



Draft National Integrated Livestock Manure Management (ILMM) Policy

Government of the People's Republic of Bangladesh

Ministry of Fisheries and Livestock

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Acronyms and Abbreviations

BLRI	Bangladesh Livestock Research Institute
BMPFUL	Bangladesh Milk Producer's Cooperative Union Ltd.
BOD	Biological Oxygen Demand
CBG	Compressed BioGas
CCAC	Climate and Clean Air Coalition
CIP	Country Investment Plan
DLS	Department of Livestock services
ERD	Economic Relations Division
Gg	Giga Gram
ILMM	Integrated Manure Management
IPCC	Inter-Governmental Panel on Climate Change
MoA	Ministry of Agriculture
MoEF	Ministry of Environment and Forest
MoFL	Ministry of Fisheries and Livestock
NAP	National Action Plan
NGOs	Non-Government Organizations
R&D	Research and Development
RDA	Rural Development Academy
SAARC	South Asian Association of Regional Cooperation
SDGs	Sustainable Development Goals
SFYP	Sixth Five Year Plan
SLCPs	Short Lived Climate Pollutants

Definitions and Terminologies

ILMM policy:	A public document containing policies and action plans of livestock manure management, clean air production and sustainable livestock farming.
ILMM:	The ILMM is stands for Integrated Livestock Manure Management, which includes one or more improved practices for producing value added products from manure e.g., biogas, organic fertilizer/ soil conditioner, organic pesticide etc. and/or practices to protect environment.
Manure:	In this document, manure broadly refers to dung of farm animals and poultry, either sole or added with urine, waste water, feed waste, litter/bedding materials unless specified otherwise.
Solid storage:	Solid livestock manure is the mixture of feces, part of urine, residues of feed, and often bedding materials, if used, and has not more than 80-85% moisture.
Slurry:	Animal slurry is the mixture of feces, urine, wash water and sometimes feed residues and bedding material, which contain variable moisture contents (90-95%).
Bio-slurry:	Bio-slurry is the semi-solid by-products from biogas plant after anaerobic digestion of manure.
Anaerobic digestion:	Anaerobic digestion refers to a collective process by which microbes break down manure materials in the absence of oxygen into CH ₄ , CO ₂ etc.
Stockpiling:	Stockpiling involves removing the solid manure from the areas storage facility and piling again along the edge of a field where the manure is to be eventually spread within the current or next growing season.
Composting:	Composting is a manure treatment system which can be used to produce a stabilized product that is free from odor, harmful coliforms, and fly problems.
Biogas:	Gases produced through anaerobic digestion of biological materials including livestock manure.
Bio-power:	Power generated from biogas/manure
Organic pesticide:	Processed manure product to be used for controlling pests.
Organic fertilizer/soil conditioner:	Processed manure products in solid, semi-soild or liquid state to be used for fertilizing land.

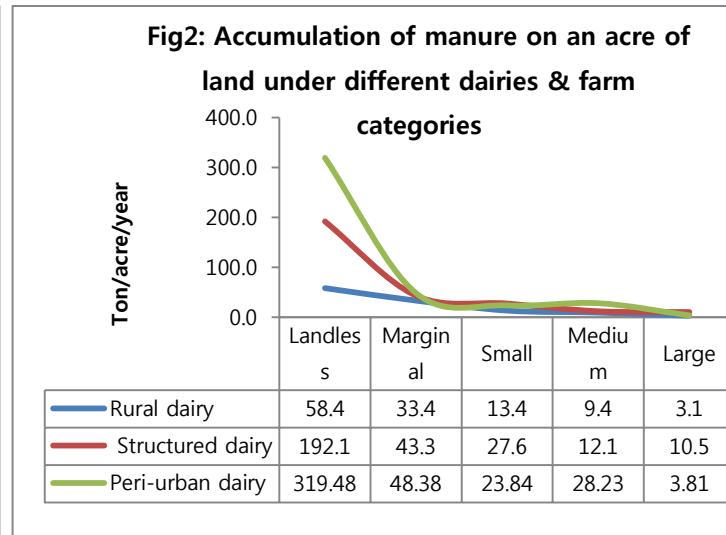
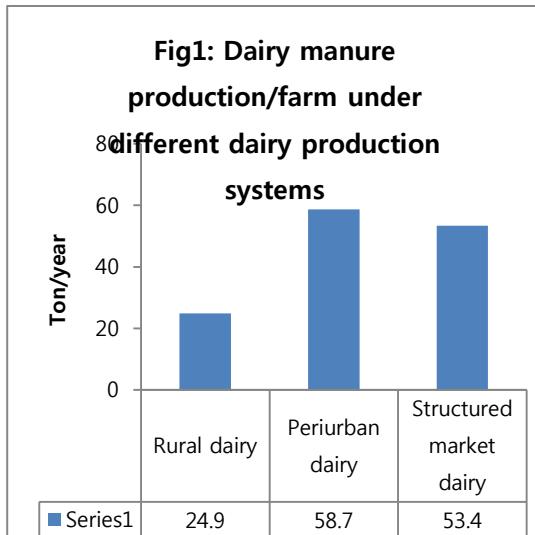
1.0 Introduction

1.1 Bangladesh livestock and manure production

The animal agriculture of Bangladesh has 26.21 million large ruminants, 17.59 million small ruminants and 137.23 million poultry (Agricultural Census, 2008), with about 70.0% to 82.0% of them being raised by landless and small farmers. Farm animals annually produce about 151.3 million tons of fresh manure, of which 3.08 million tons/year is produced under structured market dairy of Bangladesh Milk Producers' Cooperative Union Ltd. (BMPFUL) and other commercial farms. Total annual fresh poultry litter production in the country is 4.52 million tons, of which 3.10 million tons is produced under commercial poultry farming. Livestock manures, the undigested and excreted biomass of feeds and fodders fed to farm animals and poultry, from conventional management systems, are traditionally considered as waste that pollutes air, water and soil and poses a threat to public health. Biotechnological interventions, including ongoing practices of anaerobic digestion, for diversification and upgrading of value added products (organic fertilizer/soil conditioner, biopower, compressed biogas, vermicompost, organic pesticide) from manure provide cleaner production practices and make livestock farming socioeconomically and ecologically sustainable. The annual dairy cattle manure production per farm varies with farm sizes. It was estimated that annually an average dairy farm under rural, periurban or structured market dairy produces 24.9, 58.7 and 53.4 ton manure, respectively (Fig1). With the decrease of land size per acre of dairy cattle manure accumulation is increases (Fig2). Moreover, about 70% to 80% of livestock is kept by small and landless farmers. Thus, a huge amount of livestock manure is managed traditionally by the smallholders allowing air pollution and eutrophication of surface water. The medium and large farmers traditionally use manure for fertilization of their land, and this, in addition to climate pollution, fails to fetch economic benefits to farms through the biotechnological innovations made possible by improved management of livestock manure.

Integrated Livestock Manure Management (ILMM) may reduce air pollution, in one hand, and; on the other, support sustainable production of livestock. The latter is considered to be one of the most socioeconomically potential rural resources for improving livelihood of rural poor, especially, the women. Women, own almost 50% of rural farm animals and share their labor hours in manure management, will be benefitted most. This requires organizing livestock producers of landless, small and large farm categories into communities, similar to that of the existing dairy societies under

BMPCL. These communities/societies in addition to larger farms capable of supporting technological interventions and may be backed with opportunities for practice change in livestock manure management system.



1.2 Existing livestock manure management system

The livestock manure management system of Bangladesh may be categorized into i) Solid storage, ii) Liquid slurry, iii) Burned fuel, iv) Anaerobic digester, and v) Without litter, the systems defined by the Inter-governmental Panel on Climate Change (IPCC, 2006). The former four systems are followed for managing 56.2%, 1.65%, 37.3% and 4.80%, respectively, of dairy and other cattle manure. About 57% and 43%, respectively, of buffalo manure is kept in solid storage and burned as fuel, and almost 100% manure of small ruminants is kept in solid storage. The share of anaerobic digestion of cattle manure (4.80%) or poultry (25.5%), is considered to be the outcome of biased selection of farms operating digesters during 2014 field survey of Bangladesh Livestock Research Institute (BLRI), and is estimated to be higher than country average. Liquid slurry, instead of keeping it in confined systems, is practically lost out of ignorance as stated by respondent farmers, and thus, a very low share (1.65%) of the system was reported during the survey. However, liquid slurry is considered to be one of the major pollutants of air and water. It may be processed into organic fertilizer/soil conditioner, vermicompost, organic pesticides and may be marketed as value added products.

The total annual production of manure may contribute 657,585 and 197,327 tons of urea and TSP

(Triple Super Phosphate) fertilizer, respectively (Table 1), but a wide spread distribution restricts their availability for value added use. Nevertheless, gradual improvement of livestock production under confinement facilitates their improved management through biotechnological manipulations. This may help production of clean air and reduction of chemical fertilizer use, especially, of nitrogen sources, the use of which increased from 382.7x1000 ton in 1984-85 to 1037x1000 ton in 2011-12 in different chemical forms; and potassium, the use of which increased from 159.2x1000 ton in 1984-85 to 42.1x1000 ton in 2011-12 in different chemical forms. The use of livestock manure may reduce import of about 40-45% of each of these fertilizers and may help rural employment generation.

Table 1: Annual N & P (Ton) production from cattle and poultry manure

Species	Manure	Nitrogen (N)	Urea Eq. Fertilizer	Phosphorus (P)	TSP Eq. Fertilizer
Large ruminants	151,300,000	234,515	521,144	62,411	148,598
Poultry	4,520,000	61,398	136,441	20,466	48,729
Total	155,820,000	295,913	657,585	82,877	197,327

Livestock production zones may be identified by analyzing possible impact on economic development, social equity, environmental quality and public health. Organizing livestock farmers into manure management groups, functional access to biogas digesters, technological interventions for purification and condensation of bio-methane, value addition process of solid and liquid manure into organic fertilizer/soil conditioners and organic pesticides, forward linkages of private sector for marketing of manure and manure products, their quality standards and regulations, and government certification systems may be ensured for ILMM. This requires coordinated efforts of public and private sector for undertaking development programmes on ILMM. Best management practices on establishing farm, monitoring nutrient balances, separation of manure and processing, liquid waste collection and separation, water utilization, feeds and feeding practices and biosafety may be developed and extended to farmers towards reducing climatic pollutions and facilitating manure processing systems. Public awareness raising on the best management practices is also important.

1.3 Methane emission from livestock manure

The average methane emission factor from different manure management systems was estimated to be 6.77, 6.41, 5.42, 0.203 and 0.024 Kg CH₄/head, respectively, of dairy or other cattle, buffalo, small

ruminant and poultry. This translates to annual total methane emission of 120.40, 2.47, 2.71 and 2.50 Gg, respectively, from the total number of farm animals and poultry (Agricultural census, 2008, Table 2). The total annual CH₄ emission of each of the farm animals is calculated to be 94.88%, 1.64%, 1.67% and 1.80%, respectively. Commercial (having average per household 15 animals)

or subsistence (having average per household 2.0 animals), livestock farming affects extent of manure CH₄ emission (Agricultural Census, 2008).

Table 2: Annual CH₄ emission (enteric and manure) by different farm animals

Farm animals	Enteric emission, Gg CH ₄ Yr ⁻¹	Manure management, Gg CH ₄ Yr ⁻¹
Cattle	344.5	120.40
Buffalo	31.2	2.47
Small Ruminant	126.34	2.71
Poultry	-	2.50
Total	502.10	128.08

1.4 Distribution of manure

The distribution map of cattle manure under the structured market area of BMPCUL, especially in Shahjadpur, Sirajganj milk market area has the highest concentration of manure (3.0 to 4.0 million ton). Similar to cattle manure production, commercial poultry production of certain areas (e.g., Gazipur, Kisorganj, Tangail and Narshingdi) may allow accumulation of poultry litter that causes phosphorus accumulation in the soil. Major forms of pollution associated with manure management in intensive livestock production areas include i) eutrophication of surface water, ii) leaching nitrates and pathogens, iii) building up excess nutrients and heavy metals, iv) contamination of soil and water resources, and v) release of ammonia, methane and other gases. Farmers organization in the area well active for backward and forward linkage support, especially, for milk production and marketing, but manure stays neglected and managed conventionally. This causes pollution, in one hand, and, on the other, sustainability of dairying become fragile due to rising cost of feed and other inputs. The ILMM through coordinated approaches of the concerned stakeholders using the existing farmers organizations may reduce the pollution and increase value added manure products for sustainable dairy production in the areas.

The poultry producing areas having a higher accumulation of poultry litter are mostly occupied by intensive layer and broiler farms, in addition to smallholder poultry farms. A set of guidelines of commercial poultry farming is approved by the government, but they do not include best manure

management practices. Very few farmers are having anaerobic digestion systems but only biogas production is not enough to make manure management cost effective. Policy distortions, and the lack or poor enforcement of existing guidelines often intensifies pollution problems. Taxation and subsidies are typically matters of national policy. The present policy must be supported with the formulation of necessary regulations along with the subsidizing system as described in the NAP 2013. Moreover, farmers' awareness and extension service activities on safe farming and food production must be strengthened.

1.5 Manure management and public health threat

The utilization of manure for production of burning biogas either through using family or community biodigester helps improved management of manure through reduction of solid storage and burned fuel use. Reduction of fuelwood collection and women hours for household keeping and cooking and the improvement of household health and hygiene are secondary benefits, in addition to, clean air health benefits of reducing carbon monoxide and particulate matter emission. Community biodigesters facilitate production of biogas for its diversified household and commercial uses through conversion into biopower. But, in many cases bioslurry and liquid manure are left at open spaces allowing further air pollution. Bangladesh Biogas Development Foundation (BBDF) estimates that the available livestock manure in the country can annually produce 77.4 million m³ of biogas, 170x10³ MWH/year of power and 121.8 million ton of bioslurry (Table 3). In other calculation, considering 37.0 m³ biogas from a ton of livestock manure, the total biogas production in a year may be calculated to be 5765 million m³, and it is equivalent to 2.95 million tons of kerosene or 5.9 million tons of coal.

Table 3: Estimated annual production of biogas, bio-energy and bioslurry from anaerobic digestion of livestock manure

Farm animals	Annual products		
	Biogas (m3)	Energy (MWH)	Bioslurry (Million ton)
Large ruminants	68,879,880	151,536	109
Small ruminants	4,815,263	10,594	9
Poultry	3,663,106	8,058.8	3.81
Total	77,358,249	170,188.8	121.81

Source: Bangladesh Biogas Foundation (BBDF)

Livestock manure either as solid or liquid effluent may contain bacterial, viral, protozoal or parasitic pathogens that are a significant health hazard to both humans and livestock (Table 4). If an animal herd is infected with high-risk pathogens, their manure, if not treated, may be a source of zoonoses. Direct handling of manure may result in pathogenic infestation of farm personnel. Burning of dried manure cake or sticks may produce smoke containing fine particulate matter that causes a host of health effects. The World Health Organization (WHO) estimates that over 4 million people die prematurely from illness attributable to the household air pollution from cooking with solid fuels each year. More than 50% of premature deaths among children under 5 years of age are due to pneumonia caused by particulate matter (soot) inhaled from household air pollution. About 3.8 million premature deaths annually from non-communicable diseases including stroke, ischaemic heart disease, chronic obstructive pulmonary disease (COPD) and lung cancer are attributed to exposure to household air pollution. Direct discharge of livestock manure or slurry into river, pond or any water streams pose a risk for the spreading of pathogens. Nevertheless, aerobic (i.e. composting) or anaerobic digestion or even dumping in aerated lagoons may help reduction of pathogens and as well as weed seeds in livestock manure. Direct discharge of solid and/or liquid livestock manure into standing water builds up nutrient contents of water increasing biological oxygen demand (BOD) for the survivability of aquatic structures.

Table 4: Potential presence of organisms in manure and illness caused by them in humans

Name	Type	Illness in human
<i>Escherichia coli</i>	Bacteria	Some can cause bloody diarrhoea, some cause severe anemia or kidney failure that can lead to death. Infection is caused by contact with the feces of human or animals. This can happen by drinking water contaminated by feces.
<i>Campylobacter</i>	Bacteria	Produce diarrhoea and systemic illness. This organism spreads through water sources contaminated with infected animal or human feces.
<i>Salmonella</i>	Bacteria	It is a common bacterial disease that affects the intestinal tract. Symptoms consisted of diarrhoea, fever and abdominal cramps. Humans become infected most frequently through contaminated water or food.

Name	Type	Illness in human
<i>Leptospira</i>	Bacteria	Causes leptospirosis characterized by high fever, may develop kidney or liver failure, respiratory failure, meningitis, or even death. It is often transmitted by animal urine or soil containing animal urine coming into contacts with break in skin, eyes, mouth or nose.
<i>Listeria</i>	Bacteria	Causes listeriosis characterized by fever and chills, headache, upset stomach and vomiting, most likely to affect pregnant women and unborn babies
<i>Shigella</i>	Bacteria	Intestinal disease characterized by diarrhoea, which is often bloody. Shigella can be passed through direct contact with the bacteria in the feces.
<i>Cryptosporidium</i>	Parasite	Produce watery diarrhoea, life-threatening to peoples with poor immune system
Hepatitis A	Virus	It's a viral liver disease that can cause mild to severe illness. Hepatitis A infection risk is associated with lack of safe water and poor sanitation
Rotavirus	Virus	Rotavirus causes gastroenteritis. Symptoms include severe diarrhoea, vomiting, fever, and dehydration. Rotavirus infection is spread through contamination of hands, objects, food or water with infected feces.
Nipah virus	Virus	It's a newly emerging zoonotic disease causes severe illness in both animal and human. Fruit bats are the natural host and pig is the intermediate host. It causes asymptomatic infection to acute respiratory syndrome and fatal encephalitis.
Avian Influenza	Virus	Infections in humans have ranged from conjunctivitis to influenza-like illness (e.g., fever, cough, sore throat, muscle aches) to lower respiratory disease (pneumonia) requiring hospitalization. Highly pathogenic virus infections have been associated with shortness of breath, difficulty breathing, pneumonia, acute respiratory distress, viral pneumonia, respiratory failure.

1.6 Government initiative on clean air production

The Climate and Clean Air Coalition (CCAC) under the United Nation Environment Programme (UNEP) was founded in February 2012 as a voluntary network to address the areas of cooperation in knowledge, data and technologies to help reduction of SLCPs. Bangladesh is one of the founding members of the CCAC. The government of Bangladesh accordingly formulated and approved draft National Action Plan (NAP) in 2013 for reducing SLCPs from priority sources. Livestock manure is one of the major sources of SLCPs. The CCAC identified lack of knowledge, awareness, partnerships, absence of policy and weak capacity as key barriers for reducing SLCPs.

For the scaling up of biogas production from anaerobic digestion of livestock manure for domestic cooking and electricity generation, the primary responsibility for the NAP is allocated to the Ministry of Power, Energy and Mineral Resources, the Ministry of Environment and Forest, the Ministry of Commerce and the Ministry of Health and Family Welfare. However, the final stakeholder workshop on National Action Plan (NAP 2013) for reducing SLCPs organized by the Dept. of Environment (DoE), Bangladesh Road Transport Corporation (BRTC), Bangladesh University Engineering Technology (BUET) and SEI in 2013 stated that 'the Ministry of Fisheries and Livestock (MoFL) should be involved in the implementation of methane abatement measures in the livestock sector. The abatement measures of 'Control of methane emission from livestock, through anaerobic digestion of manure from cattle and poultry' and the substitution of biomass cook stoves with stoves using clean-burning fuel (biogas); and the actions like, A1) eliminating/reducing import duty on pre-fabricated components of biogas plants, in line with the provisions of the "renewable energy policy of Bangladesh (2008)", A2) Initiating and supporting programs and projects for raising awareness about domestic biogas plants and A3) Providing support (including finance) to ongoing and future domestic biogas projects and programs of the NAP 2013 are clearly linked to the activities of MoFL.

This may pave the way to achieving long-term and widespread improvements in ILMM implementation and sustainable production of livestock in the country. It can also potentially provide a source of cleaner energy (77.4 million m³ biogas and 170.2x10³ MWH power, Table 2) for millions of homes in Bangladesh and reduce the health impacts of burning biomass for cooking, provide fertilizer for crops (121.8 million tons, Table 3), as well as tackling climate change through reduced emissions of SLCPs. Therefore, the development of an integrated manure management policy and action plan

will provide a clear role for the MoFL in coordination with other relevant stakeholders, and create an enabling environment to improve market oriented manure management nationwide, and help sustainable livestock production.

1.7 Integrated livestock manure management (ILMM) and other public policies

Having a credible success in achieving Millennium Development Goals (MDGs) the country takes a vow to implement Sustainable Development Goals (SDGs). The ILMM is very much related to goals and targets 1 (1.b), 2 (2.3 & 2.4), 6 (6.2), 7 (7.2), 8 (8.3), 10 (10.1), 12 (12.2), 13 (13.2), and it also aligns well with the scope of other related existing policies of Bangladesh. Its use for crop fertilization is encouraged in the ***National Agriculture Policy (2013)***. The control of methane emission from livestock, only through anaerobic digestion of manure from cattle and poultry, is one of 16 key abatement measures identified in the ***National Action Plans (NAP, 2013)*** for SLCPs. Nevertheless, management options for bioslurry and liquid manure are not addressed in the document. ***The Renewable Energy Policy of Bangladesh (2008)*** identified livestock manure as a major potential source of new energy and has provisions of VAT (15%) exemption for all equipment and raw materials used in producing new& renewable energy, and exemption from corporate income tax for 5 years for investors. There are also provisions for considerations of subsidies to utilities for implementing new & renewable energy projects, and "incentive tariff" for electricity generation from renewable energy sources.

Table 5 Relevant policies, key linkages, stakeholders` involvement and development potentials

Policies	Stakeholders	Opportunities	Gaps	Development potentials
National Agriculture Policy (2013).	Ministry of Agriculture (MoA)	Encouraged use of organic fertilizer, organic fertilizer and compost for fertilization of crops. Livestock manure is the main raw material for these.	Conventional manure use for crop fertilization allows air pollution emitting SLCPs & threatens public health	Anaerobic digestion not only reduces SLCPs but also supports organic fertilizer/soil conditioner and organic pesticide production and adds key performance indicators to livestock production and the MoFL is the leading stakeholder
National	Ministry of	SLCPs reduction of all	Initiatives on practice	Policies and action plans

Policies	Stakeholders	Opportunities	Gaps	Development potentials
Action Plans (NAP, 2013)	Environment & Forest	relevant sources including Livestock productions; the final stakeholder workshop on the NAP (2013) made MoFL responsible for abatement measures of livestock production	changes in manure management are yet to be undertaken for cleaner air and more sustainable development of livestock.	will help undertaking of MoFL initiatives for market oriented practice changes in livestock manure management.
The Renewable Energy Policy of Bangladesh (2008)	Ministry of Power, Energy and Mineral Resources (MPE & MR)	Identified livestock manure as a major potential source of new energy, approved provision of VAT (15%) exemption for all equipment and raw materials used in producing new & renewable energy, subsidies to utilities for and incentive tariff for electricity generation from renewable energy sources.	Integrated approaches on livestock production and practice change in manure management for achieving sustainability.	Pre-fabricated anaerobic digestion system, opportunities of manure management practices within and outside the country and forward linkages of products of livestock may result in more sustainable livestock and cleaner air production.
National Livestock Development Policy, (2007) National Poultry Development Policy (2008).	Ministry of Fisheries and Livestock	Emphasized intensive management of dairy farms including waste recycling, environment management and safe and eco-friendly utilization of poultry litter.	policy and action plans are yet to be made effective and opportunities for practice changes in manure and environment management to be undertaken accordingly	ILMM and development activities importing improved practices within and outside the country may be initiated and all they may be linked with sustainable development goals (SDGs) of the country.
National Energy Policy (2004)	Ministry of Power, Energy and Mineral	MoFL is identified as a responsible ministry to develop livestock resources.	Weak awareness and initiatives	Policy and action plans of the MoFL will give impetus to development process of livestock

Policies	Stakeholders	Opportunities	Gaps	Development potentials
	Resources (MPE&MR)			production integrating manure management for new energy generation.

The **National Energy Policy (2004)** also emphasized new and renewable energy production and the MoFL is identified as a responsible ministry to develop livestock resources. All these domestic incentive provisions are approved for encouraging new and renewable energy production using different sources of biomass. New energy production is one of the improved systems of manure management. Bioslurry or liquid manure management and their value additions are also socioeconomically and ecologically important, and policy supports for their effective use are essentially required to be developed. In addition, improved options for livestock production are required to be integrated with improved manure management systems. Thus, an ILMM policy and action plans are required to be approved by the government. This will be used for undertaking development programmes for sustainable livestock and clean air production both by private and public sectors. The Ministry of Fisheries and Livestock will play a major role in the integration of improved livestock manure management and production of livestock following the ILMM and other related policies such as **National Livestock Development Policy, 2007 and the National Poultry Development Policy, 2008**. The latter policy documents emphasized i) intensive management of dairy farming including recycling of farm wastages and environment friendly farming and ii) safe and eco-friendly utilization of poultry litter, respectively.

The ILMM policy sets out the objectives, strategy and approaches for further promotion of anaerobic digestion of manure for generating new energy (biogas, biopower, Compressed BioGas (CBG), production of organic fertilizer/soil conditioner, vermicompost, organic pesticides, reduction of air pollution, threats to public health, and for making livestock production more sustainable. It will help livelihood improvement of rural smallholder farmers, especially, of the women, estimated to be owners of at least 50% of the livestock resources of the country. Linking effectively to the policies and stakeholders outlined above should go a long way towards achieving the ILMM objectives.

2.0 Mission and vision of ILMM Policy

The mission and vision of ILMM policy is to change traditional practices into demand driven, market oriented, value added utilization of livestock manure and thereby, reduce pollutions, protect public health, create new business and increase sustainability of livestock farm.

3.0 Objectives of the National ILMM Policy

The objectives of the Livestock Manure Management Policy are:

- i. To promote ILMM and sustainable production of livestock including reduction of enteric methane emission in the rumen, and thereby reduction of air and water pollution, and threats to public health.
- ii. To diversify and upgrade new energy and biological products through improved management of livestock manure, help generation of socioeconomic benefits out of livestock farming and enrich soil health.
- iii. To promote generation and adoption of new knowledge and science on the products, mechanical devices and system of improved livestock manure management.
- iv. To formulate and approve guidelines for adopting ILMM and creating people's awareness, and the necessary regulatory frameworks.
- v. To facilitate increased participation and investment of both the private and public sectors in the implementation of ILMM.
- vi. Strengthening regional and international cooperation and collaborative initiatives.

4.0 Perspectives of National ILMM Policy

The Constitution of Bangladesh is the supreme law for the country, where in Article 18A, it asked the state to protect and improve environment for present and future citizens. The Perspective Plan 2010 to 2021 of Bangladesh shared in the Rio+20 of the United Nations (UN) and the 6th Five Year Plan (FYP) described economic, social and environmental pillars to support sustainable development goals (SDGs) for graduating as a middle income country by 2021, and identified agriculture and food security as one of the priorities. The 7th FYP of Bangladesh has goal and target for environment sustainability, particularly improving air quality of major cities and enacting Clean Air Act. Reduction of Green House Gases (GHGs) was identified one of the challenges and the government has identified anaerobic digestion of bio-waste, like livestock manure, as a means of accelerating economic growth

while addressing environmental issues.

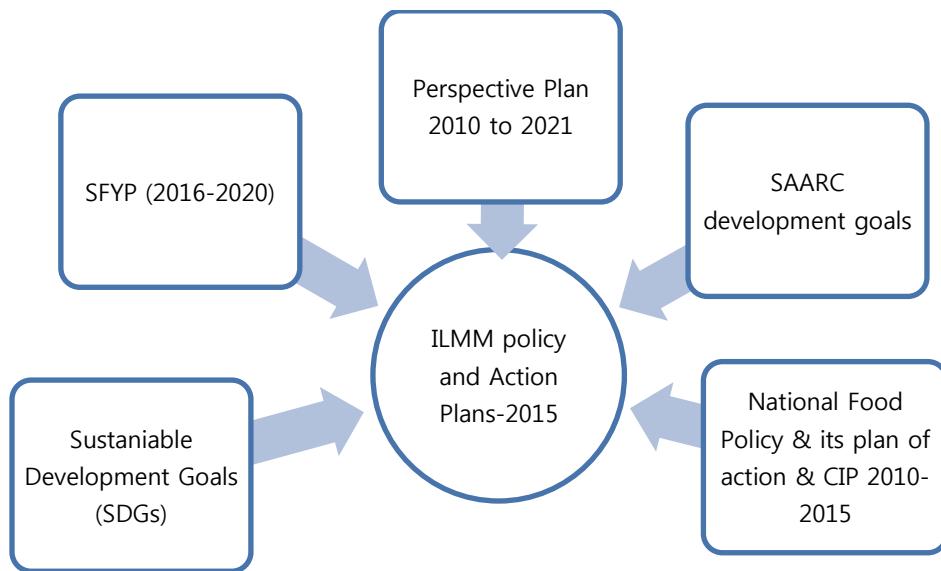


Fig3: Public policy supports to the Integrate Livestock Manure Management (ILMM) Policy and Action Plan

The perspective plan-2010 to 2021 of the government envisaging a prosperous and progressive nation, among others, underlined food and energy security, drastic reduction of poverty and environment friendly development as major development goals. Similarly, the SAARC development goals described livelihood, health, education and environment to fight against poverty. Recognizing the National Food Policy and its Plan of Actions and the Country Investment Plan (CIP) 2010-2015, the 7th FYP (2016-2020) of the government described the significant role of livestock for reducing unemployment and providing quality nutrition support and targeted it for sustainable improvement in milk, meat and egg productivity; income, nutrition and employment of landless, marginal and small farmers; and increased participation of private sector in livestock production and marketing. Thus, the present ILMM policy and action plan needs to be approved by the government for the sustainable development of livestock and the environment. All public, private, autonomous, or development organizations, NGOs and persons working within the geographical territory of Bangladesh and engaged in livestock production and management, livestock manure management, organic fertilizer/soil conditioner or biogas production or any other business related to livestock manure will be under the preview of ILMM Policy.

5.0 Inter-ministerial and organizational coordination and capacity building

5.1 The ILMM Policy and Action Plans will be implemented in integration of Ministry of Fisheries and Livestock (MoFL), Ministry of Environment and Forest (MoEF), Ministry of Agriculture (MoA), Ministry of Power, Energy and Mineral Resources; and related other organizations. The existing Steering Committee for ILMM policy formulation headed by the Secretary of MoFL may continue its' work as National Consultative Committee for ILMM (NCC-ILMM) at the end of the current project. The NCC-ILMM will maintain coordination among the stakeholders for the implementation of ILMM Policy and Action Plans. As in the Steering Committee, BLRI may continue its' secretarial role in the NCC-ILMM.

5.2 A "Livestock Production Environment Cell" will be established in the Department of Livestock Services (DLS) to coordinate, monitor and implement the policy and action plans. The DLS would be the functional organization for implementation and extension of ILMM activities at field level, and for monitoring and coordinating development of livestock farming and manure management by private organizations including NGOs. It will integrate livestock management with climate, clean air and healthy soil objectives, while maintaining strong collaboration with the Department of Environment and other relevant stakeholders. The capacity of the DLS on livestock production and environment will be strengthened creating a separate section with trained manpower on environment and manure management. Initially, one of its existing sections will be made responsible, and may undertake a manpower development programme on manure management and the environment.

5.3 Bangladesh Livestock Research Institute (BLRI) will strengthen its capacity through establishing "Livestock Production Environment Research Centre". It will take the leading responsibility of knowledge and science generation, adoption and testing of ILMM technologies at field level, identification of public health safety measures, and work in close collaboration with the DLS and other concerned public and private organization for extension, training and awareness creation on livestock manure management and clean air production.

5.4 The Ministry of Fisheries and Livestock (MoFL) along with the DLS and the BLRI will play the key role to implement the ILMM Policy and overall coordination with other stakeholders concerning manure management. The MoFL will have a separate section to coordinate and monitor the activities

of the environment and pollution including manure management and production of safe food of animal origins, maintaining integration in development programmes of different Ministries and organizations. Initially, officials from its departments may be hired and given responsibility, at least to start functioning.

5.5 The Ministry of Environment and Forest will extend support to the process of implementation of the abatement measures of the reduction of SLCPs of livestock origin as stated in the National Action Plan (2013) and implementation of development programmes.

5.6 The Ministry of Power, Energy and Mineral Resources following the National Energy Policy (2004) and Renewable Energy Policy of Bangladesh (2008) will support ILMM and maintain coordination for achieving a win-win situation both for effective utilization of manure for new energy and livestock production.

5.7 The Ministry of Agriculture deals with crop productions and uses livestock manure managed mostly through solid storage traditionally. It encourages use of livestock manure through the National Agriculture Policy (2013). ILMM will yield nutrient rich manure as organic fertilizer/soil conditioner, like that of vermicompost. Organic fertilizer/soil conditioner may reduce chemical fertilizer use helping clean air production, reducing pollution and promoting production of organic crops. Organic pesticide may help reduction of synthetic pesticide use and may help safe cereal food production. The Ministry will support the policies and action plans on ILMM and participate in the process of field activities, and facilitate manure based fertilizer/pesticide production, marketing and use by the farmers through simplifying licensing procedure.

5.8 Investment of private sector and participation of national and international development organizations including Non-Government organizations (NGOs) are extremely important for the implementation of ILMM at farm level. Organization of farmers, adoption of technologies (biogas, CBG, biopower, organic fertilizer/soil conditioner, organic pesticide), awareness development, product marketing, all requires coordinated efforts and initiatives of public and private sectors. Extension of Biogas technology is an ongoing activity of different public and private sector organizations. Initiatives on the organization of farmers' community and community Biogas production system and marketing of organic fertilizer/soil conditioner is tested and demonstrated by the Rural Development Academy (RDA). All these activities are required to be supported with livestock production and the

DLS may play key roles here. The technology needs to be refined further through adoption of knowledge and science, and through generating home solutions through research and development, and BLRI should play vital roles here.

6.0 Policy guidelines for sustainable production of livestock and clean air

6.1 Implementation of draft action plans in phases

The policy and action plans after having been approved by the government may be implemented in three phases as follows, and with the advancement of time and development and it may be revised further, when deemed necessary.

- a) Phase I (2016 to 2020): Implementation and extension of ILMM system in the livestock farms of public sector organization, and selected structured milk market areas, adoption and generation of technologies and knowledge of ILMM & its supporting machineries, awareness building, approve guidelines and legislation, capacity building. The efficiency of livestock manure management will be increased by 10-15%.
- b) Phase II (2021 to 2025): Further extension of ILMM in other livestock potential areas of the country, adoption and generation of technologies and knowledge of ILMM & mechanical devices, awareness building, capacity strengthening, market development of ILMM products, developed private sector. The efficiency of livestock manure management will be achieved at 25% and the number of profitable livestock farming increased by 10-15%.
- c) Phase III (2026 to 2030): The efficiency of livestock manure management will be achieved at 20% and the number of profitable livestock farming increased by 10%. Competitive advantages on ILMM both at public and private sector and market availability of inputs and products is improved. Farmers are quite aware on ILMM, about 50% of livestock farms in selected areas brought under ILMM.

6.2 Livestock farms at cities and towns may gradually be shifted considering the extent of air pollution and public health threats. Guidelines including compensation package may be formulated by concerned organizations, enacted accordingly after having approved by the government.

6.3 The registration process of livestock farming only includes declaration of the waste disposal

system being used. This should be amended following the existing procedure of the country to regulate and control the system. A comprehensive statement of the manure management system to be followed on the farm could be formulated, including size, type and the capacity of manure storage facility; period, rate and method of manure application; possibilities to extend the size of farm, particularly, distance of nature reserves, water bodies etc. A comprehensive guideline should be formulated and implemented by the DLS.

6.4 Livestock farmers should be encouraged and facilitated to construct either individual or community biogas plant and/or environment friendly manure storage and treatment facilities irrespective of their size of farms. Community livestock farming should be encouraged both for improved manure management and marketing of products. Existing livestock farming guidelines should be revised considering air and water pollution caused by livestock manure management system.

6.5 Legislation would be set to have mandatory ILMM facility and practices in farms of define category to be developed by concern organizations. For example, having at least 10 large ruminants (cattle/buffalo), or 20 small ruminants (sheep/goat) or 200 poultry under confined farming system should have ILMM facility and practice. Incentive package may be declared to implement the legislation.

6.6 The Ministry of Agriculture and the Ministry of Fisheries and Livestock jointly formulate guidelines and incentive package for production, processing and marketing of organic fertilizer/soil conditioner, vermicompost and organic pesticides. Technical and financial support will be provided to encourage private sector investment for organic fertilizer/soil conditioner, vermicompost and organic pesticide production from solid, liquid manure and bioslurry. Formulation of regulations and/or amendment of existing regulations will be put in place to facilitate the production, marketing and use of manure based products. The experience of relevant countries will be used to have an effective system.

6.7 Biogas processing including purification and compression of methane and organic pesticide technology will be adopted/generated and demonstration plants will be established at public sector initially and subsequently at on-farm level.

6.8 Livestock farmers in selected areas at initial phase will be brought under ILMM system. A coordinated development programmes financed by the government may be initiated and

implemented by the concerned stakeholders.

7.0 Policy guidelines for mitigation of threats to public health

- 7.1 Awareness on the use of biogas replacing livestock manure as burned fuel and public health threats will gradually be created. A time bound phase out program of manure burning will be undertaken jointly by the concerned stakeholders.
- 7.2 Awareness on direct discharging impacts of solid manure or liquid effluent into the river, water streams and pond including aquaculture would be increased using mass media.
- 7.3 Treating manure in anaerobic digesters or composting before spreading in crop field or aquaculture pond would be promoted.
- 7.4 Guidelines on the placement of manure pits or stock piles should be formulated and farmer awareness will be increased (distance from water sources, like at least 100 feet from rivers, streams, lakes or ponds, 100 feet from any open sinkhole, 100 feet from any drinking water well, distance from upslope water in hilly areas, etc) by the concerned stakeholders.

8.0 Policy guidelines for Research and Development (R&D) and Extension

- 8.1 Short and long term R&D plans of ILMM will be formulated and implemented by research and educational institutions. Multi-institutional time-bound research programs with clear goals and milestones would be developed and implemented under financial support of the government, initially, and investment in R&D activities of private sector and international development organizations will be encouraged simultaneously.
- 8.2 The impact of ILMM will be assessed keeping consideration of the improvement of clean air & water production, public health, livestock production, and improvement of farmers' socioeconomic conditions.
- 8.3 Guidelines on the demonstration and extension of ILMM will be formulated by the DLS and concerned public sector organizations. Extension activities of public and private sector will be implemented in different livestock potential areas of the country.
- 8.4 A digest of ILMM will be included in secondary education text books for awareness creation of

the concerned. The Ministry of Fisheries and Livestock and the Ministry of Education may take necessary follow up actions.

- 8.5** Programmes on sustainable livestock development for women empowerment, and safe food and clean air production will be undertaken jointly by the MoFL and the MoE&F.
- 8.6** Public-private-participatory development programmes will be undertaken for the production of compressed bio-methane, organic fertilizer/soil conditioner, organic pesticide and marketing of the products.
- 8.7** Demonstration of new processing technology of manure and necessary mechanical support systems may be adopted from global sources.
- 8.8** Biennial regional/international show and seminar on ILMM, equipment and machineries of feed and manure processing and livestock farming will be organized by the DLS and the BLRI taking financial support of the government. The organization of show and seminar will gradually be shared by the private sector.
- 8.9** Domestic competitiveness on mechanical and equipment support for ILMM, feed and livestock farming gradually be strengthened inviting support of the concerned public and private organizations. Concerned organizations will take necessary initiatives for strengthening domestic capacity in the related field.

9.0 Policy guidelines for Awareness creation

- 9.1** A package of awareness programme may be formulated and implemented jointly by the MoFL, BLRI and the DLS and other relevant stakeholders.
- 9.2** A new website will be developed and/or existing website will be updated to showcase the socioeconomic benefits of ILMM and for sharing of database of the current practices of manure management, zoonoses and human health impacts, air and water pollution.
- 9.3** Rewarding “flagship farm” for best implementation of ILMM practices will be initiated. Flagship farms will be considered for providing media coverage and hosting of field visit programme for other farmers to make an effective motivation.

9.4 Training programmes for trainers, farmers and entrepreneurs may be formulated and implemented. Flyers, booklets, leaflets, on the best practices of manure management would be promoted, published and distributed to farmers and related stakeholders.

10.0 Policy guidelines for investment, credit access and financial incentives

- 10.1 The ILMM system including organic fertilizer/soil conditioner, vermicompost, biopower and organic pesticide production and livestock farming will be included in the existing credit programmes of the government.
- 10.2 Guidelines will be formulated for the implementation of incentive packages declared in different public policies of Bangladesh, especially, the Renewable Energy Policy of Bangladesh 2008, in addition to farmers' support for establishing biogas plant.
- 10.3 The ILMM system may be linked with micro-credits and insurance for livestock farming of different banks, NGOs and other financial organizations.
- 10.4 Milk marketing organizations may support their members on ILMM and putting conditions of ILMM along with an incentive package may gradually be introduced in the milk procurement system. Private sector participation in production, processing, conversion and value addition of biogas and organic fertilizer/soil conditioner would be encouraged and promoted.

11.0 International Co-operation

Bangladesh is the founding member of the CCAC, and having an approved ILMM policy, it may play pivotal roles on livestock manure management, clean air production and development of sustainable livestock farming, especially, at smallholder level. It will be a potential leverage of funds to finance the action plans for implementing the ILMM systems. Development partners of Bangladesh may share technical and financial assistance for the implementation of the action plans addressing sustainable development goals and targets, especially target 7.a and goal 17. Bilateral understanding with research and educational organizations irrespective of restrictions of geographical boundaries of both public and private sector may be reached for harnessing new knowledge and ILMM technology and livestock farming. The Economic Relation Division (ERD) of the Ministry of Finance may play a

significant role for sharing the investment of development partners for implementing the ILMM of Bangladesh. Moreover, expert exchange programme, participation in technological show and seminar may be encouraged. Short and long term training on ILMM and livestock farming may be initiated regionally and globally for capacity building on emerging science, knowledge and technology.

Annex 1

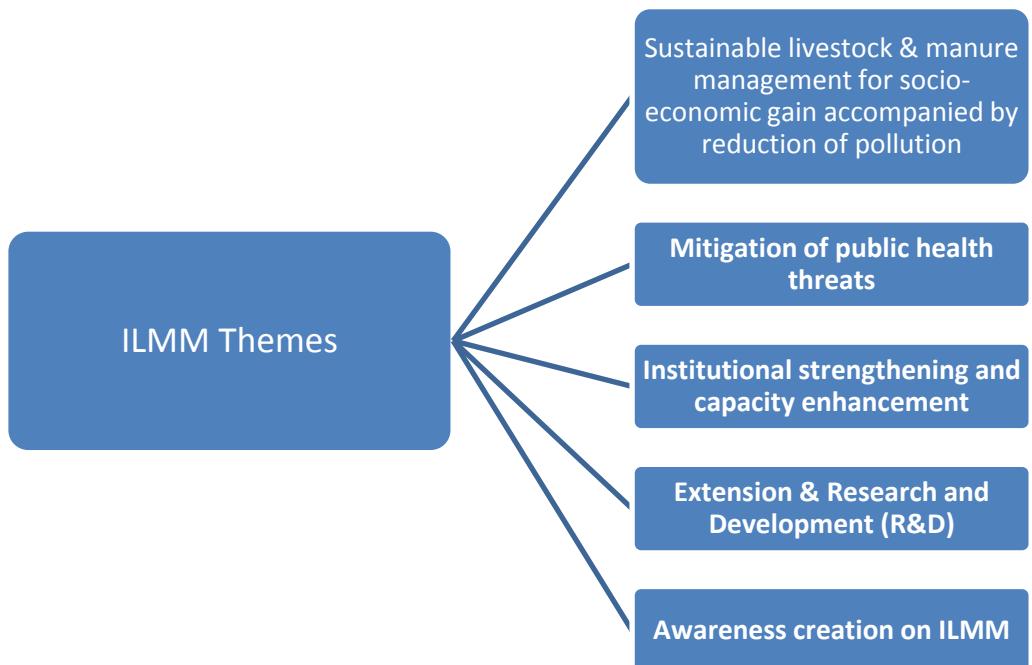
Action Plans (2016 to 2030)

The National Integrated Livestock Manure Management (ILMM) policy and action plan is a 15 years programme (2016 to 2030) with a vision to achieve sustainable livestock development through consequential reduction of SLCPs of animal farm origins. Adoption of ILMM will provide opportunities for practice change in livestock production and its manure management, and help in the gradual transformation of livestock production and its manure management into market oriented systems. Continuous improvement of competitive advantages in terms of human (management, quantity, cost, skills etc), physical (land, water, power, climate), knowledge (scientific, technical & market information) and capital resources and creation of awareness of concerned for achieving the objectives set-out in the national ILMM policy within the time-frame will be an added advantage. The action plans and themes of ILMM will help promotion of healthy lives and well beings of farmers, especially, women and children, and increase access to clean air and affordable bio-energy of rural peoples simultaneously reducing SLCPs. The implementation of action plans in phases (2016-2030) by different stakeholders will help sustainable livestock production and strengthen partnership with developing and developed nations for clean livestock practices, infrastructure development and protect natural resources from degradation. Knowhow and technology transfer on manure management will pave the way for using organic manure/soil conditioners for optimizing productivity of crops under different soil conditions in Bangladesh. Integrated efforts of concerned stakeholders, trained human resource and easy access to sustainable practice changes will help achieving sustainable development goals of zero hunger (Target 2.2, Target 2.4); gender equality (Target 5.c); affordable and clean energy (Target 7.2, Target 7.c) reduce inequalities (Target 10.1); and climate actions (Target 13.1 and Target 13.2) by 2030. Farmers and industry responsive legislation will be developed to promote biogas use and/or eco-friendly manure treatment facility at small and large

livestock and poultry farms with suitable incentives for installation, and new energy production. Compressed biogas, organic fertilizer/soil conditioner and biopesticide technology will be adopted/generated and demonstration plants on farm and on station will be established, and will cause young farmers to turn into livestock farming in different regions of the country.

The ILMM focuses on five themes along with programmes on sustainable livestock development, women health & welfare, human resource development, technology & know how transfer, and awareness building having a vision of implementation (2016 to 2030) as illustrated below.

Themes of Integrated Livestock Manure Management and programmes



(Duration : 2016 to 2030)

Theme	Programmes
Sustainable livestock &	1. On-station and on-farm adoption of improved practices in manure

manure management for socio-economic gain accompanied by reduction of pollution	<p>management for sustainable livestock production and clean air production</p> <p>2. Development of market oriented manure based value added products and reduction of SLCPs</p> <p>3. Formulation and implementation of legislations</p> <p>4. Reduction of manure burning</p> <p>5. Adoptions of abatement measures for reducing enteric methane emission in the rumen and increase of productivity of ruminants</p>
Mitigation of public health threats	1. Development and implementation of ILMM guidelines for public health protection
Institutional strengthening, capacity building and partnership development	<p>1. Establishment of Livestock Production Environment Cell in the Department of Livestock Services (DLS)</p> <p>2. Establishment of "Livestock Production and Environment Research Centre" in BLRI</p> <p>3. Strengthening human resource capacity</p>
Research and Development (R&D), and Extension	<p>1. Research and Development (R&D) programme on livestock manure management</p> <p>2. Extension of knowledge and technology</p> <p>3. Impact assessment of ILMM policy</p>
Creation of awareness on ILMM	<p>1. Create awareness using mass media</p> <p>2. Publication and distribution of printed materials</p> <p>3. On-farm awareness building</p> <p>4. Launching website</p>

Activity – T1P1

Theme	T1: Sustainable livestock & manure management for socio-economic gain accompanied by reduction of pollution
Programme	P1. On-station and on-farm practice changes in manure management for sustainable livestock and clean air production
Objective	To increase gross margin of livestock farming, employment, production and productivity of livestock, reduce SLCPs and pollution of soil, water and air

	from manure
Justification	A survey work of 2015 conducted by BLRI showed that farmers raised dairies with improved manure management had 9.97% more annual income, 17.5% increased daily milk sale and created 9.05% additional employment. Crop yield of the farmers used organic fertilizer increased by 1.70% reducing chemical fertilizer use by US\$49.8/farm. Daily milk intake of a family increased by 10.7%, and monthly expenditure for medical support reduced by US\$1.87/family. Women stated that they saved household keeping time daily by 1.35 hours/head; daily shared at least 1.0 hr more with their children, prepared hygienic food for their family, and had no tension for firewood, in addition to keeping their hands and cloths more clean. Thus, any practice change in traditional manure management adopting available technology and knowledge will help increased production and productivity of animals, and may make livestock farming sustainable helping production of cleaner air and water. This will encourage growing and literate peoples to be involved in livestock farming.
Actions	<p>A1. On-station demonstration of improved practices of livestock farming and manure management.</p> <p>A2. Formation of societies/rural livestock production community/community based organization initially in livestock potential areas and gradually extend it other farmers</p> <p>A3. On farm adoption of biogas production and organic fertilizer program</p> <p>A4. Introduce marketing strategy for manure based products, and reduction of market barriers.</p>
Timeline	Phase I (2016-2021), Phase II (2021-2030)
Implementing organization(s)	MoFL, BLRI, DLS, DAE , local and global development organizations

Program – T1P2

Theme	T1: Sustainable livestock & manure management for socio-economic gain accompanied by reduction of pollution
Programme	P2. Development of manure based value added products and reduction of SLCPs and pollutions
Objective	To increase gross margin of livestock farm, reduce SLCPs and pollution of soil, water and air from manure
Justification	Improperly/mismanaged manure is a significant source of methane and other SLCPs that pollute air, water and soil in different ways. Anaerobic digestion for biogas production is the gateway to enter into adoption of market-oriented value addition systems of livestock manure that can help sustainable livestock development and reduction of methane emission to environment. Currently many local and global organizations are working on these technologies demonstrating national ILMM. Utilization of bio-slurry from biogas plant, solid manure, liquid manure, urine which have potential use for organic -fertilizer, vermicompost, liquid fertilizer and bio-pesticide production required to be developed and strengthened.
Actions	<p>A1. Formation of societies/rural livestock production community/community based organization</p> <p>A2. Strengthening biogas production and organic fertilizer program</p> <p>A2. Development of organic -fertilizer, bio-pesticide and liquid manure production from manure</p> <p>A3. Development of appropriate marketing strategy for manure based products and reduction of market barriers.</p>

	A4. Development of entrepreneur
Timeline	Phase I (2016-2021), Phase II (2021-2030)
Implementing organization(s)	MoFL, BLRI, DLS, DAE , Local and Global development organizations

Programme – T1P3

Theme	T1: Sustainable livestock & manure management for socio-economic gain accompanied by reduction of pollution
Programme	P3. Formulation and implementation of legislations
Objective	To provide a legal framework for sustainable livestock production and effective implementation of multi-stakeholder ILMM policy
Justification	A set of legislations would be formulated and enacted to implement ILMM policy. The regulation will necessitate them to adopt specific livestock management practices and impose requirements on farmers to achieve specific levels of environmental quality. Any violation of regulations may restrict them to get permits, access of financial benefits e.g., credits and subsidies, penalties and other conditions to fulfilling minimum requirements for following management guidelines by the authority. It will also protect producers, investors, consumers along with general public interests and commitment of the Government of Bangladesh to protect environmental pollutions according to other policies.
Actions	A1. Fielding of experts A2. Formulation and implementation of manure management legislations A3. Guideline formulation for different livestock farming

	A4. Regulatory frame works for different farm practices
Timeline	Phase I (2016-2021)
Implementing organization(s)	MoFL, DLS, MOA, DAE, BLRI

Programme – T1P4

Theme	T1: Sustainable livestock & manure management for socio-economic gain accompanied by reduction of pollution
Programme	P4 Reduction of manure burning
Objective	To reduce air pollution, save women labour, increase child care and improve family health status of women and other livestock producer
Justification	<p>About 40% of the manure produced from large ruminants is burned as fuel in Bangladesh. Burning fuel produces black carbon, ash particles and smokes containing noxious gases. The women and children are the primary victim as they get exposure of these hazardous materials and biotic agents in manure during cake/ stick making. Considerable amount of women labour and time will be saved for child care and family welfare activities. Therefore, time-bound phase-out program for reducing manure burning will be formulated and initiated in the first phase.</p> <p>There are two abatement measures selected for reducing black carbon and methane emissions in the Bangladesh National Action Plan and they were related to biogas production from livestock and poultry, namely 'substitution of biomass cook-stoves with stoves using clean-burning fuel (biogas)' and 'control of methane emission from livestock through anaerobic digestion of manure from cattle and poultry'.</p>

Actions	A1. Formulation of an integrated program for reducing manure burning and implementation plan involving other stakeholders considering incentives, subsidies and legislations. A2. Proper campaign and implementation of plan, periodical evaluation of the progress.
Timeline	Phase I (2016-2021)
Implementing organization(s)	MoFL, BLRI, DLS , Local and Global development organizations

Programme – T1P5

Theme	T1: Sustainable livestock & manure management for socio-economic gain accompanied by reduction of pollution
Programme	P5. Adoptions of abatement measures for reducing methane emission in the rumen and increase of productivity of ruminants
Objective	To reduce methane emission in the rumen, increase feed utilization, increase animal productivity and thereby reduce pollution per unit of livestock production
Justification	Livestock are considered to be one of the largest single sources of methane emission with 80-115 million tons per year, equivalent to 15-20% of total anthropogenic methane (IPCC, 2001). Methane emission from ruminants not only contributes to greenhouse gases (GHG) but also a loss of feed energy to the host animal. Appropriate feeds and feeding system development along with feed processing will reduce enteric methane emission significantly. Development of protein rich feed, quality fodder, herbal or microbial feed additive for boosting animal performance in addition to reducing enteric methane emission could be a good option for

	abatement measures of methane emission from ruminants.
Actions	<p>A1. Ration balancing, balanced nutrient Feeds and feeding system, and feed additive development (e.g., herbal and/or microbial additive), value addition to feeds and fodders</p> <p>A2. Adoption of feed processing machineries, and development of feed entrepreneurs</p>
Timeline	Phase I (2016-2021)
Implementing organization(s)	BLRI, DLS, Local and Global development organizations

Programme – T2P1

Theme	T2: Mitigation of public health threats
Programme	P1. Development and implementation of ILMM guidelines for public health protection
Objective	To protect livestock producers and rural people, especially, women and children from potential health hazards concerning manure management
Justification	Solid manure storage and dung cake/stick making practices expose women and children to biotic agents present in manure that are passed out by disease carriers and infected animals. Therefore, potential threats on public health from manure management and their ways out would be recorded under the program to develop comprehensive guidelines on farm manure management.
Actions	A1. Development and implementation of ILMM guidelines for public health surveillance and protection

Timeline	Phase I (2016-2021)
Implementing organization(s)	BLRI, DLS, MoFL, Ministry of Health , Local and Global development organizations

Programme – T3P1

Theme	T3: Institutional strengthening, capacity building and partnership development
Programme	P1. Establishment of Livestock Production and Environment Cell in DLS
Objective	To coordinate ILMM policy implementation Planning & management of all environmental issues in livestock sector including ILMM
Justification	Currently there is no responsible division/section in DLS to address the environmental issues related to livestock production in Bangladesh, and in addition human resource capacity is also required to be strengthened. The ILMM policy has multi-sectoral involvement and, therefore, a cell in the DLS needs to be established to coordinate and seek cooperation of different stakeholders for proper and speedy implementation of ILMM in Bangladesh. Bangladesh Climate Change Strategy and Action Plan (2008) also felt necessity of establishing similar nodal agency / cell (e.g. to establish climate cells in ministries and their agencies) to strengthen institutional capacity for climate change management.
Actions	A1. Establishment of Livestock Production and Environment Cell in DLS. A2. Initiation of the program by hiring and giving responsibility to a group of existing manpower of DLS , add additional manpower
Timeline	Phase I (2016-2021), Phase II (2022-2030)

Implementing organization(s)	MoFL, DLS, Ministry of Public Administration, Ministry of Finance, local and global development organizations
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Programme – T3P2

Theme	T3: Institutional strengthening, capacity building and partnership development
Programme	P2. Establishment of "Livestock Production and Environment Research Center" in BLRI
Objective	To conduct R&D, adoption of technologies, training and development of ILMM system and livestock related environmental issues
Justification	Bangladesh Livestock Research Institute (BLRI) is the only National institute in Bangladesh for conducting research on livestock production and health. The scientific manpower strength is limited and not fully equipped for up front areas of environment research and development. The human resource development, therefore, it is a priority to cater future needs of scientific developments and train manpower to cope with challenges of climate change in future. Therefore, a new research division to deal with environment issues pertaining to livestock production including SLCPs will be established. The division will also work to adopt/develop/adapt cost effective sustainable technologies available locally and/or globally, and for their demonstration on farm. There is a strong need to identify and integrate indigenous technical knowledge for the benefit of farmers considering their socio-economic conditions.
Actions	A1. Initiation of the program by formulating a DPP in Phase I A2. Establishment of "Livestock and Environment Research Centre" in BLRI

	under revenue.
Timeline	Phase I (2016-2021), Phase II (2022-2030)
Implementing organization(s)	MoFL, BLRI, Ministry of Public Administration, Ministry of Finance

Programme – T3P3

Theme	T3: Institutional strengthening, capacity building and partnership development
Programme	P3. Strengthening human resource capacity
Objective	To develop adequate human resource capacity to implement ILMM policy and action plan effectively
Justification	The country at present do not have adequately trained manpower on efficiently implementation of the ILMM policy and action plan, formulate programs and projects to properly addressed manure management issues. Therefore, it is necessary to strengthen human resource capacity of the public sector, academics and research institutions, private organizations, NGOs, farmers and related stakeholders. The HRD Programmes will include short and long term training at home and abroad, study tours and exchange visits. A number of training programmes for the trainers (ToT), farmers and investors will also be organized.
Actions	<p>A1. Strengthening the capacity of policy makers, researchers and extension workers for policy implementation, project and program formulation and implementation</p> <p>A2. Strengthening the capacity of farmers (especially women), investors and other stakeholders</p> <p>A3. Formulation of integration and coordination system among the</p>

	stakeholders and training of manpower to work under the system
Timeline	Phase I (2016-2021)
Implementing organization(s)	MoFL, DLS, BLRI, Local and Global development organizations

Programme – T4P1

Theme	T4: Research and Development (R&D), and Extension
Programme	P1. Research and Development (R&D) programme on livestock manure management
Objective	Adoption of sustainable ILMM with suitable on farm modifications/adaptation of sustainable technologies or improved manure management practices, improvement of bio-gas and bio-fertilizer production technology, exploring opportunity to produce CBG, bio-power and organic pesticide from livestock manure, identification of potential public health threats from manure and suggest possible preventive or protective methods for bringing practice changes on farm.
Justification	A good number of technologies are already in practice locally and globally. Bangladesh need to adopt suitable viable practices and socioeconomically feasible technologies based on past experiences, production of biogas from manure is widely practiced in Bangladesh but the efficiency of systems is low, and sometimes become vulnerable to a wide number factors. Therefore, cost effective and sustainable systems with high efficiency per unit of manure need to be adopted initially at large farms and community farmers. Utilization of bio-slurry, a byproduct of biogas plant and of liquid fertilizer will be explored for their full potential. Development of bio-pesticide from animal urine or extracted water of slurry may be practiced for making ILMM more cost effective and

	<p>profitable. This will be possible only after extensive research on the identification of active substances, development of product and marketing strategy considering the existing legislation for pesticide production and marketing, residual presence of toxic materials on crops or vegetables and their potential impact on public health.</p> <p>Identification of threats to public health from manure management and abatement measures to reduce/alleviate them should be a major priority for research in Bangladesh due to high exposure of rural people to improper/mismanaged manure.</p> <p>There is a need to develop state – of- the- art- methane measurement facilities (SF-6 and Chamber facilities) from livestock to generate country specific methane emission coefficients and conversion factors for different livestock species under field and farm conditions. This will help reducing uncertainties in reporting emissions from livestock sector and build human resource for future research and development needs at country level.</p>
Actions	<p>A1. Formulation of short- and long-term R&D plan</p> <p>A2. Research on value added product development from manure and their marketing</p> <p>A3. Public health research concerning manure management</p> <p>A4. Development of methane measurement facility (field and farm monitoring)</p>
Timeline	Phase I (2016-2021), Phase II (2021-2030)
Implementing organization(s)	MoFL, BLRI, MoE, MoA, Universities, Local and Global development organizations

Programme – T4P2

Theme	T5: Research and Development (R&D), and Extension
Programme	P2. Extension of knowledge and technology
Objective	Dissemination of knowledge and technologies for productive and environment friendly manure management practices
Justification	Strong and extensive extension work having unbreakable link between the two is needed for better implementation of ILMM policy and action plan in Bangladesh. Existing knowledge and technologies need to be transferred effectively to stakeholders, therefore, guidelines on productive and eco-friendly manure management and technologies demonstration need to be formulated. This will also help extension agencies for educating farmers and entrepreneurs through awareness building programmes (as described under T5).
Actions	A1. Mapping of dairy production zones for piloting ILMM A2. Selection of areas for technology intervention/ transfer. A3. Formulation of guidelines for productive and environment friendly manure management practices A4. Formulation of guidelines for demonstration and extension
Timeline	Phase I (2016-2021), Phase II (2021-2030)
Implementing organization(s)	DLS, BLRI, MoFL, Local and Global development organizations

Programme – T4P3

Theme	T4: Research and Development (R&D), and Extension
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Programme	P3. Impact assessment of ILMM Policy
Objective	Periodic assessment of impact of ILMM policy and action plan for increasing livestock farm profitability, creation of new businesses, women empowerment, reducing SLCPs, environment pollutions and public health problems.
Justification	Periodically, the impact of ILMM policy will be assessed and necessary amendment will be made. Before implementing the policy, existing scenario of manure management practices and their impact on SLCPs production, pollution, public health, farm income, women empowerment, child education etc. needed to be benchmarked.
Actions	<p>A1. Identification of current manure management practices and impact assessment study.</p> <p>A2. Fielding of expert</p> <p>A3. Adoption of ILMM policy and its impact assessment</p>
Timeline	Phase I (2016-2021), Phase II (2021-2030)
Implementing organization(s)	BLRI, DLS, Universities, Local and Global organizations

Programme – T5P1

Theme	T5: Creation of awareness on ILMM
Programme	P1. Creation of awareness using mass media
Objective	To sensitize mass people and create primary awareness regarding ILMM
Justification	Livestock farmers and public in general is not fully aware of threats from manure and its miss-management, therefore, livestock farmers or related

	stakeholders, general public will be made sufficiently aware about the potential use of livestock manure as well as threats from manure on environment and public health. Information will disseminated through existing A to I system of government. Existing TV channels (about 40 television channels), news papers (25 national daily newspapers in Bengali, 12 in English) about 20 online news portals and numerous local or regional daily are circulating across the country may be used for creating awareness on health benefits of proper manure management. Therefore, sensitization of general public on health issue related to manure and primary awareness build-up may be made using mass media.
Actions	A1. Awareness building advertisement in print media A2. Mini dramas, TVC and documentary production and telecast in electronic medias(e.g., televisions, you tube, face book groups or other social media)
Timeline	Phase I (2016-2030)
Implementing organization(s)	MoFL, DLS, BLRI, Local and Global development organizations

Programme – T5P2

Theme	T5: Creation of awareness on ILMM
Programme	P2. Publication on ILMM and distribution of printed materials
Objective	To make aware the farmers, stakeholders, academicians, researchers, policy makers and general peoples To provide brief guidelines on ILMM for proper use
Justification	Printed materials are important for increasing dissemination of knowledge

	and know how. This requires continuous generation of knowledge through research and development works, adoption of knowledge and technology available regionally and globally. A digest on ILMM may also be introduced at secondary school level for creating awareness of the growing generations.
Actions	<p>A1. Publication of booklets, leaflets, flyers, folders, posters, stickers etc.</p> <p>A2. Distribution and publicity of the materials free of cost</p> <p>A3. Introduction of ILMM digest at secondary school level</p>
Timeline	Phase I (2016-2030)
Implementing organization(s)	MoFL, DLS, BLRI, Local and Global development organizations

Programme – T5P3

Theme	T5: Creation of awareness on ILMM
Programme	P3. On-farm awareness building / Farmers School programme
Objective	To introduce ILMM to farmers and encourage to practice ILMM
Justification	Practical demonstration programmes of ILMM, organization of field day, farm visit programs/ farmers' school, study tour for the farmers are most used and appreciated methods for implementing new ideas and technologies. Annual selection of "Flagship Farm" in selected areas on the basis of best manure management practices and rewarding the farm could be a good option to motivate others toward good practices. Flagship farm could be the role model and may serve as the "proof of concept" for ILMM practices in pilot areas.

Actions	A1. Organizing field day, study tour for farmers, farm visits, group meetings, and practical demonstration programs A2. Awarding "Flagship Farm" for ILMM in pilot areas
Timeline	Phase I (2016-2030)
Implementing organization(s)	MoFL, DLS, BMPCUL, MOA, DAE, Local and Global development organizations

Programme – T5P4

Theme	T5: Creation of awareness on ILMM
Programme	P4. Launching website
Objective	To open the access of information for all stakeholders and to be connected with global knowledge bank on manure management
Justification	A website on manure management kiosk in Bangladesh will provide regular updated information of national and international ILMM practices, ideas, research, knowledge and technologies. Investors may be linked-up through this website with the global community for better knowledge exchange and sharing.
Actions	A1. Development of website on manure management kiosk/sharing of existing website in Bangladesh
Timeline	Phase I (2016-2030)
Implementing organization(s)	MoFL, DLS, BLRI, Local and Global development organizations