Bangladesh Livestock
Research Priorities

Bangladesh Agricultural Research Council

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Project Implementation Unit, NATP-2
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215

May 2023

Minister
Ministry of Agriculture
Government of the People's Republic of Bangladesh

Message

I am delighted to know that Bangladesh Agricultural Research Council (BARC), has taken a noble initiative to publish a book titled, Bangladesh Livestock Research Priorities. From the perspective of chronic food deficit, the Father of the Nation, Bangabandhu Sheikh Mujibur Rahman, strongly realized that the livestock sub-sector is a crucial matter for the country's overall progress. Therefore, he took many effective measures for the development of the sector. Evidently, he initiated a great program on up gradation of our local cows by the world famous dairy breed – Holstein Friesian (HF). Accordingly, he imported some pure breeds of HF cows and bulls from Australia. The country has been enjoying that drive through increased meat, egg, and milk production. Farm friendly policies, technological innovations, strong commitment, and production support are key drivers of such an unprecedented success in livestock production and food security.

Although tangible progress is visible in the sector, it is also being confronted by increased livestock origin food demand due over increasing population, feeds and fodder scarcity, disease outbreaks, inadequate marketing, and changing climate. In this context a visionary priority research document appears, indeed, to be formulated immediately. BARC has come forward in preparing such a document following experts' consultation, listening to the root level producers, entrepreneurs, extension persons, and researchers, and reviewing related public documents, which makes it representative and far-reaching. This document spells out future research and policy support needs to address the upcoming challenges, and the way forward to achieve the goal of food and nutrition security with safe food.

I firmly believe that this compilation would be of great use to researchers, planners, policy-makers, investors, and other stakeholders involved in the sub-sector. I congratulate Dr. Shaikh Mohammad Bokhtiar, Executive Chairman, BARC, Dr. Md. Harunur Rashid, Director, PIU-BARC, and associates for their efforts in compiling this pragmatic document in the hope of making the country self-reliant in food and nutrition.

Joy Bangla, Joy Bangabandhu
Long live Bangladesh

Dr. Muhammad Abdur Razzaque, MP

Minister
Ministry of Fisheries and Livestock
Government of the People's Republic of Bangladesh

Message

I am delighted to know that Bangladesh Agricultural Research Council (BARC), an apex body of National Agricultural Research systems (NARS), has taken a noble initiative to publish a document on Bangladesh Livestock Research Priorities.

The Father of the Nation, Bangabandhu Sheikh Mujibur Rahman, strongly realized that development of Bangladesh is not possible without development of livestock sector. Therefore, after independence in 1971 he took many multidimensional initiatives and effective measures for the development of livestock as well as livelihood of the farmers. He believed in "Dudhe Bhate Banagle (Bangle Lives on rice with milk)". Evidently, he initiated a great program on up gradation of our local cows by world famous dairy breed – Holstein Friesian (HF). Accordingly, he brought some pure breeds of HF cows and bulls from Australia and put them at Savar dairy farm for R&D for higher milk production. Still now, we are getting benefits from the breed up gradation project. But, with the advancement of time, the situation is changing. Based on the country's current and emerging need, gene revolution and 4IR initiatives are in good progress under the dynamic leadership of the Honorable Prime Minister Sheikh Hasina. Government's strong political will and commitment, technological interventions and government's policy reforms have made an unprecedented success in livestock and food security.

Although much progress is visible in the livestock sector, but it is also being confronted by various challenges, of them increasing population, declining pastureland and climate change are important. Present document Research Priority in Bangladesh Livestock spells out what sorts of future research and policy support are to be undertaken address the challenges, and the way forwards to achieve food and nutrition security as well as safe food for all.

I believe this document will be very helpful and useful for researchers, planners, policymakers, investors, and other stakeholders. I express my sincere thanks and congratulations to the Executive Chairman, BARC and Director, PIU-BARC and the working team for their efforts and wisdom they paid to produce the Research Priority in Bangladesh livestock.

Joy Bangla, Joy Bangabandhu
Long live Bangladesh

SM Rezaul Karim, MP

Secretary
Ministry of Agriculture
Government of the People's Republic of Bangladesh

Message

Livestock in Bangladesh has made a noteworthy contribution to poverty alleviation and economic growth by ensuring food and nutrition security and expanding employment opportunities led by our Honorable Prime Minister Sheikh Hasina. At independence in 1971 we started voyage as a food deficit nation with a population of about 75 million but today with 169 million people, the country is sufficient in rice, potatoes, fish, meat, and egg but lags behind in milk. This has been possible due to apposite and timely implementation of livestock policies, production support and incentives, toiling farmers, and scaling up struggles.

However, the present transformation in the livestock sector is facing many challenges, notably population growth, shortage of feeds and fodder, diseases, marketing, and climate change which are to be softened to sustain food and nutrition security over time. To revert these challenges, the government has adopted productive national livestock policies and plans like National Livestock Breeding Policies 2007, National Poultry Development Policies 2008, 8th Five Year Plan 2020-25, Bangladesh Perspective Plan 2041, and Bangladesh Delta Plan 2100. Moreover, livestock technology innovation is in line with efforts to address the huge challenge of feeding the increasing population by producing increased milk, meat, and eggs.

Under the perspective, I am very happy to know that Bangladesh Agricultural Research Council (BARC) through National Agricultural Technology Program – Phase II project (NATP-2) has taken the initiative to publish a document titled Bangladesh Livestock Research Priorities. This is undoubtedly a great endeavor on research priority setting in livestock. Obviously, this would be very useful for present and future researchers to design their research experiments with an aim to attain sustainable and profitable livestock and poultry production with efficient use of natural resources. Policymakers would also be happy to find a readymade document with a direction outline of research issues to be attempted as per budget and significance.

Finally, I would like to express my sincere felicitation to Dr. Shaikh Mohammad Bokhtiar, Executive Chairman, BARC, and Dr. Md. Harunur Rashid, PIU-BARC, NATP-2, and his team for sketching out such an imperative document towards building a Smart Bangladesh by 2041 as the dream of the present government.

Wahida Akter

Joy Bangla
May Bangladesh live forever

Secretary
Ministry of Fisheries and Livestock
Government of the People's Republic of Bangladesh

Message

Bangladesh livestock has made a remarkable contribution to poverty alleviation and economic growth by ensuring food and nutrition security and expanding employment opportunities. The country started its voyage in 1971 as a food deficit country with a population of 75 million but today with 169 million people, the country is self-sufficient in meat and egg and almost sufficient in milk. This has been possible due to appropriate and timely implementation of various policies and production support of the government.

However, the present transformation in the livestock sector is not free from challenges, notably population growth, declining pastureland, climate vulnerability, fragile ecosystems, socio-economic factors and market price fluctuation. Of course, to address those challenges the government has taken up some productive national policies. Nevertheless, livestock technology innovation is also in line with the effort to address the great challenge of feeding the increasing population by producing milk, meat, and eggs.

Under the perspective I am very happy to know that Bangladesh Agricultural Research Council (BARC) through National Agricultural Technology, Phase-II is going to publish a document titled Bangladesh livestock Research Priorities. This is undoubtedly a great endeavor to produce an invaluable document on livestock priority research. Obviously, this would be very useful for the present and future researchers to design their research experiments with an aim to attain a sustainable, profitable and climate resilient livestock sub-sector.

At the last, I would like to express my sincere appreciation to Dr. Shaikh Mohammad Bokhtiar, Executive Chairman, BARC and Dr. Md. Harunur Rashid, PIU-BARC, NATP-2 and his team to prepare such an important document towards building a smart Bangladesh by 2041 as dream of the present government.

Joy Bangla

May Bangladesh Live Long

Dr. Nahid Rashid

Executive Chairman
Bangladesh Agricultural Research Council

Foreword

BARC has been functioning since its establishment in 1973 towards developing efficient, effective, and sustainable agricultural research management system covering crops-, livestock- and fisheries-subsectors for advancement of technological innovation and subsequent use. As a result of the farm friendly government's policies, enabling environment and continued support to R & D have contributed to today's incredible success in livestock. Under natural resources (soil, water, and forests) degrading and shrinking condition, climate change, ensuring nutrition security, increasing urbanization, significant food habits changes for ever-increasing population, requirement of more safe livestock produces is inevitable necessitates reshaping of livestock priority research.

It is anticipated that there is an opportunity of increasing livestock production in plain land ecosystem while more opportunity exists to increase in agro-ecologically constrained areas like Haor, Char, Barind, Coastal and Hill ecosystems. Nevertheless, presently our main goal is to address the current and emerging problems of each ecosystem through research and inventing pertinent technologies. More importantly, feed and breed together with efficient disease management approaches for both fragile and non-fragile ecosystems deserve due attention in view of providing nutritious and safe food for increasing population under changing climate. Also value addition and commercial farming need special care for livelihood improvement and employment opportunity.

I sincerely believe that this document would serve as a valuable guiding document for researchers, academicians, planners, policy makers, investors and other stakeholders.

Finally, I take this opportunity to extend cordial thanks to Dr. Md. Harunur Rashid, Director, PIU-BARC, NATP-2 and his team for their great endeavor in preparing this document focusing livestock priority research for technology innovations facilitating growth in livestock.

Joy Bangla
May Bangladesh live forever

Dr. Shaikh Mohammad Bokhtiar

Director
Project Implementation Unit
NATP-2 Project
Bangladesh Agricultural Research Council

Preface

This livestock sub-sector is potential to reduce poverty, end hunger, achieve food security and improved nutrition, and create employment opportunities. Evidently, the country has been transformed from a food deficit to a food sufficient country. Livestock policy reforms and technological innovations have played a great role in achieving such a paramount success. Nevertheless, the present transformation is likely to be threatened by several challenges and constraints. Scarcity of feed and fodder and sudden outbreaks of epidemic and trans-boundary diseases are some of the notable problems. Furthermore, climate vulnerability appears to be a challenging issue, the consequences of which are sea level rise, salinity, drought, and flood, threatening growth in livestock. However, to overcome those constraints there exist good opportunities in livestock diversification, agro-processing, value addition, commercialization, market intelligence, transformation in livestock sub-sector using 4IR, strengthening public-private partnerships, etc.

About a decade ago, BARC had produced a vision document, "Agricultural Research Vision 2030." However, meanwhile many problems and issues such as climate vulnerability and several national policy documents have been prepared which aim to transform Bangladesh into a middle-income country status by 2030 and a prosperous by 2041. Thus, identification and prioritization of research areas in livestock, are essential to undertake productive research program aligned with the different livestock related policies and related plans of the Government. Under the perspectives, the Project Implementation Unit (PIU), BARC under National Agricultural Technology Program (NATP) Phase II prepared this national document titled Bangladesh Livestock Research Priorities. This document would be a good basis for Government and donor's investment opportunities for future research program in livestock towards building a prosperous farm growth and sustaining livestock productivity.

Finally, I gratefully acknowledge Dr. Shaikh Mohammad Bokhtiar, Executive Chairman, BARC for his extreme support and cooperation in producing this precious document. The sincere support of the Director General and Director (Research) of BLRI and the DLS officials at different levels is also highly appreciated. I sincerely believe that the future researchers of BLRI and other organizations including NGOs and private sectors would come forward to undertake research program aligning this document and resolve various field problems to sustain food and nutrition security.

Dr. Md. Harunur Rashid

Joy Bangla
May Bangladesh live forever

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Abbreviation and Acronyms

4IR   The 4th Industrial Revolution
BARC   Bangladesh Agricultural Research Council
BAU   Bangladesh Agricultural University
BARD   Bangladesh Academy for Rural Development
BBS   Bangladesh Bureau of Statistics
BDP   Bangladesh Delta Plan
BIRDEM   Bangladesh Institute of Research and Rehabilitation in Diabetes
BPC   Bangladesh Planning Commission
BRAC   Bangladesh Rural Advancement Committee
BSMRAU   Bangabandhu Sheikh Mujibur Rahman Agricultural University
CHT   Chattagram Hill Tracks
CVASU   Chattogram Veterinary and Animal Sciences University
FAO   Food and Agriculture Organization of the United Nations
FYP   Five Year Plan
GDP   Gross Domestic Product
HSTU   Hajee Mohammad Danesh Science and Technology University
HRD   Human Resource Development
MoFL   Ministry of Fisheries and Livestock
IUBAT   International University of Business Agriculture and Technology
KGF   Krishi Gobeshona Foundation
NARS   National Agricultural Research System
NATP   National Agricultural Technology Program
NGO   Non-Government Organization
NRM   Natural Resource Management
OFRD   On-Farm Research Division
RDA   Rural Development Academy
RDRS   Rangpur Dinajpur Rural Service
RU   Rajshahi University
SAU   Sher-e-Bangla Agricultural University
SDG   Sustainable Development Goal
SWOT   Strengths, Weaknesses, Opportunities and Threats
UNEP   United Nations Environment Programme
WB   World Bank
WHO   World Health Organization

Units
g: Gram, kg: Kilogram, M t: Million ton

Preamble

The livestock sub-sector is potential for resolving malnutrition, unemployment, women empowerment, restoring soil fertility towards making a nutrition rich food reliant talent nation and earning foreign exchange. It has been playing an imperative role in Bangladesh economy. Its products like milk, meat, and eggs are premium quality protein sources, which are playing a pivotal role in meeting the nutritional demands in every body's daily life. The sub-sector since from its inception is efficaciously working on livestock disease management and prevention, productivity increase, entrepreneurship development and skill enhancement, livestock based nutrition improvement, animal origin food chain and market management. Now a days, the public and private sectors are working together to the country self-reliant with adequate and safe milk, meat, and eggs. Contribution of livestock sub-sector has been swelling along with employment opportunities and production. According to the Department of Livestock Services (DLS) report on Livestock Economy (http://www.dls.gov.bd/site/page/22b1143b-9323-44f8-bfd8 647087828c9b/Livestock-Economy), in 2022-23, the contribution of livestock in the Gross Domestic Product (GDP) of Bangladesh was 1.85% with GDP growth at 3.23%. Approximately, 20% of the population directly and 50% of the population partly are engaged with the livestock production related activities. The production of milk, meat and eggs increased from 5.07 million ton (M t), 3.62 (M t) and 7,617.40 million, in 2012-13 to 14.07 M t, 8.71 M t and 23,376.30 million, respectively, in 2022-23. The same report shows that in 2022-23, against the per capita requirement of 250 ml/day, 120 g/day and 104 per year for milk, meat and eggs, the availability was 221.9 ml/day, 137.4 g/day and 135 per capita, respectively. Demands of animal origin food are soaring due to rapid economic development, reduction of hardcore poor, and health consciousness among the people (Daily Star, 22 June 2022). In the context of increased demand for milk, meat and eggs, science based modern technologies development initiatives demand immediate attention to accelerate breed development endeavors for upgradation of local breeds with due coverage on animal production, disease prevention and health improvement.

The key challenges of livestock production are scarcity of feeds and fodder, scarcity in scientific knowledge on using agricultural and industrial by-products as feed, poor marketing channel and delivery services, diseases management including the transboundary ones, inadequare government regulation on imported feed ingredients and taxation on imported milk powder, incorrect upgradation of local breeds, and poor waste management. Due to sudden attack of Covid-19, livestock sub-sector suffered from a huge loss. Every small and large farm suffered immensely from the disruption of supply chain and sales. Importantly, weak supply and sales system are noticed as the main bottlenecks to flourish livestock sector, even at the usual time. Bangladesh Dairy Farmers Association claimed that nearly 12 million litres of milk were unsold at the very onset of pandemics. Other producers' associations also claimed their losses at the same time. Therefore, ensuring a smart supply chain system appeared as a decisive driver for the success of the sub-sector.

Background

There is a great need for increasing food production to feed the projected population of 184 million in 2030, 197 million in 2040, 204 million in 2050 and 176 million in 2100 (Fig. 1). It is anticipated that total food production needs to be increased by 29% in 2030, 43% in 2050 and 24% in 2100 if not otherwise constrained by severe impact of climate change (Bokhtiar and Samsuzzaman, 2023).

Fig. 1 Population and food production projection of Bangladesh up to 2100
Source: FAO and WHO (2014), BIRDEM (2013), UNEP (2021)

There is a high concern to meet the demand for milk, meat and eggs for the increasing population (currently 169 million) of the country under the scenario of decreasing natural resource base such as soil is degrading, agricultural land is shrinking (0.24% per year) (Bokhtiar and Samsuzzaman, 2023) and availability of water is declining. Now, the main plain lands of the country are the major harbor of livestock and poultry. Besides the above constraints, the country has fragile ecosystems which are affected by climate change induced floods, droughts and salinity. The future food and nutrition security depends on how effectively, with maximum possible ways, these ecologically challenged areas (haors, charlands, barind, coastal and hills) are brought under livestock production systems. As such due policies and planning, and research priority setting could be the instruemtal for improved and sustained livestock production. Livestock research and development initiatives in Bangladesh should also be directed to develop climate resilient and location specific cattle breeds using the locally available breeds like Pabna, Munshiganj (Mir Kadim), Red Chittagong and North Bengal Gray

breed. Simultaneous attention also should be paid for the development of suitable sheep, goats and poultry breeds of using local genetic resources.

Bangladesh Agricultural Research Council (BARC), as an apex body of the National Agricultural Research System (NARS), has the mandated functions to plan, execute, coordinate, monitor, and evaluate agricultural research as per national needs. BARC formulated research and strategic plans in the past with a view to warrant such as sustainable and improved agricultural production in crops, livestock and fisheries sub-csectors to satisfy the peoples requirement of balanced. Unfortunately, the strategies and research programs so far formulated are not followed according to address the location specific problems/constraints identified and consequently the desired goals are not achieved in the sub-sector.

The BARC has implemented the National Agricultural Technology Program (NATP) phase I and II project funded by the World Bank and IFAD. The first and second phase of NATP was designed for 2007 to 2014 and 2015 to 2023, respectively. During the first phase, a document on priority setting in agricultural (crops, livestock and fisheries) research vision 2030 was published in 2012. Recently, the PIU-BARC, NATP Phase II has prepared "Bangladesh Agricultural Research Vision – 2041", which highlights research priorities in Agricultural sector in general to update the previous document considering present and future scenarios. In this context, identification and prioritization of the specific researchable areas/issues under livestock sub-sector are essential for best utilization of the available natural resources to ensure variable production and increasing productivity.

This document would serve as a good guide for planning research and undertaking action plan to be implemented by BLRI, the only NARS institute for livestock sub-sector, along with BARC. It would obviously be useful in undertaking future livestock research by other institutes and government agencies (Universities, NGOs, NIB, etc.). Some national and international NGOs are actively engaged in the improvement of Bangladesh's livestock sub-sector alongside the public bodies. Beside private sector plays a significant role in the economic development of Bangladesh through contribution to livestock production, investment and export. Based on this current document, both the public and private institutes can revise their Master Plans and execute livestock research activities accordingly. It could also serve as a good basis for planning private and donor's investment opportunities for future research program in livestock production and development.

Rationale
To slacken climate risks and environmental losses in the vulnerable areas, the government of Bangladesh is committed to identify and prioritize investable sectors for transforming existing innumerable pitfalls into possibilities and potentials. This entails devising research priority areas.

Research priority setting in livestock is a dynamic process. This certainly entails devising priority research areas bearing the idea in mind that research priority setting in livestock is a dynamic process. This is required to adjust with the contextual and

temporal changes to undertake demand-driven research to address the need of the technology users. BARC prepared vision document titled Agricultural Research Vision: 2030 is being followed in planning research and execution by the NARS institutes and the universities. With the advancement of time and contextual change, this document needs updating under the situation of climate change, emerging cropping and livestock systems, food demand, government planning and thrust and socio-economic changes. Thus, research priority setting deserves due attention taking into account of the opportunities of achieving higher productivity and profitability through efficient natural resources management (NRM). The efficient NRM requires efficient, judicious, and scientific utilization of agricultural and industrial by-products (e.g. rice straw, wheat straw, fishmeal, etc.) as animal feed, cultivation of leguminous fodder with rice, adoption of Good Animal Husbandry Practices (GAHP), and effective market intelligens and linkages. In hoarding a well thought and representative document with a high insideness, a high inclusiveness of stakeholders is indeed desired. Such a requirement is fulfilled uniquely with bottom up (stakeholders' consultation) and top down approaches (consulting public policies and plans) in drafting present documents unlike the previous one titled "Research Priorities in Livestock - Vision 2030, in which case only top down (policies) tacties was followed. The detailed procedure has been described in the methodology section.

Objectives

The broad objective of preparing this document is to prepare a priority list for livestock research under key thematic areas and researchable issues as a guidance for future researchers, policy makers and donors towards building sustainable livestock production systems and ultimately a vibrant farm growth.

The specific objectives include :

- Identify and prioritize research areas based on research type (basic, applied and strategic), importance (high, medium and low) and tenure (short, medium and long term) ; and

- Facilitate ensuring livestock productiviy and growth animal origin nutrition and livelihood improvement.

Livestock Status in Bangladesh

Livestock develoment activities has been ensued during British colonial rule. In pre-independent India, Lord Linlithgow brought some Hariana cattle for improvement of the indigenous cattle. After the partition of India in 1947, several breeds of cattle such as Sindhi, Shahiwal, Tharparkar, etc. were brought to this region. In 1958, the artificial insemination program started to improve local breeds. From 1969 to 1982, German specialists worked with the Savar Dairy Farm to evolve suitable breeds for draft and milk purposes. In 1974, the Australian Government donated milk cows and breeding bulls of the Holstein-Friesian variety to Bangladesh. In addition, frozen semen of Bos taurus was imported from Germany, America, France, Australia, and Japan for use and improvement of local cattle. In collaboration with Japan International Cooperation Agency (JAICA), embryo transfer programs were successfully conducted by the scientists of both the countries (Bangladesh and Japan). Despite these efforts, the success in cattle wealth improvement of the country was not very encouraging.

The breeds of livestock available in Bangladesh are given below:

A. **Cattle:** (i) Local breed of cattle include non-descript indigenous type, Red Chittagong Cattle, Goyal, Pabna, Munshiganj (Mir Kadim) and North Bengal Gray Cow; (ii) Exotic breed include Hariana, Sindhi, Shahiwal, Jersey and Holstien-Friesian;

B. **Buffalo:** (i) River type, (ii) Swamp type, (iii) River-Swamp type ;

C. **Goat:** (i) Black Bengal, (ii) Jamuna Pari, (iii) Crossbred- Black Bengal with Jamuna Pari;

D. **Sheep:** (i) non-descript indigenous type and Garole (ii) Crossbred- local breed crossed with different exotic breeds, one of them is the famous Muzaffarnagari crossbreed sheep called locally, by mistake, as "Garol".

E. **Poultry:** (i) non-descript indigenous type - Asseel, Chittagong Fowl, Guine Fowl and Naked Neck; (ii) Exotic: White Leghorn, Rhode Island Red, Fayomi, Australop, several commercial broiler and layer breeds; (iii) Crossbreed: Indigenous with Exotic;

F. **Duck:** (i) Local: non-descript indigenous type, Sylhet Mete, Nageswari, Muscovy, different types of Geese; (ii) Exotic: Khaki Campbell, Indian Runner, Jinding, Cherry Valley; (iii) Crossbreed: Indigenous with Exotic;

G. **Pigeon:** There are 17 species, of which 2 are migratory. The resident species are Emerald Dove (Chalcophaps indica), Rock Pigeon (Columba livia), Pale-capped Pigeon (C. punicea), Green Imperial Pigeon (Duculaaenea), Mountain Imperial;

H. **Pig:** non-descript indigenous type.

The above mentioned picture is an indication that the country is fortunate to have a splendid volume of animal genetic resources.

The Government has established farms for improvement of Black Bengal goats in the country. Improved variety of bucks (male goats) is distributed in villages amongst selected farmers. Improved variety of female goats is distributed to landless poor women for augmenting their income. Alongside the public sector, there are entrepreneurs in the private sector who own and manage different farms on a commercial basis.

Local breeds of poultry are small and poor in egg production. The Government has established many poultry and duck farms in many places of the country. In the mid-eighties Backyard Poultry Porgrams was introduced with the financial assistance of UNICEF. Seven poultry units have been established with the assistance of the Netherlands Government. Two crossbred poultry farms, 'Rupali' (WLH Cock crossed with Fayomi Hen) and 'Sonali' (RIR Cock crossed with Fayomi Hen) have successfully been evolved for raising under rural conditions. Under the supervision of DLS, the Government has also established duck farm at Narayanganj and buffalo farm at Bagerhat for Research and Development.

Many commercial poultry breeds have successfully been established in recent years in Bangladesh and are profitably utilized by different entrepreneurs. Due to extension programs undertaken by the Government and poultry entrepreneurs, the number of poultry farms in the country are increasing steadily.

Transformation in Livestock sub-sector

Livestock production in the country has gone through a process of transformation over time transforming from subsistence and farm centered towards more commercialized, productive and off-farm centered. Bangladesh, after achieving food security, is currently giving a special emphasis on the production of nutritious and safe food. The Fourth Industrial Revolution (4IR) also has given much attention in livestock production as it can help in precision farming techniques by advanced use of smart sensors in detecting heat in cows and buffaloes (to aid in timely breeding of animals using artificial insemination technic). The 4IR also helps in management of commercial dairy and poultry farms ensuring controlled greenhouse gas emissions and reducing the necessity of monitoring by humans in different operations (Sattar, 2023).

In concurrence with self-sufficiency in rice production, the livestock production system is gradually transformed from subsistence to commercial farming. It is apparent that many farmers are giving importance, after rice, to dairy, poultry and beef cattle production having relatively commercial advantages (Razzaque and Hossain, 2007). Commercialization can be achieved by promotion of value addition to livestock commodities, particularly dairy (e.g. dahi, ice cream, butter, ghee, etc.), poultry products (e.g. nuget, meat ball, tanduri chicken, dehydrated chicken soup mix, chicken sausage, etc.) and eggs (e.g. whole egg powder, brined and pickled egg, egg roll, egg souffle, etc.). This value addition supports to agri-businesses and links farmers with local and international markets (World Bank, 2009). The National Agricultural Technology Project (NATP) of Bangladesh, financed by WB and IFAD, has integrated small and marginal farmers who produce rice, maize, fruits, vegetables, livestock,

fisheries, etc. into value chains. The aim is that farmers can produce more products to meet the domestic demand and can export some portion of their products in other countries in the world (MoA, 2014). Nevertheless, commercial farming is in the hand of entrepreneurs and large farmers who will act as key players to control the market.

Achievement in Livestock

Analysis of the trend of production of milk, meat and eggs, as depicted in the DLS report under "Livestock Economy at a Glance" (www.dls.gov.bd/site/page/22b1143b-9323-44f8-bfd8-647087828c9b/ Livestock-Economy), indicates that the production has nearly been tripled in Bangladesh within ten years' time. Milk production has been increased from 5.07 M t in 2012-2013 to 14.07 M t in 2022-2023. Similarly, meat production has been increased from 3.62 M t in 2012-2013 to 8.71 M t in 2022-23 and egg production from 7,617 million in 2012-2013 to 23,376 million numbers in 2022-23. Drivers behind this achievement include resilient farmers, commitments of the public sectors and stringent Government policies for the development of livestock and poultry together with urbanization, increased per capita income and health consciousness of the general people. Embargo on the export of cattle from the neighbouring country to Bangladesh also has prompted farmers to invest more in beef cattle farming and achieving sufficiency in meat production.

Highlights of national livestock policies and plans

The livestock policies have been reconciled by three basic needs: the production of animal origin food and its products, the protection of the organic green environment and the maintenance of socio-economic structure of the country. However, these have been reviewed with salient features as follows:

Livestock policies
An overview of major goals and thrusts of various policies in livestock formulated by the Ministry of Fisheries and Livestock (MoFL), Government of the people's republic of Bangladesh is presented below:

Sl No.	Name of policy	Policy information
1	National Livestock Breeding Policy 2007	First National Breeding Policy was adopted in the year 1982 with emphasis given on both selective and crossbreeding/up-grading program particularly in cattle to meet up country's growing demand for milk and meat. Later on, this policy was revised in the year 2007 with clear animal breeding guidelines and directions known as "National Livestock Breeding Policy 2007". This breeding policy categorized three distinct breeding goals (short, medium and long term) for cattle, which are coherent with existing production systems in the country.

Sl No.	Name of policy	Policy information
2.	National Livestock Development Policy 2007	The Livestock Development Policy 2007 was prepared with the objectives to promote sustainable improvements in productivity of milk, meat and egg production including processing and value addition; to promote sustained improvements in income, nutrition, and employment for the landless, small and marginal farmers; and to facilitate increased private sector participation and investments in livestock production, livestock services, market development and export of livestock products and by-products.
3.	National Poultry Development Policy 2008	It was formulated to encourage poultry industry and qulity control of inputs for sustainable poultry development through the development of new poultry breeds, conservation of local genetic resources, introduction of better health management systems, attainig selfsufficiency in poultry feed procuction, etc.

Livestock related visions and plans

The visions and plans related to livestock focus to ensure food and nutrition security, sustainable livestock production and commercialization, and improvement of livelihood through technological innovations. It also put emphasis on the following:

- Improving individual and community capabilities to develop and manage income-generating activities through raising livestock ;
- Technical and social development training programs ;
- Microfinance and technical services for livestock enterprise development ;
- Building capacity of the Department of Livestock Services ; and
- Supporting the project's implementing and management agencies.

An overview of major goals and thrusts of various plans and visions related to livestock production formulated by the different government agencies is presented below:

i. Livestock Sector Priorities

Livestock is one of the fastest growing industries in Bangladesh, contributing about 2 percent to the country's GDP and more than 16 percent to the agriculture sector in FY 2022-23. Due to the Government support, improved veterinary care, artificial insemination to increase production, the use of automation and technology in the farms, and increased investment, the number of livestock is constantly increasing and the growth of the sector is accelerating. In FY 2021-22, the total number of livestock in Bangladesh exceeded 430 million. As a result, Bangladesh is now self-sufficient in meat, milk and egg (Bokhtiar and Samsuzzaman, 2023; Hossain 2023). Consequently, the Government priorities now are:

a. Promote sustainable improvements in the production of milk, meat and eggs including processing and value addition
b. Promote sustained improvements in income, nutrition, and employment for the landless, small and marginal farmers and
c. Facilitate increased private sector participation and investments in livestock production, livestock services, market development and export of livestock products and by-products.

Other priorities are:

a. Create opportunities for sustainable livestock and poultry production, and green growth
b. Livestock zoning, and promotion of precision livestock farming
c. Promote livestock diversification
d. Introduce and popularize good animal husbandry practices (GAHP)
e. Livestock and poultry farm digitalization
f. Post-harvest management and value chain development of livestock and poultry products

ii. Vision 2041- Perspective Plan of Bangladesh 2021-2041

The Government adopted Bangladesh Vision 2041 and the associated Perspective Plan 2021-2041 (PP2021-41) for setting up the road map for the promotion of Bangladesh to an Upper Middle-Income Country (UMIC) eliminating extreme poverty by FY 2031, and to a High-Income Country (HIC) status by FY 2041. Vision 2041 or PP2021-41 was formulated in March 2020 (BPC, 2020).

The 'Vision 2041' has been adopted in line with the 'Vision 2021' to provide impetus to the development dreams of the nation. Its aim is to end absolute poverty and to be graduated into higher middle-income status by 2031, and eradicate poverty on way to becoming a developed nation by 2041. Livestock may contribute to food security through increased output of livestock products and the creation of employment and income generation that may assure access of people to food. The document therefore focuses on increasing resilience of livestock production system in the face of climate change and diversification in livestock produces and livelihood involving improved breeds of animals, off farm activities and employment generation.

iii. Eighth Five Year Plan 2020-25 (8th FYP)

The key focus of 8th FYP during the 2020-2025 period is creation of sustainable jobs and reduction of poverty for inclusive growth. The objectives of the 8th FYP for the livestock sub-sector are to meet the increasing demand of animal protein by sustainably enhancing production, productivity and value addition of milk, meat and eggs.

The 8th FYP also emphasizes on promotion of agricultural research with a particular focus on the followings:

a. Developing and refining technologies that will bridge yield gaps and promote diversification and intensification of animal and poultry products ;
b. Animal disease management ;
c. Development of breeds with postharvest technology of high value livestock commodities like milk, meat and eggs ;
d. Research on packaging, food processing, market intelligence and food technology ;
e. Biotechnology and biosecurity will be specially emphasized along with other contemporary issues; and
f. Frontier researches like genomics and phenomics, vertical farming and mechanization.

iv. Bangladesh Delta Plan 2100 (BDP 2100)

BDP 2100 has been formulated as an adaptive, general, holistic and long-term integrated plan to steer the opportunities and vulnerabilities created by the interface of water, climate change, natural disasters, environment, ecological balance, agriculture, livestock, fisheries, land use and inland water management for national development (BPC, 2018). Sustainable use of water resources and prevention of water-related natural disasters provide the backbone to the Delta Plan. BDP 2100 will also help the country achieve sustainable livestock production through the following specific activities:

a. Production of climate resilient livestock (e.g. Buffalo) and development of climate resilient poultry breeds ;
b. Improvement of livestock for food security, nutrition and livelihood especially, of the tribal/minor races people through integrated livestock projects ;
c. Integrated livestock development in the coastal areas ;
d. Establishment of Institute of livestock Science and Technology Project in Sylhet, Lalmonirhat/ Kurigram and Barishal District ;
e. Artificial Insemination (AI) Activities through Extension and Embryo Transfer Technology Implementation Project ; and
f. Renewable energy projects.

v. Bangladesh Agricultural Research Vision 2030

BARC in 2011, prepared a Vision Document 2023 as a guide for agricultural research that significantly contributed to the development of appropriate technologies by NARS institutes, agricultural universities and private organizations, and its adoption by farmers. Thereafter, in 2012, BARC, with financial support from the National Agricultural Technology Project (Phase-1) financed by the World Bank, prepared the Vision Document 2030 for agricultural research in Bangladesh (BARC, 2012). This Vision document points out the overall research needs based on key challenges in developing and scaling up the agricultural technologies through harnessing the power of science for higher and sustainable agricultural production to meet the demand of the country up to 2030 and beyond. Among the visions that are directly linked to the livestock sub-sector include the followings:

- Enhance productivity of the livestock and poultry products through improvement in the genetic capacity and breeding process combining with biotechnology;
- Enhance productivity through improving efficiency of feed and feeding system;
- Animal health protection, prevention and production of drugs, vaccines and phamaceuticals for increased production;
- Enhancing the capacity of small, marginal and landless farmers through technology innovations;
- Biosafety and climate change vulnerability;
- Livestock diversification and control of environmental pollution;
- Production of improved quality, safe and low-cost food;
- Strengthening institutional capacity, ploicy reform and implementation;
- Human resource development to harness the growing opportunities;
- Foster linkage and collaboration with public and private organizations at national and international level.

vi. SDG 2015-2030

The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by the United Nations in 2015 as a universal call for action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity. Out of the 17 SDGs, the livestock sector has critical roles to play in attaining goals 2 and 3 in relation to food and nutrition security. Animal health and animal welfare concerns mainly SDGs 2 and 3 because it addresses the crucial interface of animal and human health, where issues of zoonoses, food-borne diseases and antimicrobial resistance are major challenges to sustainability, which must be addressed. Livelihoods and economic growth relate to the SDGs 1, 8 and 12 that in turn also relates to livestock sector as the world's poor people depend directly on livestock for their livelihoods. Moreover, for the poor, livestock often provide a route to move out of the sector and into prosperous alternate livelihoods (Tarawali et al., 2019). For achieving the SDGs 12, 13 and 15 that relate to climate and natural resourceuse, livestock sector can contribute significantly. Addressing animal health challenges through robust animal health services is one of the key ways of improving animal production efficiency as healthier animals emit less greenhouse gases (Skuce et al., 2016). Limiting waste and losses along the supply chain can contribute to improved efficiency and sustainability and thus reduce the environmental impacts per unit of livestock commodity (FAO, 2011). Livestock also have the potential to play greater roles in waste reduction through their contributions to a 'circular bioeconomy', which includes bio-based products, utilisation of organic waste streams, resource efficient value chains, organic recycling, and nutrient cycling (Carus and Dammer, 2018).

vii. Master plan for Agricultural Development in the Southern Region of Bangladesh 2012

The relevant issues in the plan that relate to livestock sub-sector include :
a. Increasing agricultural productivity.
b. Promoting smallholder poultry and dairy development.
c. Promoting agribusiness development through improving agricultural marketing and through value addition activities.

Livestock Research in Bangladesh

Food safety, diversification of inputs and products, value addition, counseling of farmers and entrepreneurs are the activities of the research institutes have emerged with the on-going process of transformation of subsistence livestock into input supported commercial systems. Livestock research has been carried out within the framework of the livestock policy of the Government. Bangladesh Livestock Research Institute (BLRI) is the only NARS institute which has been playing a pioneer role in research. In the future, animal products can be a huge exportable items like the garment industry because, there is now a huge demand for meat from food animals in the global market. If meat, eggs and milk are exported on a large scale, the volume of production of these industries will increase massively with the creation of new jobs for a large number of unemployed youths. Therefore, Bangladesh's livestock sector needs to be transformed into an industry-oriented sector through developing improved technologies from the research institutes. This will increase the versatile production of milk, eggs and meat.

Research at NARS institutes

Salient research highlights and contributions of the NARS institutes are outlined below.

Bangladesh Agricultural Research Council (BARC): It is a public body mandated to coordinate, monitor and evaluate the research program of the NARS institutes and other associated organizations. It formulates national agricultural research plans and oversees their implementation. It takes care of Human Resource Development (HRD) through arranging higher studies and training for agricultural scientists.

BARC coordinated the formulation of National Agriculture Policy 2018, which facilitated for outlining an action plan for achieving SDG Goal-2 and '8th Five Year Plan (2020-2025)'. In 2012, the organization prepared "Agricultural Research Vision 2030". It has facilitated development of more than 50 promising technologies in crops, livestock and fisheries. It also acts as a bridge to disseminate the technology transfer from research organizations to the extension agencies.

Bangladesh Livestock Research Institute (BLRI): It is an autonomous public research institution for livestock improvement. The institute is responsible to identify the livestock and poultry production constraints at the national and farm level, seek solutions to those problems through multi and inter-disciplinary and inter-institutional research and to develop technologies to enhance food and nutrition security. These technologies also have contributed to poverty alleviation, employment and income generation, and reduced environmental pollution. BLRI has so far developed 93 technologies, out of which 74 are varietal technologies and 19 are management technologies (BLRI, 2022). In 2014, it developed a new breed of layer chicken whose sex was discernable at day one of their life. Among others, it has also developed cattle feed from moringa leaf and vegetable waste. Recent achievements are (a) "BLRI Meat Chicken – 1 (Shubarna)", (b) development of salt tolerant Napier grass, (c) production of milk (5-7 kg) from crossbred cows only on green grass without concentrate, (f) establishment of Semen Bank specially for preservation of high performaning local genetic resources.

Research setups under the Department of Livestock Services (DLS)

Central Cattle Breeding Station (CCBS) and Dairy Farm

CCBS and dairy farm is the state-run cattle breeding farm and research centre under DLS. This farm was established in 1959 with major research area including development of cattle breeds as per the climatic condition of the country. Its achievements include (i) rearing of superior bull calf for production of breeding bull (ii) production of safe and hygienic milk and (iii) conservation of local genetic resources. Embryo transfer protocol was established at this farm. The farm produces 2000 tons of maize every year as fodder.

Livestock Research Institute (LRI):

The LRI is a livestock vaccine producing and research organization of the country under DLS. Besides the production of vaccines, it is responsible for quality testing and conservation of master vaccine seeds. The institute also conducts research programs in collaboration with various research institutes for the development of new and effective vaccine seeds as per needs of the country to develop vaccines for the control of animal diseases.

Central Disease Investigation Laboratory (CDIL) and Field Disease Investigation Laboratories (FDIL)
The CDIL and FDILs under DLS are the network of animal health sector laboratories spreading throughout Bangladesh. The CDIL situated in Dhaka and the FDILs spreading over 11 strategic regions are responsible for investigation of the outbreak of diseases (including emerging and reemerging diseases) in animals with special emphasis to food animals in the country. The laboratories are also responsible for conducting surveillance study of the diseases that are zoonotic in nature (Avian influenza, Anthrax, Rabies, etc.) including the surveillance of antimicrobial resistance (AMR) in organisms found in food animals that has the potential of polluting the environment and transmitting to humans.

Quality Control (QC) Laboratory

The Quality Control Laboratory under DLS is a newly established laboratory situated in Savar, Dhaka. The laboratory with the modern equipment is responsible for testing animal origin foods (milk, meat and eggs) including value-added animal products and by-products. The laboratory is also responsible for testing the quality of livestock feeds to ensure production of milk, meat and eggs with adequate food value and nutrition. The newly established laboratory is planning to collect milk, meat, eggs and feed samples from across the country for analyzing the nutritional values of the products as well as to ensure that adulteration free animal products are reaching the consumers.

Research at Universities

At present, there are 54 public universities and 127 private universities along with eight agricultural universities. Among these, nine public and one private university are carrying outresearch in connection with post-graduate students' thesis and contract research projects on livestock production. Among them, Chattogram Veterinary and Animal Sciences University (CVASU) is on the top, which started developing technologies in livestock areas in early 2010s. CVASU released 5 management technologies related to livestock during 2011-2020 (Bokhtiar and Samsuzzaman, 2023).

Research at other organizations:

National Institute of Biotechnology (NIB)

NIB is an autonomous body under the Ministry of Science & Technology. It is a very dedicated organization that focus on biotechnology research, frontier sciences' training, technology transfer and awareness creation on biotechnology products and processes. Animal biotechnology under NIB is a specialized branch that encompasses a broad range of techniques for the genetic improvement of animal species, animal feed, development of vaccines, biologics, diagnostic kits etc. The objectives of the animal biotechnology are application of biotechnological approaches for enhanced production, productivity, quality and value of animal products leading to sustained food security, poverty alleviation and livelihood improvement, conservation of animal genetic resources for biodiversity and sustainable exploitation in the biotech industries.

Rural Development Academy (RDA), Bogura is a specialized national institution engaged in rural development through training, extension and action research. It also offers post graduate diplomas. RDA has conducted a good number of action research covering a wide range of areas related to livestock and rural development. It has developed vertical livestock farming with scientific management of animal waste for power generation.

Bangladesh Academy for Rural Development (BARD) at Cumilla conducts training and action research related to livestock and poultry in rural development. One of the priority programs is expansion of advanced agricultural technology. BARD facilitates farming that is managed through research for development of "social enterprise" consisting of farmers.

Research at NGOs and companies

There are only a few NGOs in Bangladesh that promote livestock research and development such as RDRS, Lal-Teer, PROSHIKA, CARE International, etc. NGOs also deliver extension services.

RDRS Bangladesh: It works with farmers for crop improvement, cropping patterns, quality seed production, rice seed banks, soil fertility, livestock feed, fish production etc. RDRS facilitated farmers in conducting experiments involving students, scientists and teachers in collaboration with NARS institutes like BRRI and BARI, and universities like BAU, BSMRAU and HSTU through Memorandum of Understanding. Most important demand led and need-based technologies were piloted for dissemination through the farmer groups.

Lal-Teer: This is an emerging and promising private company, which is doing research mainly on animal reproduction. They have a separate wing of R & D for semen evaluation, bull evaluation and reproductive performance evaluation of cattle and buffalo. Lal-Teer   is also importing high performance Murrah Buffalo semen from Pakistan to upgrade local Buffalo population.

Major Problems of Livestock Sub-sector

Cattle, buffalo, sheep, goats and poultry, that include also ducks, are the major livestock resources in Bangladesh. Their production performance is hampered by various reasons. Scarcity of feeds and fodder aggravated by loss of grazing land, biodiversity loss of fodder, conflict with other sub-sector for land use, lack of availability of high-yielding animal breeds and also the lack of knowledge and technological know-how of maintaining the high-yielding breed are the major bottlenecks in livestock production. The livestock growth has been slow due to the following reasons :

  a. High morbidity and mortality in animals due to diseases,
  b. High cost of treatment and disease contorl,
  c. Increased number of poorly managed unhealthy livestock,
  d. Animals affected with zoonotic disaeeases that threatens public health,
  e. Ill-informed/indiscriminate use of antimicrobials by the farmers (without the prescription of a registered veterinarians), which contributes to antimicrobial resistance (AMR) ; and
  f. The persistance of antibiotic residues in livestock products, etc.

Besides, poor market infrastructure, fragile marketing channel, middle-man dominated marketing system of livestock produces, etc. are the hurdles to be addresed. Moreover, poor research infrastructure in the livestock sub-sector is also considered to be a major problem that is hindering the smooth progress of livestock sub-sector through research backups. Policy and institutional reforms of the Department of Livestock Services (DLS) and its functional arms are of critical importance to induce changes necessary to meet the emmerging challenges caused by globalization, trade liberalization and WTO regulations (BIDS, 2023).

Feeds and fodder
It is the main contraint for livestock and poultry production. As per Sarker et al. (2019), on an average, 56.2% deficit of roughage dry matter (DM) and 80% concentrate DM result in a very poor plane of nutrition for farm animals under low input and mixed farming system. The recent growth rate of livestock are not matching with the requirement of feeds and fodder in the country in general. According to them, the net availability of green grass including cut and carry systems and grazing on natural grasses is not more than 2.5 kg fresh/h/day. The present poor plane of nutrition is not conducive to support an increased production of local and crossbred animals under smallholder farming system although scenerio of limited specialized farm is different. Commercial poultry is largely based on imported feeds except that a part of it is mixed with corn and the country's maize cultivation contributes to providing corn.

Breed

About 85% of cattle are indigenous in origin, small in size and low in production, but these are heat and disease resistant and can survive under fluctuating nutrient supply. Some of these like Red Chittagong, Pabna, North Bengal Grey and Munshiganj are far

better producer than the others in the existing low input management system. With rapid expansion of crossbreeding and urbanization, the indigenous cattle genetic resources of Bangladesh are under threat of extinction. Conservation of promising indigenous cattle genetic resources through pure breeding program and farmer managed *in situ* approach may be an appropriate approach for cattle development and rural livelihood enhancement in Bangladesh. In addition, up gradation of local breed with Asiatic and temperate breed may be taken with limited scale for increased production.

Productivity/reproduction disorders

The reproductive disorders are major causes of reduced fertility in cows that results in failure to produce or delay in producing the total annual calves. Overall, prevalence of reproductive disorders are 23% and among the disorders, occurrence of anoestrus is 5.1%, retained placenta 4.6%, metritis 4.4%, repeat breeder 3.7%, poor heat detection 1.6%, ovarian cyst 0.4%, dystocia 1.0% and pyometra 0.2%. (Talukdar et. al., 2005). Anoestrus and repeat breeding should get top priority considering reproductive diseases and disorders research to gain more knowledge to control these problems. Some times, farmers are unable to detect the heat of their animals.

Marketing of livestock and poultry products

Lack of organized market for selling farm produce is an important hastle. Marketing of livestock and products is a complicated system because many factors intervene the process of sale. Lack of infrastructure, transportation, funds and limited market information access lead to high marketing cost, which reduces access to formal markets and limits the opportunities to develop a successful strategy. In addition, limited extension and veterinary services are negatively impacting the sub-sectoral growth.

Disease incidence

Most local animals are weak, unhealthy, emaciated and their productive and reproductive performances are not satisfactory due to various disease infection and disorders. According to Nahian et al. (2017), among the clinical cases, endoparasitic infestation was the highest (15.56%) in all recorded cases. Moreover, there were prevelance of diseases like FMD (8.89%), bovine ephemeral fever (7.78%), diarrhea/enteritis (7.78%), mastitis (4.44 %), black quarter (1.11%), pneumonia (2.22 %), rabies (2.22%), myiasis (3.33%), ectoparasitic infestation (5.56%), bloat (6.67%), ruminal acidosis (4.44%), retention of placenta (2.22%), wound (2.22%), anoestrus (4.44%), dermatitis (3.33%) and dermatophytosis (2.22%). It was also reported by them that local breeds (78.89%) were highly susceptible than cross breeds (21.11%) of cattle. In relation to age, adult cattle (40%) were found more infected with diseases and disorders compared to calf (25.56%) and growing age (34.44%) cattle. Pandemic, epidemic and transboundry diseases along with nutritional diseases and disorders of large animals and poultry are also the problems. Loss of production was about 15% due to disease. They suggested that immunoprophylaxis and hygienic management should be initiated to curb the prevalence of common diseases and disorders in cattle.

Fragile Ecosystems

The five "hotspots" or fragile ecosystems of Bangladesh as described in Bangladesh Delta Plan 2100 are vulnerable due to climatic factors and geographical position affecting the livestock and poultry production greatly (BPC, 2018). The related features of all the hotspots has clearly been mentioned in the document which is beyond in the scope of detailing. Different hotspots are described below with limitations in livestock production.

a) Haor ecosystem

Haor is mostly populated by poor, disadvantaged and vulnerable groups of people living in flood-prone areas, and lacking access to basic services including education, employment opportunities and decent living standards. Road connectivity along with the transportation system is a serious limitation here. Flashflood is a common phenomenon in haor areas, which is occurring due to excessive rainfall and climate change. Consequently, agricultural loss, damage of home, diseases of livestock and health problems are regularly hurting haor people. Scarcity of feed, higher price of feed, lack of capital and higher transportation cost makes farmers unable to rear animals.

The main challenges in livestock rearing in haor areas are scarcity of grazing fields, insufficient livestock care services, lack of feeds and fodder and lack of modern technologies. Furthermore, lack of quality supplies, insufficient facilities and physical infrastructure, and insufficient scientific and technical innovation have all hindered livestock production in haor areas. Expanding economic opportunities and increasing incomes through livestock production is a potentially promising strategy to enhance livelihood development and poverty reduction in the haor areas. The following strategies should be taken into account for improving livestock in the haor areas:

- Huge fallow land and water provide the natural resource base for the intensification of livestock production. Some of these lands can be used for grass production for forage.
- Cattle fattening program open up a new hope for the local people in haor areas, gaining a noticeable financial support
- Sheep rearing, specially the prolific breeds, which can withstand drought and eat on any grasses available, should be promoted for income and protein supplements for the rural people in haor areas.
- Locally improved breed (Sonali/Faomi) may be reared which are disease resistant. The Jinding duck performs better than local and Khaki Campbell in terms of body weight, growth rate, egg quality and mortality rate.
- Development of important traditional and recombinant vaccines and biologics against major diseases of ruminants and poultry using molecular biotechnological approach.
- Development and application of the methodology to link the haor climate data with animal disease surveillance system could be another good strategy.

- Ipilipil and dhaincha with creeper vegetables can be grown in the homestead areas. These plants are highly tolerant to prolong sub-mergence / flood and leaves of these plants can be used as feed for goats. Flood tolerant fodder grasses like Napier, Para, etc. can be grown as fodder / silage for livestock.
- In haor areas, leaves of floating grasses e.g. pana (a natural quick growing grass) can be fed to goat. The other alternative is to grow German grass, which can survive in flood water and also withstand partial shading.

These simple livestock technologies can substantially help the haor inhabitants with food and nutrition security, income and poverty alleviation.

b) Char ecosystem

The char lands are the land masses formed through accretion of sedimentation of huge amounts of sand, silt and clay over time carried by three of the mightiest rivers of the world, the Padma, the Meghna, the Brahmaputra-Jamuna and their numerous tributaries (Satter and Islam, 2010). Part of the char ecosystem undergoes flooding regularly making for animal grazing difficult. In peak floods, shifting cattle to high land such as an embankment is a problem for char livelihoods. Due to lack of fodder and shortage of funds, farmers have to sell this important asset. There are outbreaks of various livestock diseases in the wet season. Veterinary doctors are rarely available in the char areas. Cattle and goats are the main livestock species in the riverine chars. Buffaloes are rared in the riverine chars, but being more tolerant of saline grazing they are preferred in the new coastal chars. High temperature, drought and flooding are the main environmental stresses affecting sheep and cattle production in char areas. Also, climate change could further complicate things for cattle and sheep producers in the future.

A notable feature of substantial areas of accreted char land is the extent of grasses in the riverine chars known as *khaisa* grass which may be promoted extensively in char areas as grazing/cut and carry fodder. Cultivation of quick growing fodder crops using improved technologies demand high priority. The improved animal health service and milk marketing channels for the char areas of Rangpur and Jamalpur (disease incidence rate reduced by 37%, milk production increased 0.8 l/day/cow, producer price of milk increased 37%) has shown positive impact in livestock experiments (KGF, 2017). The Bangladesh Agricultural University (BAU) has selected garole sheep from coastal region of Shatkhira to introduce in the char areas, which is very popular among the char people (The Daily Independent, 2021). These animals are hardy and can graze easily in char areas. The Fayomi chicken performs relatively well in the char areas in terms of weight gain, egg production and livability than the Sonali and local chicken breeds. To some extent, the Jinding duck performs better than local and Khaki Campbell breeds in terms of body weight, growth rate and egg quality. Sheep especially, garole sheep with their excellent body weight gain and prolific nature, contributes greatly to fulfillment of the protein demands of the char people. Cattle fattening has become very popular with local people in char areas fetching handsome profits. Large ruminants, especially buffalo, are very common in the coastal chars while ducks are abundant in the Hatia Upazila of Noakhali and in Bhola district. Bhola and

Barishal are reputed for dairy products like yogurt, sweets and ghee (clarified butter) with contributions from the char livestock. Although several unpredictable environmental conditions, mainly floods remains a limiting factor, the aforementioned livestock technologies offer good opportunities for char dwellers to improve their nutrition and at the same time generate income to alleviate poverty (Bokhtiar et al., 2023).

c) Barind ecosystem

The Barind ecosystem covers the most parts of the greater Dinajpur and Rangpur under Rangpur division, and Pabna, Rajshahi, Bogura, Joypurhat and Naogaon districts of Rajshahi division.

Heat stress and drought are the main factors affecting livestock rearing in the Barind areas. Climate change could present further challenges to cattle and sheep producers in the future, impacting production by hurting fertility or growth. Information of livestock improvement is meager especially, for the Barind Tract. There is, however, evidence of very good prospects of sheep rearing, especially garol (Muzaffarnagari sheep from India crossbred with local sheep called locally, by mistake, as "Garol") sheep rearing for meeting the protein demands because of their excellent body weight gain and prolific nature. Cattle fattening can be a good income generating endeavor for the local barind farming community. Fayomi chickens perform better in terms of weight gain, egg production and livability than Sonali and local chicken in the area. To some extent, Jinding duck performs better than local and Khaki Campbell in terms of body weight, growth rate, egg quality and livability (Bokhtiar et al., 2023).

d) Coastal ecosystem

The Ganges-Brahmaputra-Meghna (GBM) river system and the Bay of Bengal dominate the Bangladesh coast geomorphologically and hydrologically. The reduction in number of polder started with the intrusion of saline water and logging of saline water inside the polder. The livestock numbers have decreased alarmingly in almost half of the coastal districts. One of the reasons for this is the continual shrinking of pastures. On the other hand, the usefulness of cattle in farm operations has diminished, farmers now can hire machines for tillage and post-harvest operations. With human population growth, homesteads are becoming smaller in size inhibiting livestock rearing, and farmers are often forced to sell livestock during crises of cash. Due to the high dependence on the salinity affected fodder crops, livestock are affected by many negative consequences such as diarrhoea, skin diseases, liver fluke, loss of body weight, and breakdown of the immune system (Bokhtiar *et al*., 2023)

Coastal areas are very potential for livestock rearing particularly cattle and buffaloes. During early eighties the southern part of Khulna, Bagerhat and Satkhira districts had enough naturally grown grasses inside the polder. The land inside the polder had been cultivated for a single crop in a year. Therefore, there were enough grazing facilities and the rich and middle class farmers had large herd of cattle and buffaloes.

Native chicken has been found to outperform in the coastal areas in terms of weight gain, egg production and mortality rate. The Jinding duck performs better than local

and Khaki Campbell in growth performance and mortality rate. Sheep, especially, garole sheep grow and reproduce very well in coastal areas and they are a very good source of protein due to their body weight gain and prolific nature. The cattle fattening program offers hope for the coastal people as a good venture of income.

e)   Hill ecosystem

The Chittagong Hill Tracts (CHT) possesses unique characteristics and ecology as it is covered by the largest portion of forest (43%) in Bangladesh (Bokhtiar et al., 2023). The mountainous, rugged terrain with deep forests and lakes give it a divergent character. The majority of its population lives on agriculture. Although horticulture is the major source of livelihood, it has emerged as a threat to forest conservation efforts, creating a hard choice between livelihoods and conserving the natural ecosystem.

The rearing of livestock has received repeated consideration as an important option for investment in the CHT. There is no livestock market due to poor transport and communication. Water ways are the only solutions for movement. Nowadays, some road communications have been improved. Livestock farming in the areas differs from that of the plains in terms of the number of species reared. On the plains, there are religious objections to pig farming, but this is a highly profitable pursuit in the CHT that boasts the highest growth rate of all livestock farming in the region. CHT pig farmers supply pigs to both the domestic and international markets. The area is also home to a type of Bison, the Gayal, which is still in the process of domestication. Earlier, Gayal was reared by Mro farmers in forest enclosures, but other communities have now entered in the field.

Above all, the livestock production is not satisfactory at all in the constrainsted areas except notable buffalo rearing is notices in the southern and Barind char areas, mostly concentrating in Rajshahi district. The farmers are isolated and unware of vetrenariy services and not adequately market linked.

Climate vulnerability

Bangladesh has a sub-tropical humid climate, characterized by high temperature and accompanied by moderately high monsoon rainfall during kharif season (April to September) and low temperature in the rabi season (October to March). Unfortunately, Bangladesh ranks as the 7th most vulnerable country to climate change. Additionally, it was recently recorded that the mean temperature of the country is rising at a rate of 0.2°C per decade (World Bank, 2021). Two-third of the country being less than 15 feet above the sea level are making the country as one of the most vulnerable to rapid sea-level rise. The rising sea level, along with cyclonic storm surges, will increase the intensity and extent of coastal flooding, accelerate salinity intrusion, and hinder fresh water availability. So, climate vulnerability is closely related with hotspots and that will hamper livestock productivity.

Climate change presents challenges both directly and indirectly for livestock production and health. With more frequent extreme weather events including increased temperatures, livestock production and their health is greatly affected due to heat

stress, metabolic disorder, oxidative stress, and immune suppression. All these result in an increased propensity of disease incidence and death. The indirect health challenges relate to the multiplication and distribution of parasites, reproduction, virulence and transmission of infectious pathogens and/or their vectors.

Regardless of all the challenges, the Government along with NGOs has made significant progress in achieving resilience and addressing gender disparity in climate vulnerable communities. It is now a journey to achieve prosperity. Specific recommendations for adaptation and mitigation of the impact of climate change on animal production and health are as follows:

a. Research on climate resilient technologies for livestock and their adaptation.
b. Design the animal sheds considering animal comfort, animal behavior, and climate change.
c. Conservation and development of local animal genetic resources. A long term policy of breeding for disease resistant traits through continous natural selection should be formulated.
d. Development of saline and drought tolerant fodder varieties and modern feeding management practices.
e. Development and application of the methodology to link climate data with animal disease surveillance system

Socio-economic factors

Technology adoption depends on socio-economic factors like occupation, education, solvency, land tenancy, extension services, holding size, farmers' awareness, credit, etc. Besides, the Government strategies have an influencing impact on farm productivity. Overall, a technology must be sustainable, profitable and above all socially acceptable. Many technologies have not been adopted by the farmers as desired although technologies are sound. This is rather a cross-cutting relatively hard issue, which deserves attention. Socio-economic variables such as gender, age, years of schooling, service area, operational farm size, cow-shed, electricity, mobile phone, TV, computer, bicycle, motor cycle, etc. affect farmers' livestock production and income. There should be provision of effective agricultural information dissemination services by using ICT tools in farming. Special emphasis should be given to eliminate gender disparity and resolve small farm holding problems to ensure farm production and income generation (Das and Mondal, 2021).

Among the socioeconomic determinants of raising livestock, the number of cattle, goat/sheep and poultry raised per household are found to be significantly higher among the medium and smallfarms and wage-labour households. Raising cattle is higher for non-farm households, but raising poultry is lower. Gross cropped area per household, literacy rate and R&D investment significantly influence raising cattle, whereas population density negatively influences raising goat/sheep and poultry. Livestock (all types) raised per household is higher in the Old Himalayan and Tista Floodplains, and goat/sheep- and poultry-raising are higher in the Karatoa Floodplain and Atrai Basin, Eastern Hills and High Ganges River Floodplain agroecologies too.

Raising any type of livestock is not suitable in low-lying areas. Raising cattle and goat/sheep is higher in areas with high land elevation, whereas poultry-raising is lower. However, raising goat/sheep and poultry is also higher in medium-high land areas (Rahman, 2018). Considering these influences and opportunities, research priority areas for livestock sub-sectors should be designed.

Cross cutting issue

Agriculture is a broad and complex field of research with several sub-sectors. These sub-sectors are diverse, interconnected and interfacing having multiple perspectives. At the farm level where actual production takes place, these sub-sectors are seen as enterprises, such as crop, livestock, fisheries, homestead production, agro forestry, etc. These enterprises are continuously interacting with each other for resource sharing, appropriate management, and economic success. On the other hand, there is many research areas that covers parts of multiple disciplines and, however, do not fit into a single discipline, are considered as cross-cutting research area. An interdisciplinary and coordinated research approach that crosses core discipline boundaries is used to address this research area. Since the livestock and poultry sub-sector is distinctive and encompasses a wide range of research areas, including production, good practice, hygiene, veterinary medicine, safe food, economics, waste management and environments, social aspects, etc. The potential cross-cutting researches that concerning livestock sub-sector are mentioned below:

a. Climate change and environmental protection issues
b. Application of nanotechnology in animal nutrition, livestock production and disease control/prevention
c. Mitigation of antimicrobial resistance using one health approach
d. Application of molecular biological technics in animal breeding, vaccine production, disease diagnosis, etc.
e. Application of nuclear techniques in the development of stress tolerant fodder varieties
f. Renewable energy and resource cycling.

Technology validation and adoption

Technology adoption increases production, improves product quality, lowers costs and saves time at farm level. Due to lack of an effective adoption framework in place, there is a moderate to low adoption of current technologies despite major advancements in technology generation in the livestock sector. As a result, a wide gap exists between potential and actual production. Therefore, innovative and appropriate working models and practices need to be developed for effective adoption and wider dissemination of technologies. In this regard, the technology should be validated and fine-tuned before adoption at on-farm conditions among the extrapolation domains.

Effective delivery system of a technology is imperative in minimizing the wide production gap. The far-reaching, participatory information and communication technologies are to be developed continually by optimizing print and electronic delivery systems and by showcasing and piloting research products in various forms, farmers training, method demonstration etc. for effective linking of research innovations with the stakeholders. There are three concerned research areas as observed as an effective delivery system:

a) Research for technology validation

- Improvement of technology hubs and platforms for validation and dissemination of technology ;
- Development of innovative approach of technology generation and fine tuning for determination of feasibility and scalability among extrapolation domains ; and
- Development of institutional framework for farmers participatory and adaptive validation trial.

b) Research for technology delivery

- Evaluation of existing extension tools and improvements of methods for technology uptake ;
- Development of innovative approach for reducing adoption lag of potential technologies ;
- Development of innovative approach and strategy for widerscale dissemination
- Promotion of e-extension, patenting, good agriculture practice and commercialization of farm technologies ;
- Improvement of public-private partnership in technologydissemination system ; and
- Assessment of socio-economic and technological determinants in adoption.

c) Research for linkage improvement

- Development of public-private partnership for technology diffusion and entrepreneurship development ;
- Innovative methods for linkage development among researchers, extension workers, producers, manufacturers, traders, etc ; and
- Development of service providers for forward and backward linkage with researcher, Government agencies, farmers and other stakeholders.

Methodology

Multiple activities were undertaken in preparing this document. Two approaches were followed, namely, (i) holding stakeholder workshops and meetings at division (administrative) levels across Bangladesh and (ii) synthesis of national policies and plans in relation to livestock development. Many diverge problems that prevails in the field in relation to livestock production have been identified through workshops attended by the BLRI scientists, DLS personnel, university teachers, workers of NGOs and private sectors, and farmers. Similarly, there are many challenges for livestock development that are wellfocused in the various national policy and plan documents. It is mentionable that the previous document (Agricultural Research Vision 2030 published in 2012 from NATP Phase-1, BARC) of livestock research priority setting was exclusively based on top-down approach. Thus, the current document of identifying research priority is an outcome of bottom-up and top-down approaches. The first stakeholder meeting sensitized the sectoral people in finalizing methodology and thematic areas, data collection formats, plan of action, etc.

Regional workshops

The PIU-BARC, NATP-2 organized eight regional workshops across the country with an objective to identify research priorities for livestock sub-sector. The workshops were held in eight divisions (administrative) - Barishal, Chattogram, Dhaka, Khulna, Rajshahi, Rangpur, Mymensingh and Sylhet. For every workshop, the PIU-NATP-2 management formed five groups for priority setting in five areas and each group was led by some senior Professor/ Scientist /Extension personnel. The groups were provided with structured formats for preparation of report and power point presentation. The group leader from each group gave PPT presentation under the following headings: Introduction, Background, Overview of activities/approaches, possible interventions, existing priority research areas, proposed priority research areas and Way forward. The six areas of livestock research were (i) conservation, improvement and production of animal and poultry genetic resources, (ii) disease management (iii) feeds and fodder production, (iv) livestock and poultry product processing and value chain (v) technology validation and adoption, and (vi) policy issue. An open discussion was held after each presentation and comment sheets were distributed among the participants for their written suggestions. Each of the groups was composed of 10-15 members from Universities, BLRI, DLS, NGOs, etc. On an average, 52% of the participants were from DLS, 22% from BLRI, 09% from universities, 17% from farm community and NGOs, comprising 91% male and 09% female participants (Table 1). Director, Research management Specialist and Consultants from NATP-2 and Directors from DLS were present and facilitated the workshops. The group leaders, co-group leaders and members were further contacted to provide information for filling gaps.

Table 1: Share of various stakeholders in the regional workshops

Venue	Date 2022	BLRI (M+F)	DLS (M+F)	University (M+F)	NGO/Farmer (M+F)	Total (M + F)
Khulna	15 June	17+0	24+1	3+0	5+0	40 (39+1)
Rajshahi	21 June	14+0	27+5	3+0	7+0	56 (51+1)
Barishal	03 August	17+0	34+2	6+2	8+0	69 (65+4)
Chattogram	10 August	18+0	42+6	11+0	4+0	81 (75+6)
Rangpur	6 September	16+0	43+5	6+3	17+2	92 (82+10)
Sylhet	15 September	14+0	34+6	7+1	13+0	75 (68+7)
Mymensingh	26 October	13+1	36+5	8+0	22+1	86 (79+7)
Dhaka	10 November	16+6	41+6	2+0	19+4	94 (78+16)
Total (M + F) (% total)		132 (125+7) (22%)	317 (281+36) (52%)	52 (46+6) (9%)	102 (95+7) (17%)	603 (551+52) 100% (M=91% and F=09%)

BLRI=132, DLS=317, NGO= 102, M=Male, F=Female

Stakeholder workshop

Information on various aspects of priority research areas obtained from the eight regional workshops were compiled, analyzed and a draft research priority document was prepared. Later, the draft document for the purpose of awareness and inputs was presented in the stakeholder's workshop held at BARC with participation from BLRI, Universities, DLS, MoA, MoFL, NATP-2, KGF, NGOs and some other relevant organizations. Research issues were categorized by priority ranking (high/medium/low) and also by research duration (short/medium/long term). The suggestions and recommendations from this day-long workshop were incorporated in the draft report for further improvement.

Expert consultation

An expert consultation meeting was organized by NATP-2 at BARC to finalize the research priority report. This meeting was attended by the high-level officials, senior researchers, academicians, policy planners and extension personnel from public and private organizations. The final draft report was presented in front of the audience. After the presentation, experts were grouped according to their speciality and were requested to provide inputs first individually and then a concencious after discussion among them. The inputs received from the workshop were incorporated in the preparation of final document.

Synthesis of national policies and plans

For collecting secondary information, various policy, plan and strategy documents related to livestock research and development have been reviewed and synthesized.

These informationin was summarized and are outlined in the Livestock policies and Livestock related plans section. A list of these documents are as follows:

- National Livestock Breeding Policy 2007
- National Livestock Development Policy 2007
- National Poultry Development Policy 2008
- Bangladesh Delta Plan 2100
- Vision 2041: Perspective Plan of Bangladesh (2021-2041)
- 8th Five Year Plan (2020-2025)
- Master Plan for Agricultural Développent in the Southern Region of Bangladesh 2012 and
- Agricultural Research Vision 2030 and beyond

SWOT analysis

A SWOT analysis was done to determine the scope of achieving the research priority areas of sustainable safe food and nutrition security from livestock sector taking into account of Strengths (S), Weaknesses (W), Opportunities (O) and Threats (T). The analysis indicates that there is a potential scope of achieving research priority – 2041 for safe food and nutrition security from livestock sector provided the Government policy and scientists' devotion commensurate with each other.

A. Strengths (positive)	B. Weaknesses (negative)
- Established institutes e.g., BLRI, LRI, CDIL/FDIL, QC laboratory, NGO's, Universities, BARC, etc. - Srong coordination and monitoring by BARC - Qualified and skilled human resources, (44% scientists have PhD in the livestock sub-sector) - Modern and equipped laboratories in BLRI, LRI, QC laboratory, CDIL/FDIL, Universities - International linkage and collaboration - Good allocation of revenues to ADB for livestock research - Sustainable funding source for emergency research issues (e.g., KGF) - Government's strong commitment to livestock development	- There is only one research institute i.e., BLRI with mandate of conducting livestock research - Severe shortage of research manpower in the livestock sub-sector - Poor maintenance and lack of efficient technicians in most of the existing laboratories. - Minimum laboratory facilities along with the service delivery facilities at the existing regional stations and sub-stations - Weak infrastructure especially, at experimental farms - Inadequate market intelligence - Weak ICT facilities - Minimum linkage with international research and donor organizations - Lack of internationally patented technologies - Poor productivity of livestock - High yield gap - Poor waste management

	High input cost (feeds and fodder, medicine, etc.) • Poor market linkage
C. Opportunities (positive)	**D. Threats (negative)**
• Increasing the number of research institutes in the livestock sub-sector with the establishment of regional stations • Strengthening institutes with talented scientists and international standard laboratories. • Establishment of accredited laboratories. • Development of climate resilient technologies • Livestock diversification and intensification • Strengthening scientists' capacity through higher education and training to address future challenges	• Occurrence of strong natural disasters, e.g., cyclones, tornado, earthquake, floods, etc. • Outbreak of pandemic, epidemic and transboundary diseases • Resignation and migration of, competent scientists • Production of quality compromised animal origin food products that are unfit for competingin the global market to survive. • Strong compliance of importing countries

Livestock Research Prioritization

Approparite research prioritization is pivotal in innovating demand-led and profitable technologies. Research priority setting in livestock is a dynamic process requiring regular tuning in context of circumstantial and changing demand and to undertake demand-driven research. Furthermore, with the advancement of time and science, such document needs revision under climate changes scenario, emerging livestock production and marketing systems, socio-economic changes and government thrusts and policies. Considering this necessity, the current document obviously is an update of "Research Priorities in Bangladesh Agriculture: Vision 2030 and Beyond', compiled in 2012.

Vision

Ensure food and nutrition security through sustainable livestock production, commercialization and improvement of livelihood by technological innovations.

Mission

Harness potentials of science and technology for higher and sustainable livestock production to meet quality protein demand of the increasing population by 2041.

Aims

- Generate demand-driven, sustainable and profitable technologies in livestock sub-sectors.
- Technological innovations for livestock diversifications, yield gap minimization, animal origin safe food production and development of climate resilient production system
- Disseminate newly developed technologies to the stakeholders through innovating piloting tools.
- Help formulate strategies to improve and sustain livestock production with viable natural resources management.

Priority research areas

Research priority areas for livestock sub-sector have been grouped into eight thematic areas with several sub-thematic areas. An overview of the thematic areas with the sub-thematic areas is given below:

Thematic area	Sub-thematic area
1. Animal Production	- Innovative technologies for high milk, meat and egg production - Stress management towards increasing livestock production and productivity - Evaluation semen production system and measures to mitigate the factors related to breeding barriers (e.g.

Thematic area	Sub-thematic area
	infertility, repeat breeding etc) in small and large ruminants • Good livestock practices for safe production • Smart livestock farming • Database on the productive and reproductive performances of livestock and poultry
2. Genetics, Breeding, Conservation and Improvement of Livestock and Poultry Genetic Resources	• Characterization, conservation and improvement of native livestock genetic resources • Conserve and improve the hill livestock species • Improvement of existing AI services • Embryo transfer in animal breeding • Development of climate resilient assorted breeds for milk, meat and eggs purpose
3. Disease Management	• Development efficient vaccines against liestock pathogens • Development of appropriate cost-effective sanitary and zoo-sanitary measures for animals and poultry farms • Development of biologicals/antiserum against different infectious agents • Development of reproductive disease and mastitis management system of ruminants • Pathogen characterization and epidemiological of zoonotic and emerging diseases of livestock • Innovation of quality veterinary drugs and pharmaceuticals • High calf mortality in crossbred cattle and buffaloes and mitigation measures • Management of vector borne diseases of livestock • Reproductive health management in livestock (e.g. cattle, buffaloes, goat etc.) • Innovative management of metabolic diseases and surgical disorders • Mitigation of drug residues, heavy metals and poisoning
4. Animal Nutrition	• Collection, conservation and improvement of indigenous and exotic fodders • Feed information, feeding standard and feeding system development • Development of prebiotics, probiotics and phytobiotics • Develop fodder/forage crops suitable for agroforestry and for intercropping with leguminous/food crops • Develop appropriate technology for the utilization of Non-Conventional Feed Resources (NCFR) and fibrous crop residues • Innovative Total Mixed Ration (TMR) for livestock • Use of nanotechnology (nanominerals) in animal nutrition • Use of clay minerals, organic and amino acids and enzymes in animal feeding
5. Animal Products Processing and Value Chain	• Hygienic slaughter house management for safe food production from livestock and poultry

Thematic area	Sub-thematic area
	• Production of safe and functional value-added products with longer shelf life from livestock sources • Appropriate processing and preservation techniques of livestock products and by-products • Monitoring and surveillance on imported livestock products and by-products • Production and use of packaging materials
6. Technology Validation and Adoption	• Assess current dissemination system and innovative participatory technology validation and adoption • Appropriate evaluation system for technology validation and adoption • Novel method of feedback collection and refinement • Development of sustainable business models (through public private partnership) for the commercially viable technologies • Farmers' participatory technology dissemination and knowledge analyses
7. Socio-economic and Marketing issues	• Market intelligence, marketing structure and marketing systems of livestock and poultry and their products • Demand and market survey for animal products and by-products under changing scenario of animal production • Develop adequate linkage system among stakeholders for quick diffusion and marketing • Establishment of market driven animal production and products • Policy research for smallholder livestock farmer • Commercialization of technologies and introduction of benefit sharing system • Political economic analysis (PEA) of animal diseases and AMR • Socio-economic analysis of smallholder livestock and poultry farming including profitable marketing • Determination of economic burden due to diseases • Viable policies for livestock marketing, transportation, processes and preservation • Impact of piloted technologies
8. Cross-cutting issues	• Mapping climate change impact • Environmental protection issues in livestock production • Integration of fodder with food crop production • Integrated Farming systems including sustainable waste management • Mitigation of antimicrobial resistance (e.g., using one health approach)

Research Priority Ranking and Duration

The research issues with types of research, priority ranking and time-scale (duration) under each thematic and sub-thematic areas are shown below:

Thematic area: Animal production

ResearchableAreas/Issues	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
1.1 Innovative technologies for high milk, meat and egg production							
• Development of cost effective technologies for milk, meat and egg production	A	H					L
• Increase of quality milk production	A	H					L
• Increase of quality egg production especially in fragile ecosystems	A	H					L
1.2 Stress management toward Sincreasing livestock production and productivity							
• Traits identification in local livestock that make them resilient to local environmental stress	B		M			M	
• Impact of seasonal stress in animal production and productivity	A	H					L
• Stress mitigation in livestock production	A	H					L
• Stress management to increase broiler meat and egg production	A	H					L
1.3 Evaluation of semen production and measures to mitigate factors related to breeding barriers (e.g. infertility, repeat breeding etc.)							
• Exploiting the advantages of embryo transfer for different breeding system	B		M			M	
• Standardisation of embryo transfer technique in animal breeding	B		M			M	
• Reducing the risk of infectious disease transmission by using embryo transfer technique in	A		H				L

ResearchableAreas/Issues	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
animal breeding							
• Potential breeding soundness of the bull	A	H					L
• Sperm concentration in animals	B		M		S		
• Upgradation of semen quality properties of cooling or post-thawing sperm cells	A		M				L
• Factors affecting sperm production in bull	A	H					L
1.5 Good livestock practices for production							
• Improving the safety of inputs	A	H				M	
• Improving the chemical and microbiological safety of raw foodstuffs	A	H				M	
• Develop cost efffective food processing technologies to mitgate risk and prevent contamination	A	H					L
• Develop good models and approaches to assure food safety	B	H					L
1.6 Smart livestock farming							
• Develop low cost housing and feeding systems	A	H					L
• Develop user and environment friendly farm machinery and equipment	A		M				L
• Develop appropriate waste disposal and management system including antimicrobial wastes	A	H					L
1.7 Database development on productive and reproductive performances of livestock							
• Baseline survey of the productive and reproductive performances of livestock	B	H				M	

ResearchableAreas/Issues	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
• Research on the use of biosensors, big data and blockchain technology	A	H					L

Thematic area: Genetics, breeding, conservation and improvement of livestock genetic resources

Researchable area/issue	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
2.1 Characterization, conservation and improvement of native livestock (AnGR): Large ruminants (Cattle and buffaloes)							
• Conservation and development of potential native animal genetic resources	B	H					L
• QTL studies for economic traits in cattle and buffalo	A		M			M	
• Database mapping of characterized and documented cattle genetic resources	A	H				M	
• Genetic variability and gene identification for disease resistance.	A	H					L
• Genetic manipulation for microbial fermentation of rumen products in ruminants.	B		M			M	
• Detection and eradication of hereditary diseases and genetic disorders in breeding animals.	B		M			M	
• Immuno-genetic status of indigenous cattle and buffalo.	B	H					L

Researchable area/issue	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
• *In situ* conservation and improvement of rare and endangered livestock species.	A	H					L
• Cryo-preservation of genetic materials of rare and endangered livestock species	B		M			M	
• Evaluation of existing AI service and determination of factors affecting infertility in cattle and buffaloes	A	H					L
• Hormone profiling in the cyclic and pregnant indigenous and crossbred cows	A	H				M	
• Screening of the breeding males for breeding soundness, infectious and genetic diseases.	A	H					L
• Development of low cost technology for maintaining cold chain in AI service	A	H					L
• In vitro culture and fertilization of embryos in livestock	B		M		S		
• Production of seed stock for economically important indigenous livestock	A	H					L
• Genetic evaluation of indigenous and cross-bred livestock for productivity and fitness under specific agro-ecological condition	A	H					L
• Development of livestock breeds or lines for low input management system	A	H				M	

Researchable area/issue	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
• Development of livestock breeds or lines for harsh environment	A	H					L
• Production of seed stock for rare and endangered livestock	B		M			M	
• Development of HYV of dairy and beef animals for feed lot system or medium input system	A	H					L
2.2 Genetics, breeding, conservation and improvement of small ruminants (Goats and Sheep)							
• Characterization, conservation and improvement of goat and sheep genetic resources	A	H					L
• Synthetic meat and/or milk type small ruminants	A	H					L
• Development of meat type rabbit	B	H					L
• Characterization of Black Bengal goat and local sheep	B		M			M	
2.3 Conservation of poultry genetic resources and breed development							
• Development of breed/variety/ strain for meat and egg production	A	H					L
• Conservation and development of native chicken and duck	A	H					L
• Development of duck breeds for meat and egg production	A	H					L
• Development of meat type rabbit	S		M			M	

Researchable area/issue	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
2.4 Characterization, conservation and improvement of native animal/poultry genetic resources for increasing meat, milk and egg production (Ruminant and Poultry)							
• Characterization and selection of high yielding desirable traits and exploitation for breed development	B	H					L
• Molecular methods/techniques for breed development	A	H				M	L
2.5 Conserve and improve the hill livestock species							
• Conserve pig, Gayal, hilly chicken, Brown Bengal goat, hilly cattle, wild life, etc.	B	H					L
• Improve pig, Gayal, hilly chicken, Brown Bengal goat, Hilly cattle, wild life, etc.	B	H					L
2.6 Improvement of existing AI services							
• Evaluation of present AI system and services	A	H	M			M	
• Causes of infertility in cattle and buffaloes and reduction	A	H					L
2.7 Development of climate resilient breeds of livestock for low input management system (Ruminant and poultry)							
• Development of climate smart breeds	B	H					L
• Development of input efficient breed for higher productivity and adaptability to climate change effets	B		M				L
• Development of breed using indigenous germplasm	B	H					L

Researchable area/issue	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
• Selection and improvement of salt tolerant breeds.	B	H					L
2.8 Assorted dairy/beef cattle/buffalo breed development							
• Development of assorted dairy/beef cattle/buffalo	B	H					L
• Development of assorted egg and meat purpose poultry breeds	B	H					L
2.9 Milk and meat purpose breeds of small ruminants							
• Development of milk and meat purpose goat and sheep breeds for commercial production	B	H					L

Thematic area: Disease management

Researchable area/issue	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
3.1 **Development of efficient vaccines (Ruminant and poultry) against livestock pathogen**							
• Isolation and identification of causal organisms of diseases and development of vaccine seeds	B	H					L
• Improving the efficacy of vaccines	A	H				M	
• Causes of antimicrobial resistance and development of vaccines	A	H					L
• Development of vaccines using recombinant DNA technology	A		M				L

Researchable area/issue	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
3.2 Developmment of appropriate cost-effective sanitary and zoo-security measures for livestock and poultry farms							
• Cost effective zoo sanitary methods	B	H				M	
• Bio-security measures for decreasing disease incidence and reducing antimicrobial use in food animals	A	H			S		L
• Development of cost-effective zoosanitary and biosecurity measures for the control of diseases in zoo animals	B	H					L
3.3 Development of biologicals/antiserum against infectious agents							
• Development of antiserum for the treatment of infectious diseases	A	H					L
• Development of diagnostic test kits for diagnosis of infectious diseases of animals (domestic livestock, poultry, pets and wildlife)	B		M				L
3.4 Development of reproductive disease and mastitis management system of ruminants							
• Management of brucellosis, vibriosis, trichomoniasis and leptospirosis for fertility improvement in ruminants	A	H				M	L
• Mangement of clilinical and sub-clinical mastitis in the smallholder and commercial dairy farms	A	H				M	L
• Use of nanomaterials in the prevention and treatment of sub-clinical mastitis	A	H					L

Researchable area/issue	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
3.5 Pathogen characterization and epidemiological study of zoonotic and emerzing diseases							
• Characterization of causal agents including epidemiological study and surveillance of emerging and zoonotic diseases of livestock	A	H				M	
• Isolation, identification and characterization of causal agents including epidemiological study and surveillance of zoonotic diseases	A	H				M	
• Animal disease management for higher productivity	A	H				M	
• Development of location specific disease control model	A	H					L
• Development of disease free zones for FMD, PPR, etc. for capturing international makets of meat and meat products	A	H					L
• Prevention and control of transboundry disease outbreak	A	H				M	
• Correlation of antimicrobial use in food animals with the development of AMR in the organisms of zoonotic importance	A	H				M	
• Isolation and molecular characterization of AMR genes to promote antimicrobial containments	A	H				M	
3.6 Innovation of quality veterinary drugs and pharmaceuticals							
• Safety, efficacy, and quality control of herbal medicines and traditional remedies in veterinary practice	B	H					L

Researchable area/issue	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
• Pharmacokinetics (absorption, distribution, metabolism, and excretion) and pharmacodynamics of veterinary drugs in the local animal population	B		M				L
• Development of new antimicrobials, prebiotics and probiotics as quality veterinary inputs	A	H					L
• Development and evluation of alternative to antimicrobials	A	H					L
• Use of nanotechnology as an alternative to treatment with antimicrobials	A	H					L
• Health hazard due to long-term exposure to nanoparticles	A	H					L
3.7 High calf mortality in cross-breed cattles and buffaloes and mitigation							
• Causes of high calf mortality in crossbred cattle and buffaloes	B	H			S		L
• Effective measures in mitigating high calf mortality	A	H					L
3.8 Management of vectorn borne diseases							
• Development of low cost Integrated Pest Management technique for animal health	A		M				L
• Development of integrated programs for controlling mites and ticks	A		M				L
• Preventing the spread of lice and fleas	A		M				L
3.9 Reproductive health management of livestock (e.g. Cows, buffaloes, goat etc.)							
• Management of repeat breeding syndrome	A	H				M	

Researchable area/issue	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
• Cost effective methods (e.g. reproductive hormones) in treating postpertum disorders (retained placenta, dystocia, cyclic folicles, repeat breeding)	A	H				M	
3.10 Innovative management of metabolic diseases and surgical disorders							
• Surgical intervention and management of urinery system problems	A	H				M	
• Development and management of fractures using cost effective methods	A	H				M	
• Nanotechnology in the treatment of bone fractures in small ruminants and pet animals	A		M			M	
3.11 Mitigation of drug residues, heavy metals and poisoning							
• Assess and mitigate nitrite poisoning from young succulant fodder	A	H				M	
• Monitoring of toxin and heavy metals in livestock feed	A	H				M	
• Analysis of drug residue and heavy metals in animal products	A	H				M	
• Impact of environmental contaminants (Pesticides, Rodenticides, Heavy metals, Microplastics) on animal health and food safety.	A	H				M	

Thematic area: Animal nutrition

Researchable area/issue	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
4.1 Collection, conservation and improvement of indigenous and exotic fodders							
• Collection, characterization and conservation of fodders	B	H					L
• Assessment of nutritional value of fodders	B		M				L
• Development and identification of stress tolerant fodder genotypes	A	H					L
• Development and improvement of climate resilient fodder	B	H					L
• Application of nuclear technique in the development of stress tolerant fodder varieties	B	H					L
4.2 Feed information, feeding standard and feeding system development							
• Inventory of available feeds and feeding standard development	A	H					L
• Development of agro-ecological region based livestock feeding system (ration)	A	H					L
4.3 Development of prebiotics, probiotics and phytobiotics							
• Development of local prebiotics and probiotics	B		M			M	L
• Evaluation of exotic prebiotics and probiotics for use under local condition	A	H			S		
4.4 Develop fodder/forage crops suitable for agroforestry and intercropping with food crops							
• Screening potential fodder/forage crops for homestead areas in agroforestry and as monocrop	A		M				L

Researchable area/issue	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
• Improvement of fodder/forage crops suitable for various agroforestry system	A	H					L
• Development of fodder/forage crops suitable for intercroping with food crops	A		M			M	
4.5 Innovative technology for utilization of non conventional feed resources (NCFR) (e.g. algae, duckweed, water hyacinth, silkworm pupae, tree leaves, herbs and shrubs) and fibrous crop residues							
• Supplementation of feed with NCFR	A	H	M				L
• Processing of food crop residues including fibrous crop residues for utilization as livestock feeds	A	H				M	
4.6 Innovative total mixed ration (TMR) for livestock							
• Formulation of TMR (different categories)	A	H					L
• Adaptation to TMR	A	H					L
4.7 Use of nanotechnology in animal nutrition							
• Using nanoparticles for increasing rumen fermentation and growth performance	B		M				L
• Increase of reproductive performances through using supplementary dietary nanomaterials	B		M				L
4.8 Use of clay minerals, organic and amino acids and enzymes in animal feeding							
• Identification of suitable clay minerals, organic and amino acids and enzymes	A		M			M	
• Performance analysis of clay minerals, organic and amino acids and enzymes	A		M			M	

Thematic area: Animal products processing and value addition

Research area/issue	Types of Research	PriorityRanking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
5.1 Hygienic slaughter house management for safe food production							
• Standerdization of hygiene in slaughter house	A	H					L
• Sustainable management of meat hygiene	A	H					L
5.2 Production of safe and functional value-added meat, milk, and egg products for home and abroad							
• Diversified livestock based product development	A	H				M	
• Novel value addition techniques in animal origin foods and food products	A		M			M	
• Potential of supplementing nanominerals in changing the quality and nutritional value of meat, milk and eggs	A		M				L
5.3 Appropriate processing and preservation techniques of livestock products and by-products							
• Innovative processing of livestock product	A	H			S		
• Develop appropriate preservation techniques	A	H				M	
• Production of safe use of packaging materials	A	H			S		
• Addition of prebiotics in dairy products to improve food quality and consumer	A		M			M	
• Use of proteases in the dairy industry and meat tenderization	A		M			M	

Research area/issue	Types of Research	PriorityRanking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
• Evaluation of animal by-products for their diverse bioactivities (antihytpertensive, antioxidant, antidiabetic and antimicrobial properties)	B		M			M	
• Added-value food ingredients (food aroma compound) for health promoting benefits (antioxidant, and probiotic health benefits)	A		M			M	
• Use of processed slaughter by-products for the generation of new added-value food ingredients	A		M			M	
• Storage and preservation for longer shelf life of milk, meat and eggs	A	H				M	
5.4 Monitoring and surveillance of imported livestock products and by-products							
• Quality control of imported dairy products	A	H					L
• Quality control of imported meat and bone meal	A	H					L

Thematic area: Technology validation and adoption

Research area/issue	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
• Assess current dissemination system and innovative participatory technology validation and adoption	S	H			S		
• Appropriate evaluation system for technology validation and adoption	B	H			S	M	
• Novel method of feedback collection and refinement	B	H				M	
• Development of sustainable business models for the commercially viable technologies	A	H			S		
• Farmers' participatory technology dissemination and knowledge analyses	A	H				M	

Thematic area: Socio-economic and marketing issues

Research area/issue	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
7.1 Marketing intelligence and marketing structure and marketing system							
• Develop marketing structure, marketing system and value chain	A	H					L

Research area/issue	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
• Develop adequate linkage system among stakeholders for quick diffusion and marketing	A	H					L
• Demand and market survey for animal products and by-products under changing scenario of animal production	A		M				L
7.2 Policy and socio-economic research							
• Policy research for smallholder livestock farming including marketing	A	H					L
• Commercialization of technologies and introduction of benefit sharing system	A	H					L
• Political economic analysis (PEA) of animal diseases including AMR	B	H				M	
• Socio-economic analysis of smallholder livestock and poultry farming including profitable marketing	B	H				M	
• Determination of economic burden of different diseases	B	H				M	
• Economic aspects of technology transfer process of commercially viable technologies through PPP	B	H				M	

Thematic area: Cross cutting issues

Research area/issue	Types of Research	Priority Ranking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
8.1 Mapping the impacts of climate change							
• Survellience and impact of climate change on livestock diseases	A	H					L
• Impacts of climate change on animal health and production	A	H					L
• Climate resilient livestock production system development	A		M				L
• Climate linked stressors ecology, biology and farming system	A		M				L
8.2 Environmental protection issues in livestock production							
• Develop low cost waste management techniques including antibiotic wastes for livestock	A	H				M	
• Green house gas emission and adequate mitigation	A	H				M	
• Slaughter house waste management	A	H				M	
• Appropriate equipment for waste management	A	H				M	
8.3 Integrated farming systems							
• Integration of livestock in holistic farming system approach	A	H					L
• Optimization of resource utilization and recycling for total farm productivity	A	H					L

Research area/issue	Types of Research	PriorityRanking			Time scale (Duration)		
		High	Medium	Low	Short Term	Medium Term	Long Term
• Integration of fodder with food crop production through multiple cropping based farming systems	A		M			M	
8.4 Mitigation of antimicrobial resistance (AMR) using one health approach							
• Monitoring of antimicrobial use (AMU) in the aquatic and teresterial animals	A	H					L
• Monitoring of environmental pollution with antimicrobials	A	H					L
• Molecular analysis of bacterial genomes to aid in developing gene manupulated vaccines against multidrug resistance organisms (MDR).	A	H					L
• One health approach in determining economic burden of AMR in human health, animal health, aquaculture, crops and environment	B	H					L

Types of research
Basic research (B): Increase in understanding of fundamental knowledge, concept and scientific principles.
Applied research (A):   Application of the results derived from basic research to generate technologies.
Strategic research (S): It is a kind of research which addresses policy issues of the Government.

Priority rankings (Vestola 2010)
High (H)– Critical issues to be addressed in immediate future
Medium (M) – Potentially critical to be addressed in near future
Low (L) – Not critical but to be addressed if resources permit

Time-scale (BARC 2012)
Short term (S): < 3 years; Medium term (M): 3-5 years; Long term (L):>5 years

Strategy and Framework

There has been an implausible revolution in technological innovations facilitating achievement of country's food security. Consequently, the country has been transformed from a food deficit into an almost food reliant country. Several drivers, e.g, livestock policy reforms, technological advancements and production support have played a great role. Nevertheless, it is a matter of serious concern as how to meet food demand of increasing population (currently 166 million; BBS, 2022) when the country's natural resource base is at attenuation and also degrading. Besides, the country possesses fragile ecosystems wherein livestock production, food security and livelihood is threatened, which has been intensifying due to global warming bound affects. Ultimately, future food security depends on effective and maximum use of ecologically constrained areas for livestock production alongside quick technology flow. It is anticipated that about 35% food production should be increased by 2041 to meet the demand of the country's growing population (Bokhtiar and Samsuzzaman, 2023). Therefore, innovative strategies are, indeed, inevitable to sustain food and nutrition security toward building a hale and hearty nation. Irrefutably, adroit strategies are to be formulated to revert opposes to opportunities to accomplish the expected growth in livestock.

The potential strategies along with the approaches for achieving the above objectives and execution of research on priority areas identified along with the expected outcomes (Matrix 1) are stated below:

Strategy One: Develop efficient and effective technologies to improve livestock production and productivity

- Livestock intensification and improvement of input efficient production system
- Development of disease resistant and high yielding potential breed of livestock and poultry
- Technology generation for appropriate and scientific management of animal and poultry industry/farms.
- Emphasize technology innovations for submergence, rainfed, saline and other fragile ecosystem based livestock production including fodder production

Strategy Two: Strengthen infrastructure for efficient and effective technology development

- Establish more research institutes (Animal Health Research Institute, Poultry Research Institute, Institute for Small Ruminant Research, Institute for Large Animal Research, Transboundry Research Iisntittue, Livestock Vaccdine Research Institute etc.) and Regional Stations (ecosystem based)
- Establish modern laboratories and farm facilities for smooth conduction of basic and applied research
- Strengthen social infrastructure (e.g. groups, apex of groups, etc.) for linking research and technology development with farmers/stakeholders

- Establish storage and processing infrastructures help to generate high value technologies through value chain development
- Develop electronic communication facility centres for improved access of users to information and knowledge

Strategy Three: Facilitate transfer of technologies, knowledge and information

- Develop effective linkages among NARS institutes, universities, international organizations, private sectors, NGOs, farmer and other stakeholders
- Develop information and communication technologies (ICT) and extension for quick adoption and efficient marketing
- Enhance forward and backward linkages by establishing institutional mechanisms and policy framework for linking technology generation and dissemination system with the social infrastructures for communication, awareness and sensitization

Strategy Four : Increase manpower and improve quality

- Strenghen BLRI with adequate manpower
- Build up skill and capaciy of manpower (Training, MS, PhD and Post Docs)
- Improve quality of higher education through Participatory Monitoring and Evaluation (PME) system

Stragtegy Five : Establish efficient and effective research management practices

- Formulate an action plan by individual institute for implementing research as per priority areas identified
- Develop institution-wise Management Information System (MIS)
- Conduct research emphasizing group-based, multi-stakeholder, multi-disciplinary, and multi-institutional platforms
- Create gender-friendly environment for technology development and dissemination
- Ensure an efficient administration and management system by strengthening information and communication technology (ICT)
- Introduce incentives and rewards system for the best research performers

Strategy Six: Ensure intellectual property rights and benefit-sharing system for technology commercialization

- Develop intellectual property rights compatible work culture and win-win environment
- Strengthen technology development system following intelectual property rights for benifiting farmers and the society
- Harmonize Bangladesh's laws of intellectual property rights with those of other parallel countries

Strategic Framework

The strategic framework articulating approaches for execution of research priority areas to achieve the objectives and corresponding performance measures or outcomes are stated in Matrix 1.

Matrix 1. Strategic Framework

Objectives	Approaches	Performance measures/Outcomes
1. Improve livestock production and productivity	• Livestock intensification and modification of production practices to increase output per animal, per unit of land and per unit of labour • Development of disease resistant, high yielding potential breed/varieties of livestock • Technology generation for appropriate and scientific management of livestock industry/farms. • Emphasize technology development for submergence, rainfed, saline and other fragile ecosystem based livestock feed and fodder production	• Animal production and productivity increased • Climate resilient potential breed/varieties of livestock are developed • Location specific and ecosystem based technologies are invented • Feeds and fodder production increased
2. Enhance nutrient rich and safe food production	• Sustainable livestock product diversification • Exploring innovative solutions to mitigate the existing problems related to food nutrition, safe food production, foodsafety and value added products processing • Development of safe food, nutrient rich and therapeutic and functional farm products (yoghurt, cheese, burhani) considering long-terms sustainability issues	• Diversified animal origin food products available • Safe food production increased • Availability of value-added nutrient rich safe food increased

Objectives	Approaches	Performance measures/Outcomes
3. Improve post-harvesting, value addition and food processing	• Development of technologies to minimize post-harvest losses in the farms, during storage and transportation • Enhancing shelf-life of milk, meat and eggs • Improve post-harvest processing, preservation and value addition of animal origin food commodities	• Technologies available to minimize post-harvest losses in farms, storage and transportation • Shelf-life of animal origin food enahnced • Availability of animal origin value-added processed food increased
4. Improve access to genetic material, information and knowledge resources	• Conservation, exploration, maintenance and sharing germplasms of local livestock and poultry among stakeholders. • Improve access to information through effective use of ICT • Access to geo-spatial data and knowledge resources	• Germplasms conserved and shared among the institutes/stakeholders • Access to information of improved knowledge and technologies through strong websites increased. • Promoted livestock resaerch and development activities
5. Improve risk management	• Technologies and management approaches for climate change adaptation and mitigation • Address market risks through modern market intelligence and improved market access • Integrating various stakeholders with market intelligence system to sustain profit and interests. • Development of effective vaccines against major livestock diseases • Characterization of local viureses, bacteria etc. using bioinformatics • Strengthening institutional capacity for vaccine research and commercialization • Biological risk management	• Climate resilient technologies available • Modern market intelligence and improved market access are in place • Biosafety/biosecurity rules are in place and practiced • Safe and quality products are available • Effective vaccines availbale and animal health improved • Safe animal production and products ensured • Producer and farmers' interests sustained

Objectives	Approaches	Performance measures/Outcomes
	through practicing biosafety in laboratory, veterinary clinics and farms	
6. Smart integrated farming systems	• Integration of agricultural enterprises to recycle products and by-products thereby reducing production cost and increase total farm income (e.g. by-product of cheese industries like whey, can be used as a therapeutic soft drink) • Develop integrated farming system models for food and nutrition security • Livestock waste management, biogas and biofuel generation and composting to facilitate soil health improvement and productivity growth	• Total farm income increased through integration of different farm enterprises. • Soil health improved through integrated livestock waste management. • Farm productivity increased. • Carbon sequestration and soil health improved • Sustainable environment is achieved.
7. Steady technology delivery system	• Establishment of networking of research and extension machineries with forward and backward linkages. • Development of technology delivery systems by the use of mass communication tools. • Research on remote sensing, AI, IoT, Robotics, Cloud computing and Big data management towards more-informed production business and operational decisions.	• Effective network is established with imporved forward and backward linkages. • Use of mass communication tools increased for technology dissemination and feedback • Improved business and operational decisions
8. Human Resources Development (HRD) to expedite	• Strengthening scientists' capacity through higher studies and training. • Develop a futuristic human resource development	• Competent human resources are available • Competitive research environment created • Performance-based work-

Objectives	Approaches	Performance measures/Outcomes
technology development	program • Enhance competitive capacity of the HR through talent management. • Introduce a performance-based work-culture with incentives and rewards system • Social skill development to run livestock enterprises.	culture established • Technological innovations are accelerated • Smart entrepreuners available
9. Commercializat-ion of livestock technologies	• Development of intellectual property rights and benefit sharing system • Strengthening technology management system • Strengthening the linkage between academia, researcher, extension personnel, producer, traders and consumers • Research on farm friendly policy, value chain and market development • Strengthen cooperative system of livestock farming	• Production of animal origin products and by-products swells • Farm incomes increased • Effective marketing channel ensued • Quick deliversy system established and production enabling environment assured • Strong rapport among stakeholders established • Livelihood improved

Future Direction

Bangladesh has ever achieved a paramount progress in food production, where adoption of agricultural policy reforms and technological advances and their adoption have played a significant role. Consequently, the country is self-sufficient in meat, and egg production but little lag behind in milk. Moreover, a special drive is given to transform subsistence livestock enterprises into commercial ventures. However, the present transformation is threatened by many challenges like high feed cost, disease prevalence, inadequate veterinary services, and poor marketing infrastructure including unscrupulous practices of the businessman. Considering these challenges, the government has formulated several policies and adopted strategies to make livestock and poultry a sustainable and profitable sub-sector. The policies have extended strategy and plan for development of livestock in the ecologically constrained areas like Hoar, Char, Barind, Coastal and Hill regions. Eventually, future food and nutrition security largely depends on how effectively and maximally the livestock production is increased under ecologically constrained areas using novel climate smart and nutrition sensitive technologies. Therfore, an astute planning and research priority setting semmed to be instrumental choices for improved and sustained livestock productivity under favorable and fragile ecosystems.

The country still lags behind in safe and nutritious food desipte of significant accomplishment in food production. Food safety is also crucial in promoting trades, particularly with developed countries having strict compliances. The sector shall be attaining a firm ground if efficiency and intellectual capacity of all concerned are appropriately integrated with smart usage of natural resources. However, some pertinent action plans have been proposed to fulfil the strategic objectives:

- A time bound action plan is to be prepared and executed algning the outlined research areas and strategies
- Ensure safe livestock based food production as per Good Livestock Practices 2020
- Value addition through integrated value chains and market intelligence.
- Improve post-harvest processing, preservation and value addition of animal origin foods.
- Improve access to good genetic material and knowledge through the use of bioinformatics.
- Strengthen human resources in number and capacity in livestock research and development
- Introduction and management of precision farming through 4IR
- Strengthening research infrastructure through increasing the number of research institutes along with number of regional stations.
- Address emerging challenges such as weather variability, climate change vulnerability, water scarcity, waste management and increased price volatility in local and global markets.
- Accentuate linkage between private companies and public organizations

- Establish strong governance ensuring accountability, transparency, participation and handling cross cutting issues deftly.

A technological breakthrough is vitally needed for shifting the yield frontier through advanced breeding, cost effective feed development, improved management and disease controlling measures as well supportive for sustaining increased quality and safe food demand. The country needs a smart integration of innovations in livestock production technologies with enabiling policy support. Furthermore, narrowing down the existing yield gap through validation and refinement followed by quick technology piloting is indeed inevitable for a flourishing livestock growth. A Smart Bangladesh by 2041 is thus envisioned if research is conducted as per identified research priority areas following proposed strategis and approaches.

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Appendix 1. Some pictorial view of Divisional Workshop activities
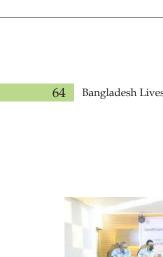
Khulna workshop

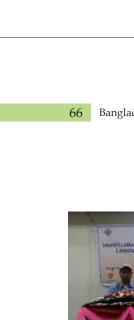**Rajshahi Workshop**

Barishal Workshop

Chattogram Workshop

Rangpur Workshop

Sylhet Workshop

Mymensingh Workshop

Dhaka Workshop

Appendix 2. List of committee members responsible for research issues identification prioritization

List of committee members responsible for research issues identification and prioritization for Dhaka Division

Sl No.	Thematic Area	Name, designation and organization
	Genetic Resources, Conservation and improvement of livestock and poultry	Dr. Nilufa Begum, Director, Department of livestock Services, Dhaka Division.
		Dr. ABM Khaleduzzaman, Director, Central Cattle Breeding and Dairy farm, Savar, Dhaka
		Prof Dr. Laymea Asad, Department of Animal Breeding and Genetics, Shere-E-Bangla Agricultural University, Dhaka
		Dr. Md. Sirajul Islam, Senior Scientific Officer, Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka.
		Dr. Shakila Farooque, Principal Scientific Officer (PSO), BLRI, Savar, Dhaka
		Ms. Farhana Afroz, SSO, Livestock Production Research Division, BLRI, Savar, Dhaka
		Md. Ashraf Hossain, Upazila Livestock Officer, Gazipur Sadar, Gazipur
		Dr. Gautom Kumar Dev, PSO, BLRI, Savar, Dhaka
		Md Ponir Chaudhury, Biotechnology Division, BLRI, Savar, Dhaka
	Disease Management	Dr. Amolendi Ghosh, Director, Research, Training and Evaluation Division, Livestock Research Institute (LRI),Mohakhali, Dhaka
		Dr. Md. Shahinur Islam, Deputy Chief Epidemio logist, Department of Livestock, Dhaka Division, Dhaka.
		Dr. Shamsun Nahar, PSO, Quality Control Section LRI, Mohakhali, Dhaka.
		Dr. Md. Golam Azam, PSO, CDIL, Dhaka
		Dr. Md. Rufiqul Islam, CSO, Livestock Division, BARC
		Prof. Dr. KBM Sariful Island, Department of Medicine and Public Health, Sher-E-Bangla Agricultural University, Dhaka
		Dr. Md. Boyzer Rahman, PSO, Foul Fox Vaccine

Sl No.	Thematic Area	Name, designation and organization
		Production Section, LRI, Mohakhali, Dhaka
		Dr. Md. Mofazzal Hossain, Veterinary Public Health Section, LRI, Mohakhali, Dhaka
		Dr. Selina Nazmun Naher, PSO, Black Quarter Vaccine Production section, LRI, Mohakhali, Dhaka
		Dr. Md. Shaheen Alam, sso, Animal Health Research Division, BLRI, DA Savar, Dhaka.
		Dr. Md. Mahbubul Islam, District Livestock Officer (DLO), Manikgonj.
		Dr Md. Julfikar Ali, Scientific Officer, Animal Health Research Division, Savar, Dhaka
		Md Abdus Samad, PSO, Animal Health Research Division, BLRI, Savar, Dhaka
		Ms. Basana Akther, DLO, Narayangonj
		Dr. Md. Zakir Hossain, SSO, Animal Health Research Division, BLRI, Savar, Dhaka
	Animal Nutrition	DR. SM Ukbil Uddin, DLO, Gazipur
		Ms. Zeenat Sultana, Deputy Director (Farm), DLS, Dhaka
		Dr. Hossain Md. Selim, Deputy Director, Planning Division, DLS, Dhaka
		Dr. Md. Masud Rana, SSO & Site Incharge, Regional Station, BLRI, Jessore
		Dr. Sarder Md Amanullah, PSO, Animal Health Research Division, BLRI, Savar, Dhaka.
		Dr. Biplob Kumer Roy, PSO, Animal Health Raseniet Division (AHRD), BLRI, Savar, Dhaka.
		Redoan Akanda Summer, SO, AHRD, BLRI, Savar, Dhaka
	Beef, dairy and Poultry based product processing, value chain	Prof. Dr. Md. Mofazzal Hossain, Department of Animal Nutrition, animal breeding and genetics, Sher-e-Bangla Agricultural University
		Dr. Md. Habibur Rahman Khan, DLO, Norshingdi
		Dr. Md Rakibul Hassan, PSO, Department of Training, Planning and Technology Evaluation, BLRI, Savar, Dhaka
		Ms. Zobaida Shovana Khanum, SSO, Department of Goat Production Research, BLRI, Savar, Dhaka
		Dr. Md. Saiful Islam, Department of Socio Economic Research, BLRI Savar, Dhaka.

Sl No.	Thematic Area	Name, designation and organization
	Technology Validation and Adoption	DR. Abu Sufian, Director (Budget), DLS, Dhaka
		DR. Kumud Rangan Mitra, DLO, Munshigonj
		DR. Ataur Rahman Bhuiya, ULO, Narayanganj Sadar, Narayanganj
		Dr. Suraya Parvin, PSO, TTMU, BARC
		Dr. Md. Abdur Rashid, SSO, Poultry Research Centre, BLRI, Savar, Dhaka
		Ms. Shaheda Aktehr, DLO, Dhaka
		Dr. Rezia Khatun, PSO, Farming System Division, BLRI, Savar, Dhaka

List of committee members responsible for research issues identification and prioritization for Mymensingh Division

Sl No.	Thematic Area	Name, designation and organization
	Genetic Resources, Conservation and improvement of livestock and poultry	Dr. Monorarjan Dhar, Director, DLS, Mymensingh Division, Mymensingh
		Dr. Md. Sirajul Islam, Senior Scientific Officer, Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka.
		Dr. Most. Pervin Mostari, PSO, Department of Animal Production Research Division, BLRI Savar, Dhaka
		Ms. Farhana Afroz, SSO, Department Animal Production Research Division, BLRI, Savar, Dhaka
		Prof. Dr. AK Fazlul Haque Bhuiya, Department of Animal Breeding and Genetics, BAU, Mymensingh
		Dr. Gautom Kumar Dev, PSO, BLRI, Savar, Dhaka
		Md Ponir Chaudhury, Biotechnology Division, BLRI, Savar, Dhaka
		Dr. Abu Sayeed Sarker, Deputy Director, Artificial Insemination Centre, Duladia, Mymensingh
		Dr. Md. Shaheen Alam, SSO Dep Animal Health Research Division, BLRI, Savar, Dhaka
		Prof. Dr. Emdadul Hoque Chowdhury, Department of Pathology Faculty of Veterinary, BAU, Mymensingh
		Dr Md. Julfikar Ali, Scientific Officer, Animal Health Research Division, Savar, Dhaka
		Md Abdus Samad, PSO, Animal Health Research Division, BLRI, Savar, Dhaka
		Dr. Mohamad Wahedul Alam, DLO, Mymensingh.
		Prof Dr. ASM Bari, Department of Pathology, Faculty

Sl No.	Thematic Area	Name, designation and organization
		of Veterinery, BAU, Mymensingh
		Dr. Md. Zakir Hossain, SSO, Department of Animal Health RResearch Division, BLRI, Savar, Dhaka
	Animal Nutrition	Prof. Dr. Kuan Mohammad Saiful Islam, Department of Animal Nutrition, BAU, Mymensingh
		Dr. Sarder Md. Amanullah, PSO, Animal Health Research Division, BLRI, Savar, Dhaka
		Dr. Md. Masud Rana, SSO & Site Incharge, Regional Station, BLRI, Jessore
		Ms. Sungmary Khatun, District Training Officer, DLS, Mymensingh
		Biplob Kumer Roy, PSO, Animal Health Research Division, BLRI, Savar, Dhaka
		Redoan Akanda Summer, SO, AHRD, BLRI, Savar, Dhaka
	Beef, dairy and Poultry based product processing, value chain	Dr. Rezia Khatun, PSO, Farming System Division, BLRI, Savar, Dhaka
		Dr. Md. Shahidul Islam, District Training Officer, DLS, Jamalpur
		Dr. Md Rakibul Hassan, PSO, Department of Training, Planning and Technology Evaluation, BLRI, Savar, Dhaka
		Ms. Zobaida Shovana Khanum, SSO, Department of Goat Production Research, BLRI, Savar, Dhaka
		Dr. Md. Saiful Islam, Department of Socio Economic Research, BLRI Savar, Dhaka.
		Prof. Dr. Raihan Habib, Department of Dairy Science, BAU, Mymensingh
	Technology Validation and Adoption	Prof. Dr. Md. Shahidur Rahman, Department of Dairy Science, BAU, Mymensing
		Dr. Md. Abdur Rashid, SSO, Poultry Research Center, BLRI, Savar, Dhaka
		Dr. Md. Abdul Hayee, District Training officer, DLS, Mymensingh
		Prof. Mukthar Khan, Department of Animal Nutrition, BAU, Mymensingh
		Dr. Mohammad Mustafizur Rahman, DLO, DLS, Sherpur
		Dr. Rezia Khatun, PSO, Farming System Research Division, BLRI, Savar, Dhaka
		Dr. Md Ashraful Islam, Farming System Research Division, BLRI, Savar, Dhaka

List of committee members responsible for research issues identification and prioritization for Barishal Division

Sl No.	Thematic Area	Name, designation and organization
	Genetic Resources, Conservation and improvemnt of livestock and poultry	Dr. Md. Abdus Sabur, Director, Department of Livestock Services Barisal Division.
		Dr. Md. Monirul Islam, District Livestock officer, Borguna
		Md. Shirazul Islam, SSO, BLRI, Savar, Dhaka
		Dr. Goutam Kumar Dev, PSO, BLRI, Savar, Dhaka
		Dr. Shakila Faroque, CSO, BLRI, Savar, Dhaka
	Epidemiology, Pathology, Central and Management of Farm Animals and Poultry Diseases	Dr. Md. Abdus Samad, PSO, BLRI, Savar, Dhaka
		Mohammad Saheb Ali, District Livestock Officer, Jhalokati
		Dr. Tarun Kumar Sikdar, District Livestock officer, Pirojpur
		Dr. Julfikar Ali, SO, BLRI, Savor, Dhaka
		Dr. Habibur Rahman, SO, BLRI, Savar, Dhaka
	Animal Nutrition	Dr. Md. Anwar Hossain, District Livestock Officer, Patuakhali
		Dr. Sardar Amanullah, PSO, BLRI, Savar, Dhaka
		Md. Reduan Akanda Sumon, SO, BLRI, Savar, Dhaka
		Dr. Md. Nurul Alam, District Livestock Officer, Barishal
		Indrojit Kumar Mondal, District Livestock Officer, Bhola
	Beef, Dairy and Poultry vased Product Processing and Vlue Chain (Small and Medium Industry)	Mohammad Saheb Ali, District Livestock Officer, Jhalokati
		Dr.Md. Anwar Hossain, District Livestock Officer, Patuakhali
		Dr. Rezia Khatun, PSO, BLRI, Savar, Dhaka
		Dr. Md. Rakibul Hassan, PSO, BLRI, Savar, Dhaka
		Dr. Md. Saiful Islam, SSO, BLRI, Savar, Dhaka
	Technology Validation ad Adoption	Dr. Most. Pervin Mustari, PSO, BLRI, Savar, Dhaka
		Dr. Md. Rashedul Hoque, District Livestock Officer, Jashore
		Dr. Arun Kanti Mondal, District Livestock Officer, Khulna
		Dr. Md. Rakibul Hasan, PSO, BLRI, Savar, Dhaka
		Dr. Maruf Hasan, District Livestock Officer, DLS, Narail

List of committee members responsible for research issues identification and prioritization for Khulna Division

Sl No.	Thematic Area	Name, designation and organization
	Genetic Resources, Conservation and improvemnt of livestock and poultry	DR. shukhendu Shekhar Gayen, Director, Department of Livestock Services, Khulna Division
		Dr. Md. Shirajul Islam, Senior Scientific Officer, Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka.
		Dr. Mrs. Pervin Mustari, PSO, Department of Animal Production Research, BLRI, Savar, Dhaka
		Dr. Shakila Farooque, Principal Scientific Officer Poultry Research Center,BLRI, Savar, Dhaka
		Farzana Afrooz, SSO, Dept. of Animal Production Research, BLRI, Savar, Dhaka
		Dr. Arun Kanti Mondal, District Livestock Officer, Department of Livestock, Khulna
		Dr. Goutam Kumar Dev PSO, Department of Buffalo Production, BLRI, Savar, Dhaka
		Md Ponir Chaudhury, Biotechnology Division, BLRI, Savar, Dhaka
	Diseases Management	Dr. Md. Shaheen Alam SSO, Animal Health Research Center, BLRI, Savar, Dhaka
		Md. Saidur Rahman, District Livestock Officer, Meherpur
		Dr. Md. Zulfikar Ali, SO, Animal Health Research Center, Savar, Dhaka
		Md Abdus Samad, PSO, Animal Health Research Division, BLRI, Savar, Dhaka
		Dr. Abul Bashar Md. Abdur Rouf, District Livestock Officer, Satkhira
		Dr. Md. Zakir Hosen, SSO, Dept. of Animal Health Research Savar, Dhaka
	Animal Nutrition	DR. Md. Rashedul Haque, DLO, DLS, Jashore
		DR. Md. Masud Rana, SSO and Site Incharge, Regional Station BLRI, Jashore
		DR. Sarder Md. Amanullah, PSO (Lead Officer), Livestock Production Research Division, BLRI, Savar, Dhaka
		Dr. Md. Golam Mostafa, DLO, DLS, Chauadanga

Sl No.	Thematic Area	Name, designation and organization
		DR. Shamim Ahmed, SSO, Support and Service Division, BLRI, Savar, Dhaka
		DR. Biplob Kumer Roy, PSO, Livestock Production Research Division, BLRI, Savar, Dhaka
		DR. Shafiqur Rahman, Associate Professor, BCS Livestock Academy, DLS, Savar, Dhaka
		Mr. Md. Redwarn Akanda Sumon, So, Goat Production Research Division, BLRI, Savar, Dhaka
	Beef, Dairy and Poultry based Product Processing and Value Chain (Small and Medium Industry)	DR. Maruf Hassan, DLO, DLS, Narail
		DR. Md. Rakibul Hassan, PSO, Training Planning and Technology Monitoring Division, BLRI, Savar, Dhaka
		Kbd. Md. Boktear Hossain, Deputy Director, Government Poultry Breeding and Developmeng Farm, Jashore
		Ms. Zobida Shovana Khanum, SSO, Goat Production Research Division, BLRI, Savar, Dhaka
		Dr. Md. Saiful Islam, SSO, Socio-economics Research Division, BLRI, Savar, Dhaka
		DR. Maruf Hassan, DLO, DLS, Narail
	Technology Validation ad Adoption	DR. Md. Rasedul Haque, DLO, DLS, Jashore
		DR. Md. Haduzzaman, DLO, DLS, Magura
		DR. Abdur Rashid, SSO (Lead Officer), Poultry Research Centre, BLRI Savar, Dhaka
		DR. Md. Siddiqur Rahman, DLO, DLS, Khustia
		DR. Mst Rezia Khatun, PSO, Farming System Research Division, BLRI Savar, Dhaka
		DR. Md. Ashraful Islam, SO, Farming System Research Division, BLRI Savar, Dhaka

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Project Implementation Unit
National Agricultural Technology Program-Phase II Project (NATP-2)
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215
Bangladesh