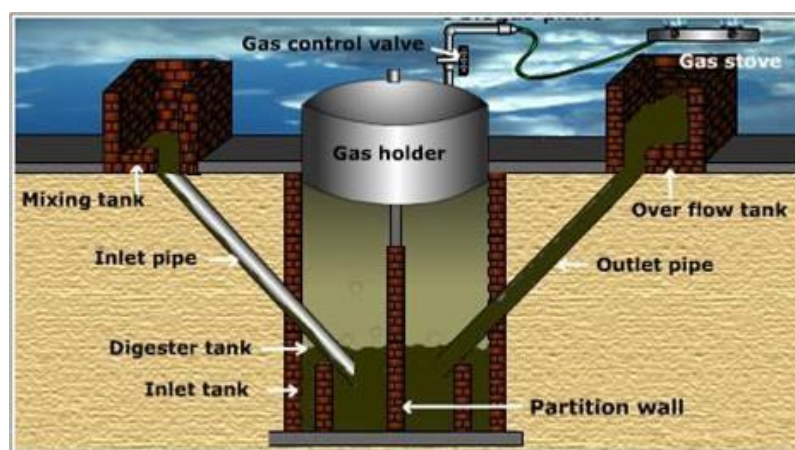


Figure 19. A2.6 Floating drum biogas system

(iii) Flexible balloon digesters

Figure A2.7 shows the schematic of flexible balloon digester technology. Flexible balloon digesters are constructed from a large plastic or rubber bag and are thus

mobile, which is the main difference from the fixed dome and floating drum digesters that are constructed on site.

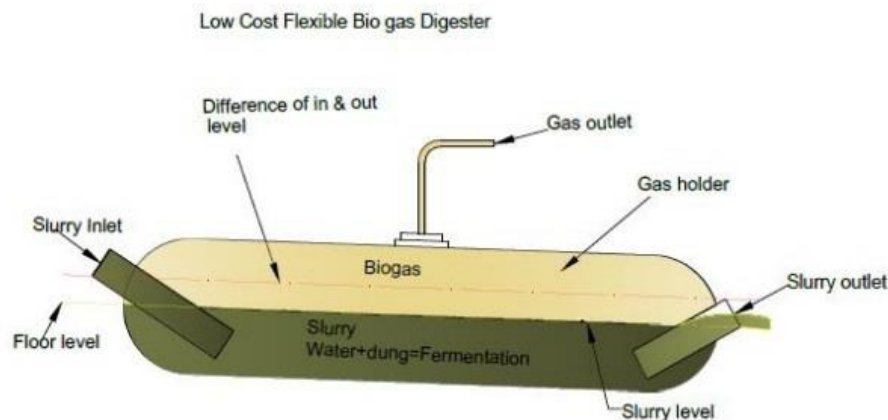


Figure 20. A2.7 Flexible balloon digester system

The operation however follows largely the same principle as fixed-dome or floating drum digesters. The balloon material should be weather and ultra-violet (UV) radiation resistant, specially stabilised reinforced plastic or rubber.

Energy efficient appliances

The conventional motors, pumps, refrigerators, etc., at the slaughterhouse facility can be replaced with the energy efficient appliances to reduce the energy consumption and its associated cost in the slaughterhouse. Bangladesh has already established Energy Performance Standards (EE labelling) for ballasts, ceiling fans, fluorescent lamps, portable fans, refrigerators and freezers. As of 2019, the EE labelling is available for fluorescent lamps, ballasts, ceiling fans, portable fans and refrigerators. The larger the slaughterhouse capacity and size, higher will be the energy consumption and equally higher potential exists for energy savings and cost savings from use of energy efficient appliances. In general, adoption of energy efficient appliances can help achieve around 5-10% energy savings. Figure A2.8 shows the sample EE labelling for refrigerator.



Figure 21. A2.8 Energy star rated electrical appliances

Economics of sustainable clean energy technologies

The slaughtering facilities, especially those operated for the public services, are not an energy intensive one. Therefore, energy efficient technologies based on electricity such as efficient lightings & appliances for public slaughtering facilities may offer some

reduction in electricity costs, but it may not be significant on the overall cost savings. However, if the energy requirements (both electricity and heating) are replaced with sustainable alternative energy technologies such as solar energy and biogas, then the cost savings/revenue generation will be significant. This cost savings will support lowering the budget/expense of the local government authorities to operate those facilities. Clean energy technologies together with EE systems can improve the overall economic attractiveness of the investment.

Therefore, economics of key RE/waste-to-energy (WTE) technologies for the slaughtering facilities are discussed below. The analysis is based on the collected data for Bangladesh conditions and where not available, from the regional and international references. The economic analysis for each technology is carried out for three different scenarios of cattle handling capacity as follows:

- Small scale facility (less or equal to 50 cattle per day)
- Medium scale facility (between 50 to 200 cattle per day)
- Large scale facility (more than 200 cattle per day)

The analysis presented here are only for demonstration purpose. However, in the practical condition, the economics of these interventions may vary due to various factors such as actual energy requirement in slaughterhouse, operational pattern, space availability, technologies available in the domestic market, etc. Pre-feasibility study will be required to decide on the exact scale/technology of RE/WtE intervention most appropriate for a given slaughtering facility.

Solar water heating system

The slaughterhouse requires hot water at a temperature of 50°C - 80°C for sterilizing knives and instruments, rendering and intestine and tripe washing. The total water required per day for the slaughtering facility depends on type of livestock slaughtered. For example, modern slaughterhouses require on average of 750 litres per day per cattle. However, the hot water requirement is only about 5%-20% of this total water requirement.

Table A2.1 presents the hot requirement in different scenarios. This hot water requirement can be fulfilled by SWH system which can operate at a temperature between 30°C & 90°C. Though wood/firewood is the traditional fuel used for heating water, efficient/smokeless operation will require LPG. The LPG must be purchased from market as per need and its price is subject to market trends. In contract, the SWH will need only one-time investment expense and marginal maintenance costs. Thus, it is assumed that SWH would replace the LPG consumption and associated costs. Flat plate SWH is considered for the analysis. The summary of the economic analysis of the SWH system for the 3 different scenarios are given in the table A3.1.

Table 32. A3.1. Economic analysis of SWH system

No.	Parameters	Small scale	Medium scale	Large scale
1	Total cattle handling capacity (nos.)	50	100	200

No.	Parameters	Small scale	Medium scale	Large scale
2	Total quantity of hot water required for (litres/day)	1,875	3,750	7,500
3	Total area required for solar water heater (ft ²)	200	400	800
4	Total cost of flat plate SWH system (USD)	10,720	18,440	30,380
5	Approximate annual operation & maintenance cost (USD)	1,500	1,750	2,000
6	Annual avoided LPG consumption (tons)	3	6	11
7	Annual LPG cost saved (USD)	3,355	6,800	13,400
8	Simple payback period (years)	5.6	3.6	2.6

Solar on-grid and off grid systems

In general, the electricity consumption varies around 20–310 kWh/cattle in modern slaughtering facilities. The electricity required for the slaughtering facility is mainly sourced from the grid. In a slaughtering facility, the electricity is majorly consumed by the refrigeration system, pumps and lighting. The refrigeration system alone consumes 50–65% of total electricity in most of the slaughterhouses and the remaining (35-50%) is consumed by the pumps & lighting. To meet these electricity requirements, the solar on-grid & off-grid systems can be used in the slaughterhouses and reduce the dependence on the carbon intensive grid electricity. The solar on-grid and off-grid systems can be considered based on the land availability, available technology in the domestic market, battery backup requirement, etc.

Solar on-grid system

The on-grid solar PV system requires substantial land area depending upon the loads in the slaughterhouse. It is economical when there is considerable operating load during sunshine hours and any excess electricity can be supplied to the grid. The excess electricity supplied to the grid would reduce electricity cost to the facility. The economic analysis has considered three different capacity of on-grid solar PV system (10 kW, 30 kW & 50 kW solar PV system) for small, medium & large slaughterhouses.

The cost of the solar PV panels varies between USD 0.26 per W_p to USD 0.35 per W_p , depending upon the type, model and efficiency of the solar panels (mono/poly, single or bifacial modules). The installation of solar PV over the roof of the slaughterhouse will reduce the mounting structural requirements and thereby reduction in system cost. If additional ground space is available within the facility, it can be ground mounted also. The battery bank is not recommended for an on-grid solar PV system, as the battery storage system not only increases the total initial investment cost, but also adds to the yearly operation and maintenance (O&M) costs and the battery replacement cost every few years. The economics of the grid-tied solar PV system is given in Table A3.2 for three categories of slaughterhouses.

Table 33. A3. 2. Economics of grid connected Solar PV system

No.	Parameters	Small scale	Medium scale	Large scale
1	Total cattle handling capacity (nos.)	50	100	200
2	Capacity of solar PV system (kW)	10	30	50
3	Total system cost (USD)	6,500	19,500	32,500
4	Commissioning and net metering costs (USD)	1,300	1,300	1,300
5	Annual O&M costs (USD)	260	520	1,000
6	Annual electricity generation (kWh)	18,000	54,000	90,000
7	Annual revenue (USD)	1,890	5,670	9,450
8	Simple payback period (years)	4.7	4.03	4

Solar off-grid system

The off-grid system installation and operation is similar to on-grid system, however, instead of supplying the excess electricity to grid, it would be stored in the battery and utilized when the grid electricity and sun shine is not available. In Bangladesh, the slaughtering is mostly carried out in early morning hours (say 2 am - 6 am) and in late evening hours (say 6 pm – 10 pm). Thus, the solar energy may not be available during the slaughtering time. The energy stored in the battery can be utilized for the slaughtering operation. The economic analysis has considered three different capacity of off-grid solar PV system (10 kW, 30 kW & 50 kW solar PV system) for small, medium & large slaughtering facilities and the summary is given in Table A3.3 below.

The off-grid solar PV system is beneficial where there is heavy dependence on diesel generator such in remote places with no or unreliable grid. The diesel must be purchased from market as per need and its price is subject to market trends. In contrast, the solar PV system will need only one-time investment expense and marginal maintenance costs. Thus it is assumed that solar off-grid system would replace the diesel consumption and associated costs. The backup time and loads served by diesel generator determines the sizing of the equivalent battery bank. However, the battery storage system not only increases the total initial investment cost, but also adds to the yearly O&M costs and the battery replacement cost every 3 to 5 years after installation.

Table 34. A3.3. Economics of off-grid Solar PV system

No.	Parameters	Small scale	Medium scale	Large scale
1	Total cattle handling capacity (nos.)	50	100	200
2	Capacity of solar PV system (kW)	10	30	50
3	Total system cost (USD)	12,600	32,500	54,200
4	Annual O&M costs (USD)	500	1,500	2,200
5	Annual electricity generated (kWh/year)	180,000	54,000	90,000
6	Annual emergency diesel consumption avoided (litre)	1,500	4,500	7,500
7	Annual savings from diesel avoidance (USD)	1,440	4,320	7,200
8	Annual savings from grid electricity avoidance (USD)	1,890	8,490	9,450
9	Simple payback period (years)	7.06	6.05	5.86

Economics of biogas technology

The solid waste and waste water generated from the slaughterhouse can be collected and disposed inside a bio-digester to generate the biogas from slaughterhouse waste. The economic analysis is conducted for 3 different slaughterhouse capacities. It is assumed that the biogas is primarily used for generation of electricity (for own use & excess supplied to nearby households) replacing the grid electricity consumption. A part of biogas will be used for water heating purpose. Though wood/firewood is the traditional fuel used for heating water, efficient/smokeless operation will require LPG.

The LPG must be purchased from market as per need and its price are subject to market trends. The final sludge can be sold as fertilizer to farms. But that is not taken into account for the analysis for conservativeness. Thus, installation of biogas digester offers multiple economic benefits. The summary of the economic analysis of the biogas plant for 3 different scenarios are given in the table A3.4 below.

Table 35. A3.4. Economic analysis of biogas system

No.	Parameters	Small scale	Medium scale	Large scale
1	Total cattle handling capacity (nos.)	50	100	200
	<i>No. of cows</i>	20	40	80
	<i>No. of goats</i>	30	60	120
2	Waste generated per day (kg/day)	750	1,500	3,000
3	Potential biogas generation from slaughterhouse waste (m ³ /day)	33	66	132
4	Annual avoided LPG consumption (tons)	3	5.8	11
5	Annual electricity generated from biogas (kWh)	NIL	75,300	150,600
6	Total cost of biogas system (USD)	15,550	40,100	72,700
7	Approximate annual O&M cost (USD)	1,000	5,000	8,000
8	Saving from LPG avoidance (USD)	3,355	6,700	13,400
9	Saving from grid electricity avoidance (USD)	NIL	7,900	15,800
10	Simple payback period (years)	6.3	4.1	3.5

Recommendations

The economic analysis of different RE/WtE interventions show that there is good potential for energy and cost savings. The payback of the investment ranges around 2 to 7 years which is attractive. The appropriate and suitable technology(ies) for the slaughterhouse can be chosen by taking into account the following aspects:

- Land/space availability for installation
- Government policies/priorities and incentives for the proposed technology, if any
- Resource potential in the specific project site
- Technology availability in domestic market
- Investment and other related costs for the technology