ADDRESSING FEED SHORTAGES THROUGH EXPLORATION OF UNCONVENTIONAL FEED RESOURCES FOR ACCELERATED LIVESTOCK DEVELOPMENT IN BANGLADESH

October 2020

SDGs:

Countries: Bangladesh

Project Codes: TCP/BD/3607

FAO Contribution USD 250,000

Duration: 1 September 2018 – 31 December 2019

Contact Info: FAO Representation in Bangladesh

FAO-BD@fao.org
Implementing Partner
Department of Livestock Services (DLS), Ministry of Fisheries and Livestock.

Beneficiaries
Women and men leading smallholder dairy households experiencing insecurity of feeds for their livestock, and policy-makers.

Country Programming Framework (CPF) Outputs
Programme Pillar 3: Resilient and Inclusive Agro-Economic Growth.
Country outcome 3: Sustainable agricultural production and commercialization through inclusivity and resilience building.
Priority area 2; outcomes 3A, 3D and 3E of priority area 3 and outcome 4A and 4B of priority area 4, where technical capacity of DLS animal nutrition laboratories and officials, assessment of feed stocks, improved technologies to increase post-harvest feed losses, as well as their preservation techniques and way out diversified use of unconventional feed resources will be possible.

BACKGROUND
Growing demand for livestock products in Bangladesh offers attractive opportunities for strengthening household-level food security, nutrition and rural livelihoods. However, the sector’s ability to capitalize on these opportunities is constrained by poor productivity of animals at farm level. Scarcity of feeds and fodder is one of the major constraints identified for cattle production in the country. In addition to forage scarcity, the cost of feeding represents the largest expense (around 70 percent) in most livestock operations. However, the country has many resources that can sustain ruminant livestock, such as agro-industrial by-products, on which ruminant livestock can survive. In view of this, it was necessary to recognize the availability of these resources and use them skilfully. Methods include physical, chemical and biological treatments of coarse material.
Against this background, the Government of Bangladesh requested that FAO provide assistance in the development of animal nutrition. The project aimed to increase animal productivity and profitability for beneficiary farmers, leading to better health of animals and decreased costs in the treatment of animals.

IMPACT
It is expected that the project will contribute to strengthening dairy productivity, decreasing feed costs, increasing profitability and enhancing livelihoods, as a result of the efficient use of new and existing feed resources.

ACHIEVEMENT OF RESULTS
The key achievements of the project were the identification of cattle feed practices in Bangladesh through a cross-sectional cluster survey; the development of methodology and guidelines for national Feed Balance Sheet (FBS) preparation; and strengthened laboratory capacity of the Department of Livestock Services (DLS) for good quality practice and feed analysis. These will assist in adopting appropriate feeding systems based on local feed resources that maintain the environment, as well as helping policy-makers formulate more sustainable livestock development programmes. Capacity development was a major component of the project, the key training activities are outlined below.
Fifteen participants from the DLS, academia, research institutions and the feed industry were trained on least cost dairy animal ration formulation, comprising how to formulate rations using the FAO ration balancing tool and mobile applications.
Chemicals and equipment were procured to enhance the capacities of the Central Animal Nutrition Laboratory (CANL) of the Animal Nutrition Section, Livestock Research Institute of the DLS, and the district animal nutrition laboratory (DANL) of Rangpur, in testing for the presence of anti-nutritional factors and toxins in feed ingredients, and performing proximate analysis. This has enabled the trained staff to test toxins and anti-nutritional factors according to the developed standard operation procedures (SOPs) mentioned below.
DLS officials and other stakeholders, including laboratory technicians, researchers, academic staff and officers, were trained to increase the laboratory capacity of DLS and other stakeholders. Documents were provided on quality assurance for microbiology in a feed analysis laboratory, and FAO helped establish quality control within the laboratory, and improve sample collection storage and use of the FAO Laboratory Internal Audit Tool and software.
DLS personnel were trained on ration formulation and FBS preparation based on a database, including both unconventional and conventional feed available in Bangladesh. The training provided the DLS with the information and tools needed to generate data on an annual basis, to create and maintain a national FBS. In addition, templates, together with relevant documents, such as questionnaires on agro-industrial by-products and competitive use of crops and crop-to-crop conversion factors, were provided to the DLS for preparing a national FBS. Other training activities comprised: i) the integration of practices, including a quality control system for feed analysis laboratories and testing for anti-nutritional factors in food sources; ii) Quality Management Systems (QMS), International Organization for Standardization (ISO) Certification and laboratory accreditation; iii) the fundamentals of ISO 17025; and iv) skills development for feed analysis.

Nine standard operation procedures (SOPs) were developed to test myo-inositol, aflatoxin Enzyme-Linked Immunosorbent Assay (ELISA), among others.

With regard to training for the beneficiary farmers, 238 dairy farmers (of whom 45 were women) from five districts were successfully trained on various technologies for cattle feed management, comprising high-yield fodder production, total mixed ration, silage, urea molasses straw (UMS), calf management, among others. Some of these farmers were also entrepreneurs, who benefited from learning about modern technologies for business planning. In addition, a relationship was fostered between farmers and entrepreneurs.

**IMPLEMENTATION OF WORK PLAN**

The activities of the project were implemented on time, as per the revised work plan and Letter of Agreement (LoA). The partner stakeholder regularly monitored and delivered reports on the project activities according to the LoA. All the project activities implemented within the planned budget.

**FOLLOW-UP FOR GOVERNMENT ATTENTION**

As mentioned above, trained laboratory scientists and technicians of the CANL are now able to test toxins and anti-nutritional factors, according to the developed SOPs. They will follow this up with testing toxins and anti-nutritional factors in animal feed. The Agriculture (crop, fisheries and livestock) Census was done in June 2019, but the result has not been published yet. To make the national feed balance database more accurate, livestock data can be obtained from the census result.

Trained DLS officials on least cost dairy animal ration formulation can now provide training to field officials, who can then train the farmers. In addition, the trained individuals from academia can educate students on ration formulation by using the FAO ration balancing tool and mobile applications.

It is recommended that the DLS continue to provide training on calf milk replacer to farmers, through the dairy farmers’ association in each district/division of Bangladesh.

With regard to the development of a feed resource database, CANL can move forward by compiling their feed samples’ nutrient composition, to obtain an average value and standard deviation of a particular feed. In addition, DLS can collate the nutrient composition data from the research institutes and agricultural universities to make a more comprehensive feed database. It is recommended that the Government of Bangladesh use this database for the formulation of any livestock development programme in the future. It is also recommended that the DLS share this information on their website for further use by other stakeholders in the livestock sector.

The FAO Laboratory Internal Audit Tool and software was used to evaluate the laboratories according to ISO/IEC 17025:2005, and the results indicated that quality control systems needed to be strengthened in laboratories across the country. It is highly recommended that the Directors General of the DLS and the BLRI support improvement in this area, in order to make quality control an integral part of the laboratory functioning. Decision-makers were provided with several tools and manuals to assist with these efforts.
Sustainability

1. Capacity development

The project developed guidelines and methodologies to prepare a national FBS, which will be helpful in generating baseline information on feed resources and their management, together with the development of specific feeding strategies and feeding standards to augment sustainable livestock production. It will also contribute to establishing strong evidence to convince policy-makers of the value of animal nutrition services, and the urgent need for a significant increase in government investment in animal nutrition. Finally, the strengthened animal nutrition laboratories will help to establish a highly dynamic animal nutrition service capable of dealing with the ever-evolving food security and emerging challenges that animal owners will continue to face.

As a result of the project interventions, the trained DLS officials and other stakeholders will be able to assess laboratory quality using the FAO Laboratory Internal Audit Tool for testing laboratories compliant with ISO/IEC 17025:2005. This will greatly help to maintain good quality practice in animal nutrition laboratories.

The project established strong partnerships between the Government and the following: i) Sher-e-Bangla Agricultural University, to conduct surveys or livestock nutrition-related studies; ii) Chittagong Veterinary and Animal Sciences University, for animal nutrition laboratory strengthening; and iv) the dairy association, for technology transfer.

In addition, through the laboratory training a strong linkage was formed among different stakeholders, including academia, the private sector, research institutes, the BLRI, the Bangladesh Standards and Testing Institution (BSTI) and the DLS.

2. Gender equality

The planned project activities sought to maintain gender equality. Women’s participation was encouraged during farmers’ selection, and 45 female dairy farmers participated in the farmers’ training activities. In addition, during the field survey conducted on cattle feed practice, almost 50 percent of the surveyors were women.

3. Environmental sustainability

The project had environmental advantages, which contributed to improving animal productivity. DLS officials and other stakeholders were trained on preparing least cost dairy ration formulation. In addition, farmers were trained on balanced ration formulation. Feeding a balanced ration to livestock is one of the most promising ways to reduce methane emissions in ruminants.

4. Human Rights-based Approach (HRBA) – in particular Right to Food and Decent Work

Farmers were trained on cattle feeding management, which is essential for profitable and sustainable livestock production, and increases the occupational safety of dairy farmers. The project did not support any type of child labour.

5. Technological sustainability

SOPs for feed analysis and guidelines to prepare a national FBS were provided to the DLS. Farmers were introduced to different livestock feeding technology, such as UMS, total mixed ration, calf starter, silage preparation and high-yielding fodder production.

The project beneficiaries and stakeholders are now capable of sustaining the project activities, as they gained technical knowledge on maintaining good quality practices in animal nutrition laboratories. This will help the DLS to monitor the feed quality of different feed manufacturers of Bangladesh, which will help farmers to have quality feed. This is the prime demand of farmers, and will encourage policy-makers to maintain good quality practice in laboratories. In addition, the technical knowledge acquired by beneficiaries and stakeholders in national feed inventory and balance sheet preparation will be of immense use for policy-makers, government agencies, Non-governmental Organizations (NGOs) and developmental agencies in implementing sustainable livestock development activities and in preparing for and coping with global climatic changes.

6. Economic sustainability

The products and services developed by the project were mostly affordable to stakeholders. For example, stakeholders gained knowledge in least cost dairy animal ration formulation, feed inventory and balance preparation and good quality practice in animal nutrition laboratories for feed analysis. Feed inventory and balance will help in making informed decisions related to the nature and quantities of feed resources that could be traded locally, imported and exported, and potential areas for feed markets. It will also assist in modelling economic, nutritional, ecologival and environmental optimization of alternative feeding systems that use local feed resources.
DOCUMENTS AND OUTREACH PRODUCTS

- S. Dunkle, R. Ara Karim and Z. Hasan. 22 September 2019. Questionnaire on Identify the Cattle Feed Practice in Bangladesh. 5 pp.
- H. Makkar. Selection criteria of participants for Feed balance and inventory, Least cost Dairy Animal Ration Formulation, and Integration of good practices, including quality control systems in feed analysis laboratory, and on anti-nutritional factors in feed resources training.
- H. Makkar. Feed balance and inventory training documents.
- Least cost Dairy Animal Ration Formulation training documents.
- Nine SOPs (for myo-inositol, aflatoxin ELISA, cellulose, hemicellulose and lignin, aflatoxin by HPLC, tannin, protein content by Kjeldahl, histamine, Gossypol and Pb).
- Basic Components of an Effective SOP.
**Achievement of Results - Logical Framework**

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<tr>
<th>Expected Impact</th>
<th>Outcome</th>
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<tr>
<td>Efficient use of new as well as existing use of feed resources will increase animal productivity and profitability to the farmers by reducing feed cost. In addition, good nutrition increases immunity of the animals, leading to better health of animals and decrease in the cost of treatment of animals.</td>
<td>Comments on level of achievement:</td>
</tr>
<tr>
<td></td>
<td>Comments and follow-up action to be taken</td>
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<tr>
<td></td>
<td>Follow-up actions:</td>
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</table>

**Indicators**

1. No. of major feed ingredients used in ration formulation.
2. No. of feed ingredients tested for presence of anti-nutritional factor.
3. No. of nutrients analysed in Central Animal Nutrition Laboratory (CANL).
4. Existence of Feed Balance Sheet (FBS).

**Baseline**

1. 12 major feed ingredients used in ration formulation.
2. 8 feed ingredients tested for presence of anti-nutritional factor.
3. 14 nutrients analysed in CANL.
4. No existence of FBS.

**End Target**

1. 24 major feed ingredients used in ration formulation.
2. 24 feed ingredients tested for presence of anti-nutritional factor.
3. 30 nutrients analysed in CANL.
4. FBS developed.

**Achievements**

- 15 participants from DLS, academia, research institutions and the feed industry were trained on least cost dairy animal ration formulation, which comprised training in how to formulate rations using the FAO ration balancing tool and mobile applications.
- Chemicals and equipment were procured to enhance the capacities of CANL of DLS and DANL of Rangpur in testing for the presence of anti-nutritional factors and toxins in feed ingredients, and performing proximate analysis.
- 16 DLS officials and other stakeholders, including laboratory technicians, researchers, academic staff and officers, were trained to increase the laboratory capacity of DLS and other stakeholders. Documents were provided on quality assurance for microbiology in a feed analysis laboratory, and FAO helped establish quality control within the laboratory, and improve sample collection storage and use of the FAO laboratory audit tool. In addition, the project provided a number of training courses on: i) the integration of practices, including a quality control system for feed analysis laboratories and testing for antinutritional factors in food sources; ii) Quality Management Systems (QMS), International Organization for Standardization (ISO) Certification and laboratory accreditation; iii) the fundamentals of ISO 17025; and iv) skills development for feed analysis.
- Nine SOPs were developed to test myo-inositol, Aflatoxin ELISA, cellulose, hemicellulose and lignin, Aflatoxin by high-performance liquid chromatography (HPLC), tannin, protein content by Kjeldahl, histamine, gossypol, and lead (Pb) in animal feed, which were handed over to CANL.
- Fifteen participants from DLS, academia, research institutions and the feed industry were trained on Feed Balance Sheet (FBS) preparation. Templates, together with relevant documents, such as questionnaires on agro-industrial by-products and competitive use of crops and crop-to-crop conversion factors, were provided to DLS for preparing a national FBS.
- A cross-sectional survey was conducted to better understand cattle feeding practices in Bangladesh.

**Follow-up actions:**

- As a result of the equipment, chemicals and reagents procured through this project, trained personnel of CANL are able to test toxins and anti-nutritional factors, according to the developed SOPs. Trained DLS laboratory scientists and technicians will follow up to test toxins and anti-nutritional factors in animal feed.
- The Agriculture (crop, fisheries and livestock) Census was done in June 2019, but the result has not been published yet. To make the national feed balance database more accurate, livestock data can be obtained from the census result.
- As a result of the training provided on least cost dairy animal ration formulation, private companies from the feed industry were upskilled. Trained DLS officials can now provide training to field officials, who can then train the farmers. In addition, the trained individuals from academia can educate students on ration formulation by using the FAO ration balancing tool and mobile applications.
### Output 1

Mainstreamed use of unconventional feed resources including agro-industrial by-products through identification, availability assessment (quantity) and determination of nutrients content, presence of anti-nutritional factor if any.

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<thead>
<tr>
<th>Indicators</th>
<th>Target</th>
<th>Achieved</th>
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<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>Yes</td>
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#### Baseline

<table>
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<tr>
<th>Comments</th>
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<tr>
<td>N/A</td>
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#### Activity 1.1

**Identification of both conventional and unconventional feeds**

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<tr>
<th>Achieved</th>
<th>Comments</th>
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<tr>
<td>Yes</td>
<td>A cross-sectional cluster survey was carried out to identify cattle feeding practices in Bangladesh. Information was collected from 5,351 households. Sixty postgraduate students from Sher-e-Bangla Agricultural University participated in the survey, who gained important insight into the dairy farmers’ situation in the field.</td>
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#### Activity 1.2

**Analysis of unconventional feeds**

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<tr>
<th>Achieved</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Partially</td>
<td>Fifteen DLS officials were trained to improve their competency in this area. A total of nine SOPs were developed to identify potential anti-nutritional factors and mycotoxin, which were handed over to CANL. The trained laboratory personnel are now capable of conducting laboratory analysis to identify the nutrient composition, anti-nutritional factors, and a risk analysis of animal and zoonotic diseases in feed.</td>
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#### Activity 1.3

**Feed Resource Data-base development**

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<th>Achieved</th>
<th>Comments</th>
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<tr>
<td>Partially</td>
<td>During the FBS preparation and ration balancing training, participants were introduced to Feedipedia, which can be used to create a national animal feed resource database, including both unconventional and conventional feed available in Bangladesh, and to compile the nutrient composition of feed samples originated from different sources in this country. CANL can move forward by compiling their feed samples’ nutrient composition, to obtain an average value and standard deviation for nutrients in a particular feed. DLS can also collate the nutrient composition data from the research institutes and agricultural universities to make a more comprehensive feed database. The Government can use this database for feed formulation in any livestock development programme in the future. In addition, DLS can share this information on their website for further use by other stakeholders in the livestock sector.</td>
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#### Activity 1.4

**Arrangement of workshops**

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<th>Achieved</th>
<th>Comments</th>
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<tr>
<td>Partially</td>
<td>An inception workshop was held to disseminate the project objectives, outputs, and activities among the participants from DLS, including the Director General and other officials, university professors, research organizations, scientists and the private sector.</td>
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#### Activity 1.5

**Training and technology demonstration**

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<th>Achieved</th>
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<tr>
<td>Yes</td>
<td>238 dairy farmers (of whom 45 were women) from five districts (Rangpur, Gazipur, Sirajganj, Sathkhira and Manikganj) were successfully trained on various technologies for cattle feed management during a two-day awareness-development training workshop. The training topics were: high yield fodder production, total mixed ration, silage, urea molasses straw (UMS), calf management, dairy feeding management, vaccination and record keeping.</td>
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ADDRESSING FEED SHORTAGES THROUGH EXPLORATION OF UNCONVENTIONAL FEED RESOURCES FOR ACCELERATED LIVESTOCK DEVELOPMENT IN BANGLADESH

**Output 2**

Strengthened capacity and skills of existing DLS animal nutrition laboratory at Rangpur district as well as reinforcing central animal nutrition laboratory at Dhaka for ease the access of farmers and other stakeholders in getting feed analyses

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<tr>
<th>Indicators</th>
<th>Target</th>
<th>Achieved</th>
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<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>Partially</td>
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</table>

**Baseline**

N/A

**Comments**

- Two animal nutrition laboratories were assessed, namely CANL to identify the gaps for testing antinutritional factors, mycotoxin and heavy metals, and DANL, Rangpur, which was assessed for proximate analysis.
- A total of 19 pieces of equipment and eight types of chemicals were purchased to improve the capacity of CANL and the regional laboratory in Rangpur. Six ISO standards were procured to identify antinutritional factors and toxins, such as tannin content in sorghum, total and free gossypol in animal feed, aflatoxin B1 in animal feed, histamine in fish and fishery products, aflatoxins B1, B2, G1, G2 in cereals, nuts and lead content in milk products.
- A survey was conducted to identify the facilities and capabilities of the food and feed testing laboratories in Bangladesh for antibiotic residue analysis by HPLC.
- Nine SOPs (for myo-inositol, aflatoxin ELISA, cellulose hemicelluloses and lignin, aflatoxin by HPLC, tannin, protein content, histamine, gossypol and lead) were developed and handed over to DLS. A document on the SOP development was also shared with CANL.
- Four DLS officials (of whom two were women) working in CANL were trained on the following topics: the fundamentals of ISO 17025, QMS in the laboratory, good laboratory practices, method selection, validation and verifications, and quality manual writing.
- 15 laboratory personnel (of whom four were women) from BLRI, DLS and the feed industry were trained on the integration of good practices, including quality control systems and anti-nutritional factors in feed resources. Through this training, the participants were introduced to the FAO Manual entitled The Feed Analysis Laboratory: Establishment and Quality Control and to the FAO laboratory audit tool for ISO 17025:2005 compliance. In addition, they learned about mechanisms for the inactivation of anti-nutritional factors.

The FAO Laboratory Internal Audit Tool and software was used to evaluate the laboratories according to ISO/IEC 17025:2005; the results indicated that quality control systems needed to be strengthened in laboratories across the country. It is strongly advised that the Directors General of the DLS and the BLRI support improvement in this area, in order to make quality control an integral part of the laboratory functioning.

Decision-makers were provided with several tools and manuals to assist with these efforts.

**Activity 2.1**

Procurement of lab equipment, instruments, chemicals and reagents

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<thead>
<tr>
<th>Achieved</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Yes</td>
<td>The list of procured laboratory equipment, chemicals and reagents for animal nutrition laboratory at DLS, Rangpur was as follows: i) analytical balance (0.0001g to 220g); ii) Kjeldahl Block-Nitrogen Analyzer (eight tubes digestion and distillation unit); and iii) acid dispenser (5-50 ml).</td>
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**Activity 2.2**

Scaling up district animal nutrition laboratory at Rangpur

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<th>Achieved</th>
<th>Comments</th>
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<tr>
<td>Partially</td>
<td>DANL in Rangpur was assessed, based on the available facilities and the condition of the equipment.</td>
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<td></td>
<td>The laboratory staff were trained on proximate analysis of animal feeds, determination of aflatoxin in feed by ELISA and antibiotic residue in meat samples. Staff turnover was identified as a limitation at the laboratory. It is very important for sustainable improvement to keep permanent personnel in the laboratory.</td>
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</table>
### Activity 2.3

**Reinforcement of central animal nutrition laboratory of DLS**

<table>
<thead>
<tr>
<th>Achieved</th>
<th>Yes</th>
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</table>
| **Comments** | - CANL was supported with equipment, chemicals and reagents. The laboratory staff were trained on the basic requirements of ISO 17025 for laboratory accreditation. They were also trained on SOP writing, QMS, good laboratory practices, methods selection, verification and validation, and laboratory manual writing.  
- The list of procured laboratory equipment, chemicals and reagents for CANL and DANL in Rangpur was as follows: analytical balance (0.0001g to 220g); Kjeldahl Block-Nitrogen Analyzer (eight tubes digestion and distillation unit); Soxhlet apparatus (for crude fat analysis); deionization water purification system; hot plate with magnetic stirrer; conductivity meter; distilled water plant; acid dispenser (0.5-5 ml and 5-50 ml); micropipette (100 µL – 1000 µL; 1 µL – 10 µL; and 10 µL – 100µL); micropipette tips (1000 µL, 500 µL, 10-100µL and 0.1-10 µL); extraction thimble; stainless steel weighing dishes - dia-30-40 mm; Alfa-clean immunoaffinity column; total mycotoxins (aflatoxins B1, B2, G1 & G2); aflatoxin B1; tannins; glucosinolate; Phytic acid solution; ferric chloride; Histamine ELISA kits; six ISO standards; and one computer and UPS. |

### Activity 2.4

**Skill development training for DLS officials**

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<tr>
<th>Achieved</th>
<th>Yes</th>
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</table>
| **Comments** | - Several training sessions were provided for the development of the skills required for laboratory activity through the project:  
  - 11 DLS officials (of whom four were women), as well as four participants from the feed industry, university, research institute and government organization were trained for three days on the integration of practices, including quality control systems and testing for anti-nutritional factors in feed resources.  
  - 4 (of whom two were women) CANL staff members were trained for two days on QMS, ISO certification and laboratory accreditation.  
  - 4 (of whom two were women) CANL staff members were trained for two days on the fundamentals of ISO 17025.  
  - 5 (of whom two were women) DLS laboratory staff members were trained for six days on skill development for feed analysis. |
LIVESTOCK DEVELOPMENT IN BANGLADESH

ADDRESSING FEED SHORTAGES THROUGH EXPLORATION
OF UNCONVENTIONAL FEED RESOURCES FOR ACCELERATED

TCP/BD/3607

<table>
<thead>
<tr>
<th>Output 3</th>
<th>Developed Feed Balance Sheet (FBS) for Bangladesh through establishing feeds, fodder and forages inventory; and established national feed resource database</th>
<th>Indicators</th>
<th>Target</th>
<th>Achieved</th>
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<td>N/A</td>
<td>N/A</td>
<td>Partially</td>
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Baseline

<table>
<thead>
<tr>
<th>Comments</th>
<th>12 DLS officials, as well as three officials from Bangladesh Agricultural University, BLRI and the feed industry association were trained on preparing an FBS for Bangladesh. Documents to prepare an FBS were provided to DLS.</th>
<th>N/A</th>
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<tr>
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<td>A feeds, fodder and forages inventory was prepared, based on a survey of cattle feeding practice in Bangladesh.</td>
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<td>The National Project Coordinator from DLS, in coordination with the other trained DLS officials, agreed to adapt and sustain the FBS preparation technique through an annual reporting system.</td>
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Survey on feeds required annually

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<tr>
<th>Activity 3.1</th>
<th>Comments</th>
<th>Achieved</th>
<th>Targets</th>
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<tr>
<td>Survey</td>
<td>The Government was encouraged to collect accurate livestock population (including indigenous and cross-bred breeds) and herd structure data, in order to calculate the total feed required annually by ruminants, potentially by conducting a census. Participants were taught methods for estimating the total poultry population based on the number of DOC produced by private farms and commercial companies. This information, collected on a monthly basis by DLS for commercial broilers, Sonali broilers and layers, together with targeted surveys to estimate the number of scavenging birds/ducks and mortality rates for DOC, can be used to estimate the total population.</td>
<td>Partially</td>
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Inventory development

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<tr>
<th>Activity 3.2</th>
<th>Comments</th>
<th>Achieved</th>
<th>Targets</th>
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<tr>
<td></td>
<td>An inventory of feeds, fodder and forages was prepared based on the survey conducted on cattle feeding practice in Bangladesh.</td>
<td>Yes</td>
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Post-harvest losses of feeds and fodder

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<tr>
<th>Activity 3.3</th>
<th>Comments</th>
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<th>Targets</th>
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<td>DLS was provided with questionnaires to capture information on the proportion of feed resources that were used for various purposes and the uses of agro-industrial by-products. Once these surveys have been completed by DLS, this information can provide an estimate of post-harvest losses. There was not sufficient time to conduct the surveys during the project.</td>
<td>Partially</td>
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Deficit of feeds and means of feed security

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<th>Activity 3.4</th>
<th>Comments</th>
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<td>If a feed deficit exists, DLS will be able to identify it through the FBS database. The feed balance calculation template was provided to DLS during training. Once the national level FBS has been prepared, further initiatives can be taken.</td>
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Training on FBS preparation

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<th>Activity 3.5</th>
<th>Comments</th>
<th>Achieved</th>
<th>Targets</th>
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<td>12 DLS officials (including eight representatives from eight districts), as well as three officials from Bangladesh Agricultural University, BLRI and the feed industry were trained on preparing an FBS for Bangladesh during a five-day training programme. Documents to prepare an FBS were provided to DLS. Four of the participants were women.</td>
<td>Yes</td>
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<td></td>
<td>The National Project Coordinator from DLS, in coordination with the other trained DLS officials, agreed to adapt and sustain the FBS preparation technique through an annual reporting system.</td>
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</tbody>
</table>

Feed balance sheet development

<table>
<thead>
<tr>
<th>Activity 3.6</th>
<th>Comments</th>
<th>Achieved</th>
<th>Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>An FBS is the comparison between the feed requirement of livestock and the amount of utilizable feed. Templates for establishing a feed inventory, feed requirements, the herd structure of ruminants, assessing competitive uses of feed resources, and conducting surveys on</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>
### Activity 4.1: Enhancing feed and fodder availability

**Achieved**: Partially

**Comments**
- 238 dairy farmers (of whom 45 were women) from milk pocket areas of Bangladesh, including Sirajganj, Rangpur, Gazipur, Sathkhira and Manikganj (including 50 farmers in Bathan areas of Shahjadpur upazila of Sirajganj district) were trained on high-yielding fodder production and the preparation of UMS. The farmers were selected based on a decision taken during the inception workshop.
- Agro-industrial by-products, such as pineapple and mango waste and peels, are nutritious sources of animal feed which are overlooked by the dairy industry in Bangladesh. The source of these by-products are the mango and pineapple units of fruit processing companies, and, potentially, household waste collection. Before introducing these ideas among farmers, it is important to check their availability on a large scale by using the agro-industrial by-products questionnaire provided to DLS during feed balance and inventory training. Once this information has been collected and analysed, a decision can be taken regarding whether to introduce these by-products as animal feed. In Bangladesh, the technology needed to process mango and pineapple by-products is not available as it is in other countries, such as India. DLS, together with research institutions, such as BLRI and the agricultural universities, could play a role in ensuring the adaptation of available technology in Bangladesh.

### Activity 4.2: Public-private partnership enhancement

**Achieved**: Partially

**Comments**
Dairy farmers were trained on how to produce a total mixed ration, UMS and silage during a two-day awareness development training workshop. Some of the farmers were also entrepreneurs, who benefited from learning about modern technologies for business planning. In addition, a relationship was fostered between farmers and entrepreneurs. This activity was not fully completed, as it was not possible to follow up this initiative to ascertain whether the trained farmers had managed to adapt this for short/long-term business.

### Activity 4.3: Introduction of calf replacer

**Achieved**: Yes

**Comments**
- Farmers from five districts were introduced to the preparation of calf milk replacer during a calf management session of the awareness-development training course.
- Owing to the unavailability of the required amount of commercial calf milk replacer in Bangladesh, 250 boxes of mineral feed supplement were purchased and distributed to the farmers at the training course.

### Activity 4.4: Introduction of record keeping

**Achieved**: Yes

**Comments**
Farmers from milk pocket areas of Bangladesh were trained on record keeping at the farm during the two-day training course on Cattle Feeding Management.

### Activity 4.5: Modern feeding system development

**Achieved**: No

**Comments**
The template for FBS development was shared with DLS. A modern and appropriate feeding system can be developed on a regional basis after the database on feed availability at the district-level has been prepared. The preparation of guidelines for introducing modern feeding systems is a long-term procedure. For this reason, during the inception workshop it was decided not to carry this out during the project, and to focus project activities on making progress towards that goal.