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FEED THE FUTURE INNOVATION LAB FOR FOOD SAFETY (FSIL)

Food Safety System in Bangladesh: Current Status of Food Safety, Scientific Capability, and Industry Preparedness

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Food Safety System in Bangladesh: Current Status of Food Safety, Scientific Capability, and Industry Preparedness

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Acronyms

Abbreviations	Descriptions
AAS	Atomic Absorption Spectroscopy
AOAC	Association of Official Agricultural Chemists
APAC	Asia-Pacific Accreditation Cooperation
AWD	Acute Watery Diarrhea
BAB	Bangladesh Accreditation Board
BABBMA	Bangladesh Auto Biscuit and Bread Manufacturers' Association
BAEC	Bangladesh Atomic Energy Commission
BAM	Bacterial Analytical Manual
BAPA	Bangladesh Agro-Processors Association
BARI	Bangladesh Agricultural Research Institute
BCSIR	Bangladesh Council of Scientific and Industrial Research
BFFEA	Bangladesh Frozen Foods Exporters Association
BFSA	Bangladesh Food Safety Authority
BITBEE	Bangladesh Improving Trade and Business Enabling Environment
BLRI	Bangladesh Livestock Research Institute
BRC	British Retail Consortium
BSCIC	Bangladesh Small and Cottage Industries Corporation
BSCMFP	Bangladesh Sustainable Coastal and Marine Fisheries
BSFF	Bangladesh Fish and Shrimp Foundation
BSTI	Bangladesh Standards and Testing Institution
CAFSP	Center for Agriculture and Food Security and Preparedness
CDIL	Central Disease Investigation Laboratory
DAE	Department of Agricultural Extension
DGHS	Directorate General of Health Services
DLS	Department of Livestock Services
DNCRP	Directorate of National Consumer Rights Protection
DOF	Department of Fisheries
DPHE	Department of Public Health Engineering
EMS	Early Mortality Syndrome
EQCLIFP	Establishment of Quality Control Laboratory for Livestock Inputs and its Food Products
EU	European Union
FAO	Food and Agriculture Organization
FDA	United States Food and Drug Administration
FIQC	Fish Inspection and Quality Control
FSIL	Feed the Future Innovation Lab for Food Safety
FSMA	Food Safety Modernization Act
FSSC	Food Safety System Certification
GAHPs	Good Animal Husbandry Practices
GAPs	Good Agricultural Practices
GAqPs	Good Aquaculture Practices
GC	Gas Chromatography

GC-MS	Gas Chromatography-Mass Spectrometry
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFSI	Global Food Safety Initiative
GHPs	Good Hygiene Practices
GMPs	Good Manufacturing Practices
HACCP	Hazard Analysis and Critical Control Points
HPAI	Highly Pathogenic Avian Influenza
HPLC	High-Performance Liquid Chromatography
IAF	International Accreditation Forum
IAS	Integrated Assessment Services
ICMSF	International Commission on Microbiological Specifications for Foods
IDG	International Development Group, LLC
IEDCR	Institute of Epidemiology, Disease Control and Research
IFRB	Institute of Food and Radiation Biology
IFST	Institute of Food Science & Technology
ILAC	International Laboratory Accreditation Cooperation
INARS	Institute of National Analytical Research and Service
IPH	Institute of Public Health
ISO	International Organization for Standardization
JICA	Japan International Cooperation Agency
JIFSAN	Joint Institute for Food Safety and Applied Nutrition
LGD	The Local Government Division
LGRD	Ministry of Local Government, Rural Development & Co-operatives
MERS-CoV	Middle East Respiratory Syndrome Coronavirus
MoEF	Ministry of Environment and Forests
MoHFW	Ministry of Health & Family Welfare
MoST	Ministry of Science and Technology
MoU	Memorandum of Understanding
MRLs	Maximum Residue Limits
MSME	Micro, Small, and Medium Enterprises
MT	Metric Tons
NABL	National Accreditation Board for Testing Laboratories
NFSL	National Food Safety Laboratory
NHP	Necrotising Hepatopancreatitis
NRCP	National Residue Control Plan
PAC	Pacific Accreditation Cooperation
PCR	Polymerase Chain Reaction
PHL	Public Health Laboratory
POPs	Persistent Organic Pollutants
PPW	Plant Protection Wing
QA	Quality Assurance
RMP	Residue Monitoring Plan
RT-PCR	Reverse Transcription - Polymerase Chain Reaction
RTE	Ready-To-Eat
SAFETI	Safe Aqua Farming for Economic and Trade Improvement

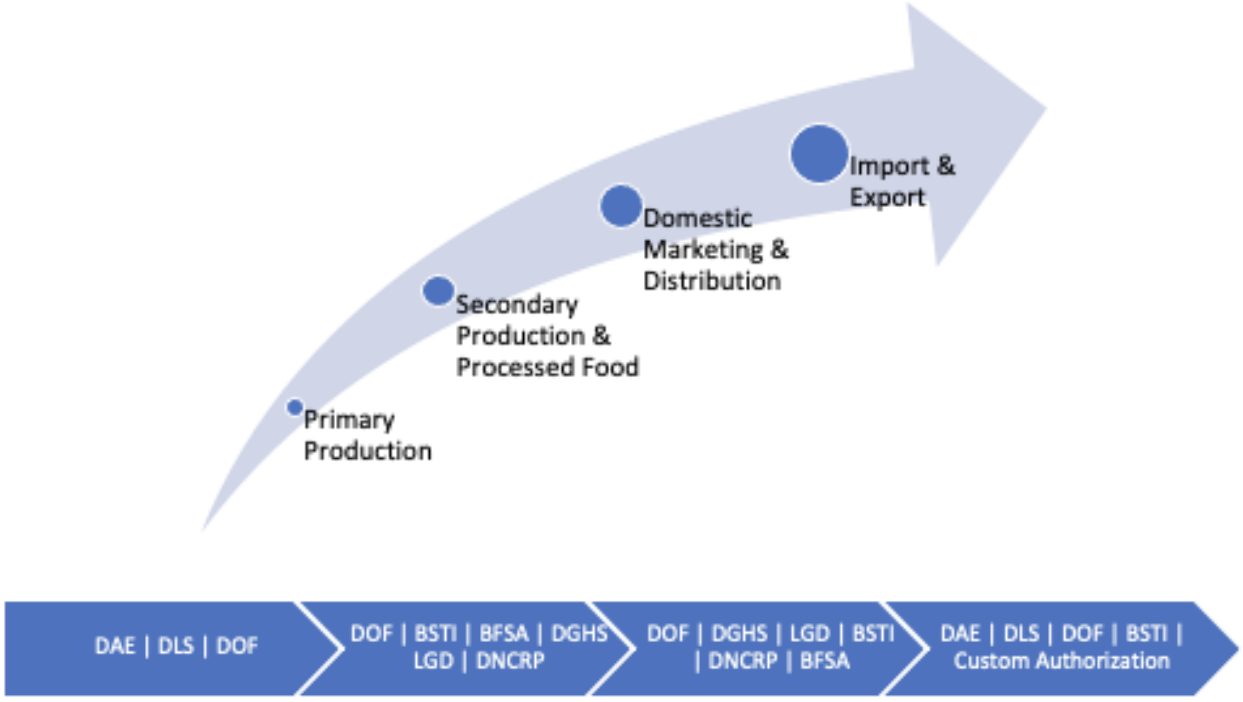
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SGS	Société Générale du Surveillance
SMEs	Small and Mid-size Enterprises
SPS	Sanitary and Phytosanitary Measures
TCC	Total Coliform Count
TPC	Total Plate Count
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WHO	World Health Organization

Executive Summary

Agriculture in Bangladesh has remained subsistence-based, with inconsistent crop yields, under-developed infrastructure, and a reduction in arable land due to urban expansion all contributing to food insecurity. These problems must be addressed to advance the food security and safety of the nation. A high economic growth rate of about 8%, with the service sector contributing approximately 50% of the gross domestic product (GDP), along with urban population growth and spending is increasing the demand for processed and high-quality food in the country.

The objective of this project was to assess foodborne pathogen detection capacity and lay a foundation for implementing a science- and risk-based approach in the detection and design of controls for microbial food safety hazards. A landscape assessment and primary stakeholder consultations were carried out to understand the current status and identify key gaps and challenges. The report presents a brief analysis of the current food safety system and the status of food safety implementation. The report also emphasizes the food testing needs of micro, small, and medium enterprises (MSMEs) and possible interventions to address the gaps. The report is based on the information gathered during primary stakeholder consultations (Appendix 1) as well as secondary research.

Food Safety Enforcement & Regulatory Bodies in Bangladesh



Abbreviations: BFSA: Bangladesh Food Safety Authority; BSTI: Bangladesh Standards and Testing Institution; DAE: Department of Agricultural Extension; DGHS: Directorate General of Health Services; DLS: Department of Livestock Services; DNCRP: Directorate of National Consumer Rights Protection; DOF: Department of Fisheries; LGD: Local Government Division

Key Segments of the Food Processing Industry

Segment	Current Trends	Risks, Hazards, and Concerns
Shrimp Processing	One of the most organized, well-developed, and export-oriented sectors. Shrimp accounts for 85% of the country's aquaculture exports.	Presence of antibiotics; pathogenic microbes such as *Salmonella* spp., *E. coli, Listeria monocytogenes,* and *Vibrio* spp.; and viral infections such as white spot and yellowhead diseases.
Fish Production & Processing	Annual growth rate of 6%. Fish is one of the principal protein sources in the country and amounts to 60% of the animal protein consumed.	Chemical contaminants such as formalin, an aqueous solution of formaldehyde, were previously observed. Controlled and monitored currently.
Bakery/Confections	Industry growing quickly (biscuits, an annual growth of about 15%) and has many domestic players. Very import dependent (i.e., oils, wheat, sugar).	Governed by the BSTI standards. Food safety risks in the sector are pesticide residues and post-processing contamination with pathogenic microbes such as *Salmonella* and *E. coli.*
Fruit/Vegetable Processing	About 2% of the fruits and vegetables (i.e., mango, tomato, frozen vegetables) produced in the country are processed into value-added products.	Currently no established food safety and hygiene licenses issued by any agencies, with an exception for tomatoes via BSTI.
Maize Processing	99% of its total maize production is processed, and only 1% is consumed raw.	Pesticide residues and aflatoxins are major food safety hazards in maize and other cereal processing sectors.
Spice Processing	Major crops are turmeric and chili.	Chemical contaminants (pesticide residues) and adulteration (synthetic dyes).
Livestock (Beef, Poultry/Egg)	Growing demand in poultry (15% of market), beef (60-65% of market), and eggs. Most meat is consumed as fresh.	Excessive usage of antibiotics; unregulated and unofficial slaughter sites.
Other Smaller Commodities	Noticeable increase in the importation of edible oil and rice.	Mostly limited to chemical hazards such as pesticide residues and heavy metals.

Industry Composition and Status of Industry's Food Safety Compliance

The total number of manufacturing industries in Bangladesh is 42,792, of which about 6.5% are large, 6.51% are medium, 50.89% are small, and 36.05% are micro-sized industries. The classification of MSMEs based on their revenues and workforce is shown in Table 1.

Table 1: Classification of industries in Bangladesh, by revenues and number of workers

Type of Industry	Manufacturing Value in Bangladeshi Taka (Tk.)	Number of workers
Micro	Between 0.5 million and 5 million Tk.	10 to 24
Small	Between 5 million and 100 million Tk.	25 to 99
Medium	Between 100 million and 300 million Tk.	100 to 250

Source: Ministry of Industries, 2010

Key Issues & Challenges

I. Despite the presence of sufficient food testing equipment capacity due to extensive investment in capacity development by various donor agencies, it is underutilized for various reasons (i.e., shortage in human resources and lack of leadership).
II. Few of the food testing labs under various departments/public institutions have accreditations for some of the testing parameters.
III. Time-consuming conventional testing methods for microbiological contamination of food analysis is a key constraint faced by private companies as they incur production loss.
IV. There is a need to secure affordable, rapid detection kits and adopt molecular methods for pathogen detection in-country instead of importing from neighboring countries and the U.S.
V. Despite the potential for food safety hazards to cause serious food safety issues, BFSA has not yet framed product recall procedures for the country. There have been several instances in the recent past wherein the authorities (BSTI, BFSA, and the DNCRP) were unable to recall affected products.
VI. Lack of data on the number of registered food manufacturing facilities and service providers and real-time data sharing between various agencies is also limited.

Way Forward

- Increasing demand for food testing in Bangladesh
- Real-time data sharing across agencies
- Provision of hands-on training to food testing labs
- Development and validation of rapid detection devices/kits
    - Technologies are available globally that Bangladesh can adopt with local validation.
    - Affordability of the rapid detection kits for wider adoption by industry
    - Low-cost detection kits will facilitate mass adoption by the food industry, including MSMEs, and promote affirmative in-house testing in processing plants
    - Rapid detection systems will enable regulators to do mass testing
    - Domestic capacity development for manufacturing diagnostic kits
- Providing wide access for rapid detection devices/kits for target segments/contaminants

Introduction

Attaining independence in 1971, Bangladesh is the youngest country in the South Asian region, sharing a common history with neighboring countries. Bangladesh is the most densely populated country in the world, with about 60% of the population living in rural areas. Agriculture, with 70% of the land area devoted to cultivation, is the main occupation of about 40% of the population and contributes to about 13.3% of national gross domestic product (GDP)[1]. Subsectors of crops (55%), fisheries (22%), livestock (14%), and forests (9%) largely comprise the agricultural economy[2]. The wide range of crops cultivated in Bangladesh includes rice, jute, wheat, tea, pulses, aquaculture, oilseeds, and fruits/vegetables. Agriculture plays an important role in serving the needs of food, nutrition, and livelihood for the country, thereby contributing to sustainable economic development. Despite being an important contributor to the national economy, agriculture has remained subsistence-based, with inconsistent crop yields and under-developed infrastructure[3]. With the added pressure from urban encroachment on arable land, these problems must be addressed to advance the food security and safety of the nation. Having a high economic growth rate of about 8%, with the service sector contributing approximately 50% of the GDP, along with urban population growth and spending, the demand for processed and high quality food is increasing in the country[4].

The share of the agro-food processing sector in the GDP, despite recording substantial growth over the last decade, has remained less than 2%[1]. Industries like ready-made garments dominate the manufacturing sector. Agro-food processing contributes to around 1.5% of total exports, valued at more than USD 420 million in 2018. Though its share of agro-food exports is small, Bangladesh exports food products to more than 140 countries. The country also depends largely on imports of major food commodities such as rice, dairy products, wheat, edible oils, and sugar to meet the food security demands of the country. An efficient food safety surveillance and control system in the country is needed to address the food safety risks arising through domestic, import, and export channels. Owing to high population density and underdeveloped infrastructure, the incidence of foodborne diseases and other food safety risks is quite high in Bangladesh. Diarrheal diseases, enteric fever, and hepatitis are the most common foodborne diseases in Bangladesh[5]. According to the Dhaka-based Institute of Epidemiology, Disease Control and Research (IEDCR) surveillance, acute watery diarrhea (AWD) is the most common foodborne

[1] Bangladesh Bureau of Statistics. (2019). *National accounts statistics.* http://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/cdaa3ae6_cb65_4066_8c61_d97e22cb836c/NA_BlueBook_2018-19.pdf

[2] Bangladesh Bureau of Statistics. (2017). *Bangladesh strategic plan on agricultural and rural statistics (2016-2030).* http://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/b343a8b4_956b_45ca_872f_4cf9b2f1a6e0/SPARS_Final_BBS_Rev_090817.pdf

[3] Food and Agricultural Organization of the United Nations. (n.d.) *FAO Regional Office for Asia and the Pacific: Regional perspectives: Bangladesh*. http://www.fao.org/asiapacific/perspectives/agricultural-statistics/global-strategy/results-in-the-region/bangladesh/en/

[4] USDA Foreign Agricultural Service. (2013). *Food Processing Industries in Bangladesh.* GAIN report number BG3013.

[5] Food and Agricultural Organization of the United Nations. (n.d.) *Improving food safety in Bangladesh: Study tour on food-borne illness surveillance*. http://www.fao.org/in-action/food-safety-bangladesh/news/detail/en/c/346448/

disease in the country, with about 0.28 million cases in 2015[6]. Two other foodborne illnesses tracked by IEDCR, enteric fever and acute hepatitis, resulted in approximately 30,000 and 500 recorded cases, respectively, in 2015. Some studies have reported a high incidence of disease-causing microbes in street-vended food, adulterated food, and food processed with contaminated water[7]. In the agro-food processing sector, micro, small, and medium enterprises (MSME) comprise a large share, and the country's current food safety system and testing infrastructure are inadequate to assess these foodborne pathogens and other food safety risks.

The food safety system and the regulatory framework in the country are still in their infancy. The new food safety authority is building the necessary systems and required resources, such as a skilled workforce and testing infrastructure. The Bangladesh Food Safety Authority (BFSA) was established in 2015 under the Ministry of Food as a result of Bangladesh's 2013 Food Safety Act. BFSA is currently involved in coordinating among agencies, formulating rules and regulations, and establishing maximum residue limits (MRLs) for chemicals and other contaminants. The BFSA is in the process of addressing issues including interagency coordination, workforce development, and infrastructure. In the meantime, it is important to consider the prevailing gaps and challenges in the existing scenario to efficiently address food safety risks and build a robust food safety system.

The current project is aimed at understanding the prevailing situation of food safety systems, food safety risks, scientific research capability, and the regulatory framework in Bangladesh. The objective of the project is to assess foodborne pathogen detection capacity and lay a foundation for implementing a science- and risk-based approach in the detection and design of controls for microbial food safety hazards. A landscape assessment and primary stakeholder consultations were carried out to understand the current status and identify key gaps and challenges. The report presents a brief analysis of the current food safety system and the status of food safety implementation. The report also emphasizes the food testing needs of MSMEs and possible interventions to address the gaps. The report is based on the information gathered during primary stakeholder consultations (Appendix 1) as well as secondary research.

[6] Institute of Epidemiology, Disease Control and Research. https://www.iedcr.gov.bd/website/images/PDF/foodborne_illness/AWD-2015.pdf

[7] Noor, R, & Farahnaaz, F. (2016). Food safety in Bangladesh: A microbiological perspective. *Stamford Journal of Microbiology*, *6*(1), 1-6.

Food Safety Administration in Bangladesh: Overview of Institutions Involved in Food Safety in Bangladesh

Bangladesh Food Safety Authority (BFSA)

The Bangladesh Food Safety Authority (BFSA) under the Ministry of Food was established in 2015 following the 2013 Food Safety Act. The main duties and functions of BFSA are "to regulate and monitor the activities related to manufacturing, importing, processing, storage, distribution, and sale of food so as to ensure access of safe food through exercise of appropriate scientific methods, and to coordinate the activities of all organizations concerned with food safety management" [8]. The BFSA is the main governing body for ensuring food safety and for establishing rules and regulations. This includes setting permissible limits of chemical contaminants, microbial contaminants, heavy metals, processing aids and food additives, mycotoxins, and MRLs of pesticides, veterinary and fishery drugs, antibiotics, etc. Also included in BFSA's role is providing concerned authorities or organizations with necessary support in updating or upgrading permissible limits/MRLs at the highest safety levels for contaminants in food products as determined by any other organization under the existing laws, as well as monitoring the implementation thereof. Food safety at the farm production level is controlled by the Department of Agricultural Extension (DAE), Department of Fisheries (DOF), and Department of Livestock Services (DLS). Per the Act, the BFSA has a role in coordinating the activities of DAE, DOF, and DLS by establishing a food safety network up to the field level[8]. After the farm products become food, they are classified and monitored by the BFSA to control adulterated foods and food additives.

BFSA regulates imported food products as per its regulations (i.e., food labeling regulations, additives and contaminants regulations). During the import of food products, the Bangladesh Standards and Testing Institution (BSTI) checks for label compliance and its standard marks on the food product. During enforcement, both BFSA and BSTI are responsible for testing food samples from the domestic market. However, due to a lack of sufficient testing resources under BFSA, it is difficult for BFSA to execute this task. In addition, because BFSA is a young organization, it lacks workforce and technical capability. The Authority is in the process of inducting 100 young scientific professionals who will form the core technical team to be deployed in various operational functions of the Authority (Appendix 1: BFSA, FAO). BFSA has designated 10 food testing labs under various departments and public institutions, and a few of them have accreditations for various testing parameters (Appendix 1: BFSA, FAO). Several food testing labs within the public organizations do not have a mandate for regulatory testing and therefore do not pursue accreditation.

To enhance capacity, BFSA and the Food and Agriculture Organization of the United Nations (FAO) established a National Food Safety Laboratory in 2012 at the Institute of Public Health in Dhaka, which is accredited with the International Organization for Standardization (ISO) 17025[9]. The FAO has supported training and equipment for five additional laboratories with food safety testing capabilities, including BSTI, the Bangladesh Agricultural Research Institute (BARI), the Department of Food, Dhaka University

[8] Bangladesh Food Safety Authority. (2019). Harmonization of Bangladesh's food safety standards with Codex Standards and other international best practices. https://bfsa.portal.gov.bd/sites/default/files/files/bfsa.portal.gov.bd/notices/a84613c2_1de6_475f_97c9_784374431701/BFSA-Strategy-for-Harmoniztion-of-Standards-draft-V-1.pdf

[9] Food and Agricultural Organization of the United Nations. (n.d.) *Improving food safety in Bangladesh: Activities.* http://www.fao.org/in-action/food-safety-bangladesh/activities/food-analysis/en/

(chemistry department), and the Central Disease Investigation Laboratory (CDIL)[9]. BFSA is now planning to set up one central referral lab in Dhaka and eight regional labs that will be run by the state (Appendix 1: BFSA, FAO). In March 2019, mobile food safety laboratories (air-conditioned minibuses) were established across the capital of Dhaka by USAID, FAO, and BFSA to detect food adulteration and contamination (i.e., toxic chemicals, heavy metals, pesticides, antibiotics, *E. coli*, *Salmonella*, *Shigella*, and formaldehyde). These mobile laboratories will first be operationalized in different places within Dhaka and gradually become available in all districts of Bangladesh. The mobile laboratory is equipped with television screens to provide the public with educational visuals and information to raise awareness about food safety.[10] However, BFSA has no control over food licenses and registrations, which are managed by BSTI. Thus, both BFSA and BSTI need to collaborate to coordinate the implementation of food safety and control in Bangladesh. At this point, BFSA and BSTI have not signed Framework Agreements or a Memorandum of Understanding (MoU), which limits coordination between the two agencies.

Enforcement of food safety

Enforcement of food safety laws and regulations in Bangladesh is weak due to several limitations within the legal and regulatory systems. Overlap of the regulatory responsibilities among various ministries and agencies and complexity due to numerous acts, laws, and regulations of different categories of food products contribute to limited enforcement and lack of coordination among ministries. Science-based food safety management systems are emphasized in the 2013 Food Safety Act. Under the Act, BFSA's role is to establish a food safety network, up to the field level, among authorities involved in the food safety management system for the development and implementation of Good Agricultural Practices (GAPs), Good Aquaculture Practices (GAqPs), Good Manufacturing Practices (GMPs), Good Hygiene Practices (GHPs), hazard analysis, food safety auditing systems, etc. At the field level, DAE is responsible for implementing GAP standards while DOF is responsible for GAqP standards in Bangladesh. At present, the standards on GMP, GHP, and hazard analysis are not made under the safe food regulations. BFSA is now shifting its approach from reactive to risk-based inspections; recently, BFSA and the Directorate General of Health Service (DGHS) partnered to train 725 designated Food Safety Inspectors from across the country on risk-based assessments (Appendix 1: BFSA, FAO).

Most food establishments are not registered by the BFSA, but by the BSTI under the Ministry of Industries. There is no single point of registration for the 2.56 million food establishments in Bangladesh (Appendix 1: BFSA) and FAO, and the current conflicts between BFSA and BSTI in coordination of food safety activities are salient. If food establishment regulation and registration are united under the jurisdiction of one authority, or communication among authorities is improved, food safety and the food system would become more viable, functional, and effective.

BFSA recently released "Harmonization of Bangladesh's Food Safety Standards with Codex Standards and other international best practices" to review the existing standards and draft new standards and codes of practice for implementation in the country. BFSA has proposed the following two approaches: revision or formulation of vertical standards for different food products or groups of food products and revision or formulation of horizontal standards[11].

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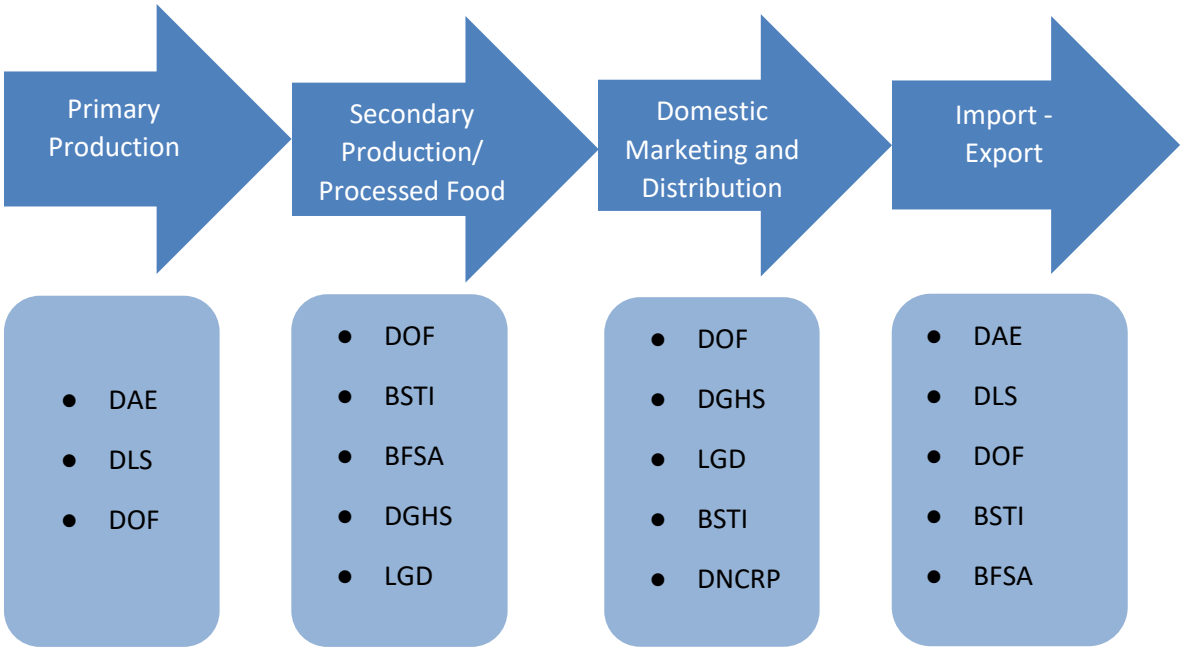
[10] Food and Agriculture Organization of the United Nations. (2019). *New Mobile Food Safety Laboratory to hit the streets of Dhaka.* http://www.fao.org/bangladesh/news/detail-events/ru/c/1253807/

[11] Bangladesh Food Safety Authority. (2019). Harmonization of Bangladesh's food safety standards with Codex Standards and other international best practices.
https://bfsa.portal.gov.bd/sites/default/files/files/bfsa.portal.gov.bd/notices/a84613c2_1de6_475f_97c9_784374431701/BFSA-Strategy-for-Harmoniztion-of-Standards-draft-V-1.pdf



Abbreviations: BFSA: Bangladesh Food Safety Authority; BSTI: Bangladesh Standards and Testing Institution; DAE: Department of Agricultural Extension; DGHS: Directorate General of Health Services; DLS: Department of Livestock Services; DNCRP: Directorate of National Consumer Rights Protection; DOF: Department of Fisheries; LGD: Local Government Division

Figure 1: Involvement of various departments and agencies in food safety across the food value chain

Primary production, which starts at the farm level, is controlled by the DAE, DLS, and the DOF. As per the Fish Feed and Animal Feed Act, 2010, the DLS and DOF regulate feed control at the farm level. The DAE regulates the registration and inspection of pesticides and fertilizers through the Pesticides (Amendment) Act, 2009; Fertilizer (Control) Ordinance/Fertilizer (Management) Act 2006; and the Import Policy Order. DAE provides skill development training on topics such as good agricultural practices to producers, including small farm holders. BFSA has limited implementation governance at the farm level. For example, per the recommendations of the Food Safety Act, 2013, BFSA has set the MRL of pesticide residues for food but has no control over the pesticides used at the crop production level. Pesticide usage is controlled by the Plant Protection Wing (PPW) under the DAE.

BFSA and BSTI play a vital role in food processing through the implementation of specific food product standards and enforcement policies. BSTI also performs inspection procedures and testing of food products during processing to regulate quality standards. However, BFSA regulates the standards for food additives, contaminants, toxins, pesticides, packaging and labeling, hygiene and sanitation management, and testing at the processing stage. City corporations, district health departments, sub-district health departments, and the Directorate of National Consumer Rights Protection (DNCRP) are responsible for the implementation of food safety through inspections. The Local Government Division (LGD), DGHS, and DNCRP ensure food safety at domestic distribution and marketing levels through the inspection of public markets, restaurants, supermarkets, and retail (Appendix 1: FAO). Specifically, food safety officials of DGHS, DAE, DLS, DOF, and the Ministry of Food control enforcement at the district and sub-district levels while BSTI, DOF, BFSA, and DNCRP food safety officials have control at the division level through license

control, sample monitoring, and testing. The food safety officials from the LGD control the inspection of food at the city corporation and rural city levels.

The Institute of Public Health (IPH), BSTI, and Bangladesh Council of Scientific and Industrial Research (BCSIR) assist these agencies by providing technical capabilities and testing infrastructure. BSTI tests imported and domestic market samples in its own lab for enforcement purposes. BCSIR and IPH provide support in testing for the regulatory authorities. They also have technical resources to assist in research and advise on testing parameters. DAE, DOF, and the customs office regulate the export of food products. DOF provides the mandatory health certificates for fisheries and fishery products for export after those fisheries and products meet export compliance requirements. DAE controls plant product exports as per the sanitary and phytosanitary (SPS) requirements. BSTI is the agency responsible for the control of imported food products through inspection, testing, certification, and import clearance.

Bangladesh Standards and Testing Institution (BSTI)

The Ministry of Industries is responsible for leading and facilitating the legal and technical institutional framework for national standards (except pharmaceutical products), quality, and conformity assessment. Its main institutions are the Bangladesh Standards and Testing Institution (BSTI) and the Bangladesh Accreditation Board (BAB). BSTI is the sole national quality certification body that also provides metrology and calibration services. BAB is the sole agency in the country with a mandate to provide accreditation services to laboratories in accordance with national, regional, and international standards.

Prior to the formation of BFSA, BSTI was the only national standard-setting entity, providing both voluntary and mandatory standards for product registration and certification to ensure the quality and safety of food products. BSTI has developed approximately 600 agriculture and food standards, including Hazard Analysis and Critical Control Points (HACCP) and GHP, with 153 standards adopted from the Codex Alimentarius of the FAO/WHO[12,13] (Appendix 1: BSTI). Examples of voluntary standards include:

BDS CAC GL 18:1998 Guidelines for the application of the HACCP system
BDS CAC RCP 1:2002 Code of practice general principles of food hygiene
BDS 935:1980 Code of hygienic practices for handling and processing of fresh fish
BDS 522:2015 Fruit and vegetable preserves (morabba)

However, out of 600 BSTI agriculture and food product and process standards, only 76 are mandatory food products (Appendix 1: BSTI). Mandatory food products require prior approval from BSTI for certification and license. Examples of mandatory food products brought under the mandatory certification marks scheme of BSTI include:

BDS ISO 6079:2015 Instant tea in solid form
BDS 1866:2014 Fortified edible rice bran oil
BDS 1807:2008 Cumin powder
BDS 1084:2015 Coriander powder
BDS 1773:2016 Fortified edible sunflower oil

[12] Food and Agriculture Organization of the United Nations. (2017). *Bangladesh food safety cluster evaluation.* http://www.fao.org/3/a-bd703e.pdf

[13] Bangladesh Standards and Testing Institution. (2020). *List of Bangladesh Standards (BDS) on agricultural & food products – 2020.* http://www.bsti.gov.bd/site/page/35c55da1-ce37-4800-981e-a7d3d4c85148/-List-of-bd-Standards(BDS)-on-Agricultural-&-Food-Products-

BSTI has not prepared standards for all foods, and many products that are widely consumed in the country do not require mandatory approval from BSTI. With only 76 mandatory food products requiring prior BSTI certification, most of the packaged food business in Bangladesh operates without certification. Due to the limited number of mandatory product standards, BSTI cannot regulate/test the full spectrum of food products in the country (Appendix 1: BSTI).

As the leading national entity for product certification, BSTI provides certified customs clearance to imported products. They check the standardization of imported products approved using Import Policy Order, 2015-2018; Food Safety Act, 2013; and the BSTI Standards Catalogue, 2018.

BSTI plays a vital role in food safety management through the control of licenses, sampling, and testing and monitoring of imported food products for compliance. BSTI can inspect and approve agriculture and food products based on its developed standards. BSTI grants licenses to food manufacturers and has the power to cancel licenses for companies whose products are identified as substandard. BSTI performs market surveillance throughout the year and conducts mobile court drives. The mobile court drives are jointly conducted by BSTI and Dhaka district administration to check food adulteration throughout the year but with increased frequency during the Ramadan season. These mobile court drives also use basic rapid detection methods for sample tests (such as the formalin test kit for milk, iodine test kit for starch, etc.). BSTI has now increased focus on surveillance, which takes samples from markets and factories for testing. BSTI performs food testing for enforcement purposes as well as internal standard-making purposes and tests samples from other government agencies such as BFSA, LGDs, customs, etc. as per request for market surveillance and import clearance. In addition to the above, BSTI receives more than 5,000 testing samples per year from industry. BSTI is also trying to adopt rapid testing methods for enforcement but is facing challenges due to result variations and errors (Appendix 1: BSTI). Another challenge is the importation of non-standard test kits. Market sampling by BSTI is often inadequate due to technical limitations, as they cannot collect representative samples for entire markets.

Structure and functions of BSTI

Aside from the Administrative Wing, the BSTI performs food and agriculture commodity standardization and testing through five technical wings: Standards Wing, Physical Testing Wing, Chemical Testing Wing, Metrology Wing, and Certification Marks Wing. Under the Standards Wing, BSTI technical committees within the Agriculture and Food Division develop food and agriculture commodity standards. The Food & Bacteriology Division under the Chemical Testing Wing performs standard testing for the quality and safety of food products. The Chemical Testing Wing has several labs for food products testing[14], including:

- Cereal and Bakery Lab
- Processed Food Products and Fruit Drinks Lab
- Water and Beverages lab
- Microbiological Lab
- Oils and Fats Products Lab
- Instrumental Lab

[14] Bangladesh Standards and Testing Institution. (2014). *Food & bacteriology division.* https://bsti.portal.gov.bd/site/page/e14a1e07-32ed-45a3-8e36-a8a5dd014eba/-

The Metrology Wing has three fields[15]: legal metrology, industrial metrology, and scientific metrology. The legal metrology division is responsible for the regulatory structure and enforcement of the metrology of food products. The Certification Marks Wing is responsible for promoting quality control, ensuring compliance of products with Bangladesh regulatory requirements, implementation of Bangladesh standards through the national certification marks strategy, and certifying the quality of commodities that are imported, exported, or produced in the country[16].

There is a need to develop standards for food products that are not currently made using the latest developments in food science, including food consumption patterns, new specifications, and addressing the presence of new contaminants and toxins as well as the use of new food additives and ingredients required by producers and manufacturers. As part of ongoing efforts to harmonize food standards, BFSA recently released a report titled "Harmonization of Bangladesh's Food Safety Standards with Codex Standards and other international best practices" to review the existing standards and draft new standards and codes of practice for implementation in the country. BFSA has proposed the following two approaches: revision or formulation of vertical standards for different food products or groups of food products and revision or formulation of horizontal standards[17].

Private standards, including British Retail Consortium (BRC) and Halal certification, are also now being implemented in Bangladesh. Islamic Foundation Bangladesh, a government organization under the Ministry of Religious Affairs, is the only recognized state-owned body to certify the country's Halal products in Bangladesh. Private companies such as TÜV SÜD, Société Générale du Surveillance (SGS), and Integrated Assessment Services (IAS) provide BRC certification in Bangladesh.

Directorate General of Health Services (DGHS)

The DGHS under the Ministry of Health & Family Welfare (MoHFW) is also involved in food safety through its enforcement and surveillance activities. DGHS has food inspectors who work in coordination with BFSA to enforce specific quality and safety standards of food samples in the market. The National Food Safety Laboratory (NFSL) at the Institute of Public Health (IPH) under MoHFW is involved in food safety testing. Established with support from FAO and a USAID-European Union (EU) partnership, the NFSL-IPH lab tests food, feed, and water quality samples. IPH receives samples from both industry and the public sector. The cost of testing for government and private samples is borne by the government/respective departments and private companies, respectively. The facility is equipped for both microbiological and chemical testing of various food and water samples; however, the microbiological lab is not accredited (Appendix 2). Microbiological tests performed at IPH include:

- Aerobic Plate Count
- Yeast activity test
- *E. coli*

[15] Bangladesh Standards and Testing Institution. (2014). *Categories of metrology.* https://bsti.portal.gov.bd/site/page/642ab781-a871-47eb-b314-137f9b140175/-

[16] Bangladesh Food Safety Authority. (2019). *About Certification Marks Wing.* https://bsti.portal.gov.bd/site/page/35713692-fa73-4ca5-991b-81370d64d096/-

[17] Bangladesh Food Safety Authority. (2019). Harmonization of Bangladesh's food safety standards with Codex Standards and other international best practices. https://bfsa.portal.gov.bd/sites/default/files/files/bfsa.portal.gov.bd/notices/a84613c2_1de6_475f_97c9_784374431701/BFSA-Strategy-for-Harmoniztion-of-Standards-draft-V-1.pdf

- *Bacillus cereus*
- *Salmonella*
- *Staphylococcus aureus*
- Psychrophilic bacteria
- Total coliform
- Total mold count
- Fungi
- *Listeria monocytogenes*
- *Campylobacter*
- Fecal coliform
- *Shigella*

Chemical tests performed at NFSL-IPH include:

- Heavy metals (As, Cd, Cr, Pb, Hg)
- Essential elements (Fe, Zn, Ca, Mg, Na, K, Mn, Cu, Sn, Se)
- Formaldehyde
- Artificial sweetener
- Preservatives
- Mycotoxins
- Pesticide residues
- Artificial colors
- Proximate analysis testing
- Fatty acid profile of oil
- Drug residues
- Vitamins
- Methanol, ethanol
- Sugar in food items
- Monosodium glutamate
- Caffeine

The performance of IPH in managing food safety is currently below optimal due to a shortage of scientifically trained personnel to perform tests with advanced equipment and a lack of operational funding.

Bangladesh Council of Scientific and Industrial Research (BCSIR)

The BCSIR, under the jurisdiction of the Ministry of Science and Technology (MoST), is responsible for research and development activities in emerging technical fields. One of BCSIR's 11 research institutes is the Institute of Food Science & Technology (IFST) in Dhaka. The IFST focuses on food-related research and development. Three BCSIR labs in Dhaka, Chittagong, and Rajshahi provide research and technical support for food product testing/analysis (Appendix 2) to industry as well as authorities such as BFSA. IFST possesses the scientific capability to detect and test both microbial and chemical contaminants. Additionally, IFST provides training support and conducts research on a wide gamut of food products.

The IFST microbiological lab lacks accreditation (Appendix 1: IFST). However, the chemical lab is accredited for some parameters (toxicology, heavy metals, and chemical contaminants by EU accreditation). In

addition, IFST follows the ISO standards for testing and is in the process of attaining formal accreditation. Courts in Bangladesh rely on IFST for testing in cases involving the prosecution of food establishments. All types of samples, including custom samples and trial samples, are tested at IFST. IFST has developed rapid detection kits for testing water, iodine, and formalin (Appendix 1: IFST). These rapid detection kits were developed as part of IFST's research programs. However, IFST does not have the capacity for commercial production of these kits, nor have the kits been transferred to industry for commercialization. Thus, Bangladesh still imports rapid detection kits for food testing due to limited domestic production.

Safety of Farm Produce

The Plant Protection Wing of DAE, under the Ministry of Agriculture, regulates pesticide registration, production, use, and quality control under the Pesticides Act 2018 and the Pesticide (Amendment) Rules 2010. Between 2014 and 2015, Bangladesh exports had several non-compliance issues with European countries[18,19] (Appendix 1: Hortex Foundation). The EU rejected several export consignments including Betel leaf, citrus fruits, and vegetables due to pests and the absence of phytosanitary certificates[17, 18].

Following these incidents, DAE supported the implementation of GAPs in Bangladesh. The exporters now have contracts with farmers who have adopted integrated pest control approaches. Exportation of fruits and vegetables is now increasing[20], and non-compliance with European regulations has been significantly reduced since these approaches were implemented in 2017 (Appendix 1: Hortex Foundation). On the other hand, the lack of trained auditors for certification of GAPs in Bangladesh may hinder the adoption of GAPs. Recently, DAE constructed a central packhouse in Dhaka with sorting, grading, cooling, and packaging facilities to ensure fruits and vegetables meet export safety and quality standards[16]. However, there is a lack of accredited labs for testing fresh produce, and the national standards for fresh produce are still being drafted (Appendix 1: FAO). The designated laboratory of DAE's Plant Protection Wing does not provide a commercial testing facility for the farmers/exporters but only verifies the concentration of the active ingredient as per the claim of the applicant for pesticide registration[21]. The Pesticide Analytical Laboratory of the Entomology Division of BARI, Gazipur, is an accredited lab for pesticide residue analysis for crops; however, it has a limited capacity for sample testing.

The Department of Fisheries (DOF), under the Ministry of Fisheries and Livestock, regulates fish and seafood products for domestic use, as well as for import and export markets. There are three Fish Inspection and Quality Control (FIQC) stations under DOF at Dhaka, Chittagong, and Khulna, catering to the key regions of fishery production. FIQC stations are responsible for quality control measures in the fisheries sector and issue health certificates for exportable fish and fish products (Appendix 1: FIQC). The inspection division of FIQC monitors industry compliance, issues inspection reports, and performs sampling. The quality control department undertakes testing and issues test reports. Licensing of fish

[18] Bangladesh Foreign Trade Institute. (2016). *Analysing export readiness of the vegetables sector of Bangladesh.* http://katalyst.com.bd/wp-content/uploads/2017/05/Analysing-export-readiness-of-the-vegetables-sector-of-Bangladesh.pdf

[19] European Commission Directorate-General for Health and Food Safety. (2017). Final report of an audit carried out in Bangladesh from 08 November 2016 to 17 November 2016 in order to evaluate the system of official controls and the certification of plants for export to the European Union. DG(SANTE) 2016-8799 - MR.

[20] Hortex Foundation. (2019). *National export status of fruits, vegetables, and potato in Bangladesh.* http://www.hortex.org/10_years_Export_data_on_fruits_vegetables_potato.pdf

[21] Md K. Hassan 2018. Review of existing crop-sector related laws and identify any gaps that impact food safety in Bangladesh. IFSB-BD, FAO.

processing units in the respective regions is also under the purview of FIQC (Appendix 1: FIQC). The labs in the FIQC are accredited by BAB and can conduct chemical and biochemical tests as well as microbial assessments, which include bacterial tests such as *Salmonella, Escherichia coli, Staphylococcus aureus, Listeria monocytogenes, Vibrio cholerae*; diseases such as Early Mortality Syndrome (EMS), necrotising hepatopancreatitis (NHP), etc.; and viruses such as white spot syndrome and yellowhead disease. Additionally, DOF also organized training programs in HACCP with BFSA as an outreach activity undertaken by FIQC.

DLS, under the Ministry of Fisheries and Livestock, is the responsible body for overseeing the control of livestock diseases related to animals and animal products. Supervision by DLS is limited to the primary production stage of livestock farmers. Slaughter control, market management, distribution, and sales are regulated under other departments or agencies. DLS provides import and export certificates for trade in animals and animal products as well as guidance and supervision to livestock farmers for controlling disease and enforcing legal compliance for animal product safety. DLS officers train livestock farmers for disease outbreaks in animals through their field visits (Appendix 1: CDIL). However, good animal husbandry practices (GAHP) are not yet followed in Bangladesh due to the lack of resources under DLS.

The Veterinary Public Health Unit of DLS has the mandate to perform diagnosis, surveillance, and control of zoonotic diseases; ensure food safety of animal origin; and liaise with the Health Department[22]. Multi-drug resistant bacteria are another emerging threat due to the indiscriminate use of antibiotics in livestock and poultry industries. Some of these diseases directly affect human health (e.g., anthrax), while others affect meat and milk quality, leading to food safety issues (e.g., abuse of antibiotics). DLS has recently set up an "Establishment of Quality Control Laboratory for Livestock Inputs and its food Products (EQCLIFP)" that will include facilities for assessing nutritional, biological, chemical quality, etc. EQCLIFP is expected to take necessary measures for ensuring quality control of livestock inputs and outputs, certification, and application and formulation of new laws and standards[23].

Food Processing in Bangladesh: Sub-Segments and Associated Food Safety Risks and Challenges

Food processing is one of the key industries contributing to the manufacturing sector in Bangladesh. The food sector accounts for 22% of total manufacturing production, employs 20% of the labor force, and contributes about 1.5% to the national GDP[24]. The processed food market in Bangladesh was valued at USD 19.7 billion in 2018 and witnessed an estimated growth rate of 15% during the period between 2013

[22] Khatun et al. (2019). Current status of veterinary public health activities in Bangladesh and its future plans. *BMC Vet Res 15:* 164.

[23] Government of the People's Republic of Bangladesh. (2017). Establishment of quality control laboratory for livestock inputs and its food products (EQCLIFP). EOI No. EQCLIFP/SD-02/2017-18. https://dls.portal.gov.bd/sites/default/files/files/dls.portal.gov.bd/notices/fe0e2c61_6c19_4201_8efd_5238d2fb2d9e/Notice%20and%20SRFA%20for%20International%20Lab%20Consultant%20under%20EQCLIFP%20project.pdf

[24] Bangladesh Bureau of Statistics. (2019). Statistical Year Book Bangladesh 2018. http://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/b2db8758_8497_412c_a9ec_6bb299f8b3ab/SYB-2018.pdf

and 2018[25]. There is a growing, under-met demand for secondary and tertiary processed foods from the growing middle class of 30 million people, resulting in a rise in imports of processed packaged foods. The sector is challenged by low investments, technological inefficiency and obsolescence, low capacity utilization, and poor implementation of food safety and quality standards[26]. The food processing sector includes the processing of cereals, pulses and oilseeds, bakery and confectionery, fruits and vegetables, dairy, carbonated beverages, non-carbonated fruit juices, other beverages, and various other food items. The growth of the food industry in Bangladesh is very high, but the sector has remained stagnant at 2% of GDP since 2004[27].

Key segments of the food processing industry

Shrimp processing: Shrimp processing is one of the most organized, well-developed, and export-oriented sectors of the country. Frozen shrimp has contributed about USD 400 million to exports and comprises 85% of the country's aquaculture exports[24]. There are about 105 registered frozen food units under the Bangladesh Frozen Foods Exporters Association (BFFEA), of which 76 are approved for EU exports (Appendix 1: BFFEA). These units are mainly concentrated in the Khulna, Jessore, and Chittagong regions. The companies in the sector are aware of food safety risks and testing requirements and most of the units are certified for ISO 22000/FSMS 22000 or HACCP. Some of these companies have well-equipped quality assurance (QA) labs. The companies in the sector are subject to inspection from the FIQC wing of the Department of Fisheries, which is also the key testing agency for approving export consignments. Dependence on private testing labs is currently limited, as the testing through FIQC is mandatory for export clearance. Based on primary consultations with industry stakeholders, FIQC labs appear to be well equipped, as the current testing requirements are being met with no significant problems, though they may need additional personnel, training, and readiness for future growth. During primary stakeholder consultations, it was mentioned that testing at FIQC tends to become a bottleneck due to their practice of initiating testing on a particular weekday rather than testing throughout the week (Appendix 1: BFFEA and shrimp processing companies). For example, chemical and microbial testing is initiated on a fixed weekday and companies may have to wait until the next cycle of testing the following week if their samples are not submitted on the fixed weekday. Although this can be managed in the current scenario, it may become problematic when production levels increase. The sector is currently facing acute shortages of raw material, and the processing units are operating below operational capacities. Prevalent food safety hazards in the sector include the presence of antibiotics; pathogenic microbes such as *Salmonella* spp.*, E. coli, Listeria monocytogenes,* and *Vibrio* spp.; and viral infections such as white spot and yellowhead diseases.

Fish production and processing: Fish production in Bangladesh amounted to 2 million metric tons (MT) in 2015 with an annual growth rate of 6%. Fish is one of the principal protein sources in the country and amounts to 60% of the animal protein consumed.[28] Jessore, Mymensingh, and Narsingdi are the key

[25] Sathguru Management Consultants estimates

[26] Food and Agriculture Organization of the United Nations. (2017). Evaluation of FAO's contribution to Bangladesh. http://www.fao.org/3/BD730/bd730.pdf

[27] Innovision. (2016). Study on the roles and opportunities for Private Sector in Agro-food Processing Industry of Bangladesh. http://katalyst.com.bd/wp-content/uploads/2017/01/Roles-and-Opportunities-for-Private-Sector-in-Agro-food-Processing-Industry-of-Bangladesh.pdf

[28] Bangladesh Bureau of Statistics, 2015.

production regions, with most processors having established plants in Chittagong and Mymensingh. In Bangladesh, fish is mainly consumed fresh, while a small quantity is processed into various frozen products. A significant quantity of fish is often imported from India, depending on the seasonal availability and region of the country. Frozen fish exports (including fresh and marine) contribute to 15% of aquaculture exports. Chemical contaminants such as formalin, an aqueous solution of formaldehyde, were previously observed in fish imports but are no longer a common occurrence in recent times due to increased surveillance and outreach by the Department of Fisheries.

Bakery and confectionery sector: The bakery and confectionery segment is growing quickly and has many domestic players. Recent duty hikes on imported biscuits have increased the demand for local products, at the same time boosting exports. According to the Bangladesh Auto Biscuit and Bread Manufacturers' Association (BABBMA), there are approximately 5,000 semi-automated or manual small bakeries and 60 large factories registered manufacturing bakery products in Bangladesh [29]. The market size of branded biscuits in the country was valued at USD 354 million in 2018, with an annual growth of about 15%. There is a growing demand for a variety of quality biscuits by consumers in the market, which is dominated by a large number of small players. The bakery industry consists of nearly 5,000 bread and baked goods makers, including 100 automatic and semi-automatic bakeries. The sector depends on imports for its principal raw materials, including wheat, edible oil, and sugar. The market size of candy and confectioneries in Bangladesh was around USD 165.2 million in 2018, with big-name brands holding 40% to 50% of the total market share[27]. Bakery and confectionery products are mandatorily governed by the BSTI standards for finished products, raw materials, and processing conditions. The prevailing food safety risks in the sector are pesticide residues and post-processing contamination with pathogenic microbes such as *Salmonella* and *E. coli.*

Fruit and vegetable processing: Overall, about 2% of the fruits and vegetables produced in the country are processed into value-added products. Mango pulp processing is one of the key fruit processing segments, with some firms exporting the pulp to other countries. There are currently no established food safety and hygiene licenses issued by any agencies for mango pulp industries. Processed mango products were valued at USD 15.6 million in 2013, and the mango pulp market was valued at USD 15.1 million. Bangladesh exported a total of 16,000 MT of processed mango products in 2015 at a value of USD 12.3 million. Mango drinks and juice accounted for 91% of processed mango exports in 2015. Tomato processing is another important fruit processing segment in the country. Bangladesh produces 360,000 MT of tomatoes, of which 5% are processed and added to products like paste, ketchup, and sauce[30]. Tomato products are mandatorily governed by the BSTI standards for various quality and food safety parameters. Frozen vegetables are another minor segment in the fruit and vegetable processing sector, with new companies entering every year. There are no established regulations or standards for frozen vegetables or other processed ready-to-eat (RTE) frozen products. Most frozen vegetable companies adopt ISO 22000 or other voluntary quality and food safety standards.

[29] Bangladesh Agro-Processors' Association (BAPA) Foodpro International Expo. https://foodpro.com.bd/baketech.php

[30] Innovision. (2016). Study on the roles and opportunities for Private Sector in Agro-food Processing Industry of Bangladesh. http://katalyst.com.bd/wp-content/uploads/2017/01/Roles-and-Opportunities-for-Private-Sector-in-Agro-food-Processing-Industry-of-Bangladesh.pdf

Maize processing: Bangladesh processes 99% of its total maize production and only 1% is consumed fresh. Animal feed accounts for 90% of processed maize, followed by maize flour (6%), industrial starch (2%), and popcorn and snacks (2%). A total of 2.2 million MT of maize is utilized in maize processing in Bangladesh[27]. Dinajpur and Rangpur are the key procurement areas of maize in Bangladesh. Very few companies operate in the processed maize chips and snacks segment. The presence of pesticide residues and aflatoxins are major food safety hazards in maize and other cereal processing sectors. In previous studies, aflatoxins were found to occur in various food products and poultry feed above the safe limits[31] [32].

Spice processing: The major spices produced in Bangladesh are chili and turmeric. The total turmeric production in Bangladesh amounted to 136,000 MT in 2014[33]. Major hubs for turmeric include the Chittagong Hill Tracts, especially Khagrachari, Rangamati, greater Mymensingh, Dinajpur, and Lalmonirhat. The key turmeric procurement hubs in the country are Natore and Khagrachari. Almost all turmeric produced in the country is processed into turmeric powder. The total chili production in the country amounted to 110,000 MT in 2014. Chili powder is the most common processed form, while a lesser quantity is processed into other products, such as sauces. Dhaka, Chittagong, Rajshahi, and Rangpur are the key production regions for chili. The main food safety hazards associated with spice processing are chemical contaminants, such as pesticide residues, and adulteration with synthetic dyes. The products in the category are governed mandatorily using the BSTI's physical, chemical, and microbiological standards.

Dairy processing: Bangladesh produced a total of 9.4 million MT of milk between 2017 and 2018, with goat's milk accounting for the largest share at 54.2%. Cow's milk holds the second-largest share at 42.4%, which is followed by buffalo milk (1.8%) and sheep's milk (1.5%)[34]. Bangladesh's national per capita daily demand for milk is 158 ml, which is lower than the World Health Organization's (WHO) recommendation of 250 ml per day. About 55% of the total raw milk produced is processed either by traditional processors of sweetmeats or industrial processors[32]. Traditional processors account for 90% of the total processed milk while only 5% of the milk is used by industrial processors. Food safety remains a concern not only at the small traditional processor level but at the industrial level as well[32]. In June of 2019, the Bangladesh Food Safety Authority (BFSA) carried out a series of tests at six government and private labs and detected lead in 11 brands of pasteurized milk. These pasteurized milk brands were from top milk processors, including both state-run and private players, and all the processors are registered with BSTI. BSTI tests milk against only nine parameters, while developed countries test against 25-30 parameters. BSTI's lack of adoption of international standards for food safety raises concerns about milk safety in Bangladesh. Just two weeks before the test conducted by BFSA, Dhaka University researchers found detergent and

[31] Lubna et al. (2018). Detection of aflatoxin in poultry feed and feed materials through immuno based assay from different poultry farms and feed factories in Bangladesh. *Bangladesh J Microbiol*, *35* (June), 75-78.

[32] Roy et al. (2013). Aflatoxin contamination in food commodities in Bangladesh. *Food Additives and Contaminants: Part B Surveillance, 6*(August), 17-23.

[33] Innovision. (2016). Study on the roles and opportunities for Private Sector in Agro-food Processing Industry of Bangladesh. http://katalyst.com.bd/wp-content/uploads/2017/01/Roles-and-Opportunities-for-Private-Sector-in-Agro-food-Processing-Industry-of-Bangladesh.pdf

[34] United Nations Food and Agricultural Organization (FAO) & United Nations Industrial Development Organization (UNIDO). (2019). The dairy and beef value chain in Bangladesh. https://www.unido.org/sites/default/files/files/2019-05/Bangladesh%20dairy%20and%20beef%20vc%20report%20%28Wei%27s%20final%20version%29%20.pdf

antibiotics in pasteurized milk from top brands. Prior to these incidents, there were also reports of food processors failing food safety tests due to the presence of *E. coli* and *Salmonella* in milk[35].

Bangladesh imports a large quantity of powdered milk to meet its domestic milk demand. The utilization of powdered milk for making various processed products is high among industrial processors, while traditional processors utilize less than 20% of imported powdered milk. Industrial dairy relies on powdered milk due to its lower cost and to manage seasonal variation in local milk production. The cheaper powdered milk available in markets may contain high concentrations of toxic substances. These incidents raise a food safety concern for packaged milk, which accounts for 88.1% of the total retail sale of dairy products. In rural areas, milk is mostly purchased from local farm producers and consumed after the raw milk is boiled. Consumers lack awareness regarding milk safety and may not know that human diseases can be caused by animal diseases or poor food safety.

Beef processing: Total meat production in Bangladesh amounted to 2.2 million MT between 2017 and 2018, and beef accounts for 60-65% of the share of the meat market. Poultry makes up the largest number of the animals slaughtered but accounts for the second-largest meat supply (15.23%). It is followed by goat meat, which holds 12.61% of total meat production, buffalo meat (5.6%), and sheep meat (1.07%)[32]. About 99% of the meat consumed in Bangladesh is consumed as fresh meat and purchased from fresh food markets that practice the traditional methods of slaughtering. Hence, food safety is a major concern for the beef sub-sector. Only 20-30% of the cattle in major cities are killed in official slaughter facilities and almost none are killed in official facilities in peri-urban or rural areas. Most slaughtering occurs in unofficial and unregulated sites, without veterinary supervision. Less than 1% of the total meat is purchased from formal retail, supermarkets, and restaurants. Consumers prefer fresh meat over processed meat due to quality and price concerns.

Poultry: The poultry sector plays an important role in the supply of meat in Bangladesh, and the demand for poultry is growing at a rate faster than those for other animal products. Poultry production is segmented into traditional backyard poultry, a low-input and low-output system accounting for 40% of the poultry meat and 50% of the egg supply, and commercial poultry, which holds 60% of the meat and 50% of the egg supply[36]. About 78,171 poultry farms are registered with DLS. The consumption of indigenous breeds is growing in Bangladesh due to consumer concern over the safety of commercial poultry meat. Excessive use of antibiotics in commercial poultry, *Salmonella*-related food poisoning, pesticide residues from feed production, lack of disease control, use of expired drugs, shortages of vaccines, unhygienic production and processing, and inadequate inspection drive the unsafe consumption of poultry meat in Bangladesh. Also, there is a lack of training for farmers and poultry meat producers on poultry rearing and management as well as good manufacturing practices in the poultry industry[34].

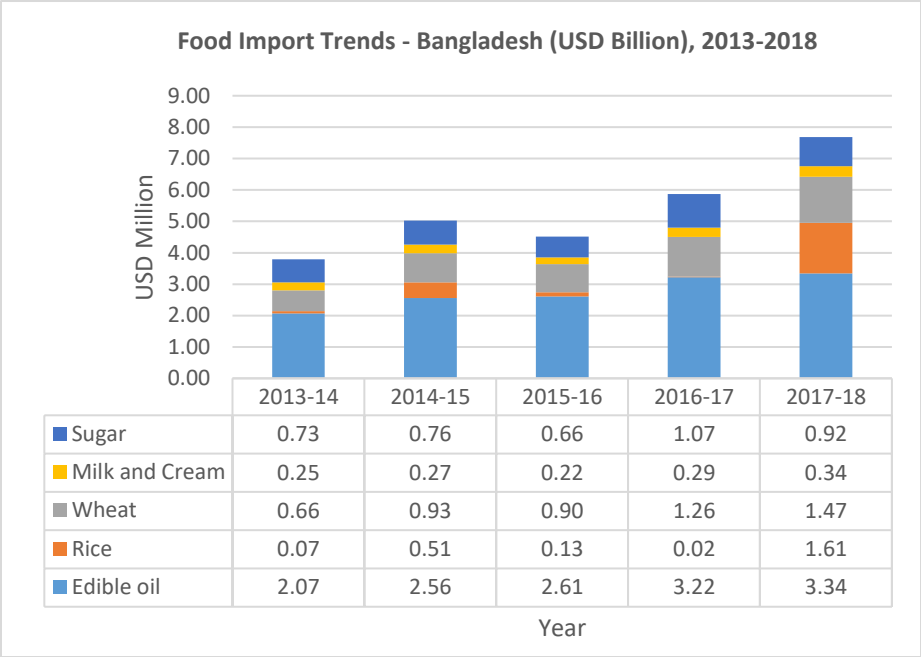
Other sectors: The other important food processing sectors in Bangladesh include mustard, potato, pulses, and beverages.

Bangladesh also depends on imports for major commodities such as edible oil, rice, wheat, milk, cream, and sugar. From 2015 to 2020, there has been a noticeable increase in the importation of edible oil and

[35] The Daily Star. (2019). New tests find lead in milk. https://www.thedailystar.net/frontpage/bangladesh-food-safety-authority-new-tests-find-lead-milk-1772533

[36] BeezBistar Foundation. (2017). *Study on food safety governance in poultry sector, Bangladesh.* http://beezbistar.org/index.php/home/showAerticle/24/english/Beezbistar-Foundation/Study-on-Food-Safety-Governance-in-Poultry-Sector-Bangladesh

rice, and other categories grew as well. The food safety risks of these categories, excluding dairy products, are mostly limited to chemical hazards such as pesticide residues and heavy metals.

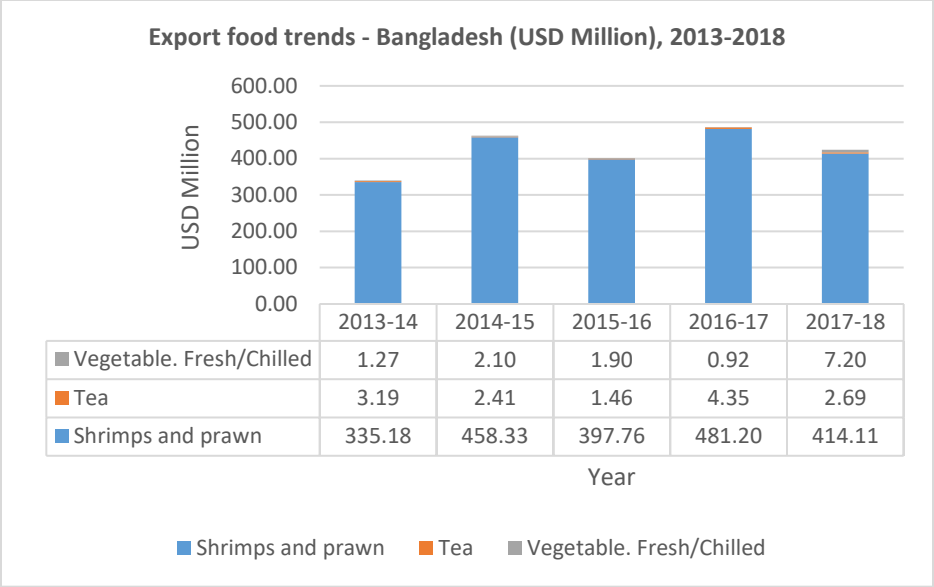


	2013-14	2014-15	2015-16	2016-17	2017-18
Sugar	0.73	0.76	0.66	1.07	0.92
Milk and Cream	0.25	0.27	0.22	0.29	0.34
Wheat	0.66	0.93	0.90	1.26	1.47
Rice	0.07	0.51	0.13	0.02	1.61
Edible oil	2.07	2.56	2.61	3.22	3.34

Source: Bangladesh Bureau of Statistics, 2018.

Figure 3: Bangladesh food import trends

Frozen fish, shrimp, frozen food products, tea, and spices (dry and wet) are the major food products exported from Bangladesh. Together, frozen shrimp and fish products contributed to exports totaling about USD 500 million in 2019 and have contributed to more than 90% of agri-food exports and 1.5% of total exports (Appendix 1: BFFEA Khulna and seafood companies). With a 39% share, the United States (U.S.) was the single largest export market for Bangladesh shrimp until 2007; however, exports to the U.S. decreased steeply over time due to increased freight costs compared to EU markets. Between 2005 and 2006, the EU imposed restrictions on frozen shrimp imports from Bangladesh due to antibiotic residues. BFFEA enforced a voluntary ban on shrimp production and undertook a detailed assessment that found that the EU's restrictions were due to improper test sampling methods employed in several European labs. Subsequently, with improved compliance, in 2015 the EU withdrew its 20% mandatory sampling and checking requirements (Appendix 1: BFFEA Khulna and seafood companies).



Source: Bangladesh Bureau of Statistics, 2018.

Figure 4: Bangladesh food export trends

Though exported in a lesser quantity, ready-to-eat products, snacks, and confectionery products are also of considerable importance as they are key revenue sources for MSMEs.

Food import in Bangladesh is controlled by various ministries, including the Ministry of Industries, Ministry of Food, Ministry of Agriculture, and Ministry of Fisheries and Livestock. Importers of food to Bangladesh are required to provide samples to the Bangladesh Standards and Testing Institution (BSTI) for testing before their products are imported. BSTI checks imported food product labels for producer contact information and expiration dates, as well as any mislabeling or fake product information. These food product samples are tested at the BSTI labs. A clearance certificate is required before the product can be released to the public. If regulatory compliance is not met, the product will not be released in the market. The importing agencies may undertake legal action if any substandard products are released without prior approval. Importers of meat and fishery are required to obtain import permits from DLS and DOF, respectively. Animal and fish product samples are also tested by DLS and DOF, respectively, before goods are imported to Bangladesh. For import of plant products, the pesticides used on the products must be registered under the administration of the Plant Protection Wing within the Department of Agricultural Extension and should comply with the Food Safety (Contaminants, Toxins and Harmful Residues) Regulations, 2017. For the import of processed food products, no facility registration or product registration is required by the importers.

As per the Import Policy Order 2012-2015, inspection and disease-free/phytosanitary certifications (i.e., import permits) are necessary in most cases when importing plant products or live animals and animal products. Pre-shipment testing and certification are mandatory for all processed food and agriculture products. Additionally, radioactivity testing and country of origin certifications are required for all imported food and agricultural products. It is mandatory to include the date of production, date of expiration, and storage information on the packaging of imported meat products. Importers of eggs and live birds must provide proof that goods are free from avian influenza virus and other harmful bacteria, such as *Salmonella* spp. and *Campylobacter* spp. Also, all fish and fish products imported to Bangladesh must be free of formalin; proof of a formalin test is required for importing these products.

Industry composition and status of industry's food safety compliance

The total number of manufacturing industries in Bangladesh is 42,792, of which about 6.5% are large, 6.51% are medium, 50.89% are small, and 36.05% are micro-sized industries. The classification of MSMEs based on their revenues and workforce is shown in Table 2.

Table 2: Classification of industries in Bangladesh, by revenue and number of workers

Type of Industry	Manufacturing Value in Bangladeshi Taka (Tk.)	Number of workers
Micro	Between 0.5 million and 5 million Tk.	10 to 24
Small	Between 5 million and 100 million Tk.	25 to 99
Medium	Between 100 million and 300 million Tk.	100 to 250

Source: Ministry of Industries, 2010

Food and beverage processing establishments account for 2.05% of the total manufacturing industry in Bangladesh. MSMEs contribute a very significant economic output in the Bangladeshi economy and employ many workers in the country. MSMEs account for 98.75% of the total food and beverage processing industry in Bangladesh, with a total of 8,698 MSMEs. The total number of food and beverage processing establishments by size in 2018 is shown in Table 3[37]:

Table 3: Food and beverage industries according to size of the establishment

	Total	Micro	Small	Medium	Large
Manufacture of food products	8,441	5,733	2,416	187	105
Manufacture of beverage products	367	161	187	14	5

According to a survey conducted by the Bangladesh Agro-Processors Association (BAPA) in 2014 on the MSME food processing companies in the country, as a part of an EU-funded project titled "SME Competitiveness Grand Scheme of European Union (ASIE/2013/333-073)," only 14% of the companies are HACCP compliant and only 4% are ISO certified. 30% are certified through BSTI. Lack of knowledge, complexity of systems, and methodology were cited as key barriers to implementing functional food safety systems[38]. From the time stakeholder consultations were conducted, the number of firms with certifications might have increased. However, based on the primary consultations with industry/MSME stakeholders (Appendix 1), it was observed that the previously cited barriers are still prevalent, including:

- At present, there is no surveillance and monitoring of quality for the before-market/consumer stage; the focus has been on levying monetary penalties and legal action on the industries for non-compliance. Instead, those consulted believe that that emphasis should be on training industry members to prevent the re-occurrence of non-compliance. As per the Food Safety Act, 2013, the

[37] Bangladesh Bureau of Statistics. (2019). Statistical Year Book of Bangladesh 2018. http://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/b2db8758_8497_412c_a9ec_6bb299f8b3ab/SYB-2018.pdf

[38] Bangladesh Agro-Processors' Association (BAPA). (2014). *SME Competitiveness Grand Scheme of European Union (ASIE/2013/333-073).* http://www.bapabd.org/projects/projects073Information

Food Court has the power to issue warrants, and provisions have been made in the Act for issuing search warrants, arresting individuals, and seizing goods.

- As per the current recall system, any non-conformance with regards to adulteration or sub-standard products requires recalling the whole production lot as opposed to the affected lot, which is the practice in other countries.
- Product standards vary by agency. Sometimes they are also different from other markets, making it difficult to model them on those from nearby countries (e.g., standards for spices between India and Bangladesh are very different).
- There is no reliable scientific data on local conditions and food products to be used in establishing food shelf life. There is a need for a national database to create minimum levels of shelf life of various foods.
- It is not economically feasible for MSME companies to have microbial or advanced analytical labs. In countries like Japan, MSME companies have common testing facilities under their associations; similar infrastructure could be created in Bangladesh.
- Accredited labs are needed at the regional level, as the cost of testing is increasing due to shipping samples longer distances.
- The cost of testing is also a factor, with private lab fees being unaffordable at present. Sometimes the cost of testing is more than the net profit being made by the MSME. Service levels of the public labs are improving over time, but the pace has not kept up with MSME needs and growth.

In Bangladesh, food processing companies with exports and large companies with multiple product groups and plants are better equipped to comply with the food safety certifications, including Food Safety System Certification 22000 (FSSC 22000), International Standard Organization 22000 (ISO 22000), and HACCP certifications. From consulting primary stakeholders, it was observed that frozen fish and shrimp companies are well informed and have better compliance levels due to quality and food safety requirements set by the importing countries and through the continuous inspection and training carried out by the FIQC teams of the Department of Fisheries.

Since 2010, the Management System Certification cell of BSTI has issued about 59 certifications to companies in various sectors, including food processing companies. Most of the certifications are issued following the IS0 9000 series of standards, with food companies representing about a third of the recipients. In 2019 and 2020, three companies received ISO 22000 certification from BSTI, while nine other companies received ISO 22000 certifications in prior years[39,40]. Certifications from private certifying agencies constitute a major share in the private food industry. Private companies invest in these certifications as they help in meeting the requirements of international markets or customer specifications and enhance their brand or premium in domestic markets. The number of HACCP/FSMS-

[39] Bangladesh Standards and Testing Institution. (2019). Annual Report 2018-2019. https://bsti.portal.gov.bd/sites/default/files/files/bsti.portal.gov.bd/page/7b097c56_b6a5_46f4_9644_f2be0b870917/Annual%20Report-2018-19.pdf

[40] Bangladesh Standards and Testing Institution. (2020). *Management system accreditation.* http://bsti.portal.gov.bd/site/page/1120924c-83e6-47bf-b80b-5d188ab7d4a6/-

certified institutions has significantly increased from 10 in 2015-16 to 70 in 2017-18[41]. There are currently 14 private sector certification agencies accredited by BAB in addition to BSTI. The Global Food Safety Initiative (GFSI) recognized voluntary standards like FSSC 22000 and BRCGS are still less popular and mainly limited to larger export-oriented companies. There are approximately 41 companies in Bangladesh with FSSC certification[42].

During an interview conducted by a newspaper reporter in October 2019 with leading Bangladesh frozen food processing companies, most stated that they are certified with HACCP, ISO, or other GMP certifications. It was also reported that these companies employ their own product and food safety standards, as there are currently no regulatory standards for frozen foods[43]. The prevalence of foodborne pathogens in food products in markets has been studied by various research and academic groups, including the following examples:

- As per the study by Feroz and Noor (2018)[43], vegetable and salad vegetable samples from the cities of Dhaka and Chittagong were found to contain *Salmonella Paratyphi A, Enterobacter,* and *Vibrio* spp.[44]
- A study carried out to check for the presence of pathogenic microbes in dessert products collected from Dhaka demonstrated the presence of pathogens such as *Staphylococcus* and *E. coli* in some samples[45].

Additional studies shared similar observations on the presence of pathogens in categories like poultry products, frozen RTE food, processed shrimp, etc. It is critical that more surveillance, risk-based food safety approaches, training, and capacity building be undertaken to ensure consumer safety and the growth of the food processing sector.

Divided control between multiple agencies, lack of proper technical expertise, limited training and capacity-building opportunities, lack of differentiation at the consumer level in the domestic market, and cost implications of certifications for MSMEs are key impediments in adopting voluntary standards and certifications by food processing companies. Certifications have become an eligibility requirement for access to international markets and meeting customer specifications. Certifications can also be a premium driver in some markets, including the domestic market. Depending on the certification type and scale of operations, the cost of certification may not always be offset by the price premium. The initial investments required in terms of time and resources can be challenges for MSMEs. Strategies to support MSMEs in certifications, with a commitment from them to invest in maintaining the certifications thereafter, could be encouraged.

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[41] Ministry of Food, Government of People's Republic of Bangladesh. (2016). Bangladesh Second Country Investment Plan, Nutrition-Sensitive Food Systems (2016-2020). http://extwprlegs1.fao.org/docs/pdf/bgd191142.pdf

[42] FSSC 22000. (n.d.) *Certified organizations map.* https://www.fssc22000.com/certified-organizations/map/

[43] The Independent. (2019). Processed frozen foods thrive sans supervision. http://m.theindependentbd.com/post/219369

[44] Feroz, F., & Noor, R. (2019). Transmission of pathogens within the commonly consumed vegetables: Bangladesh perspective. *Stamford Journal of Microbiology*, *8*(1), 46-49. https://doi.org/10.3329/sjm.v8i1.42440

[45] Akter, S., Sarkar, A., & Das, K. (2020). Occurrence of pathogenic microorganisms in dessert items collected from Dhaka city. *Stamford Journal of Microbiology*, *9*(1), 19-22. https://doi.org/10.3329/sjm.v9i1.45653

Foodborne Disease Surveillance in Bangladesh

The IEDCR under the MoHFW has developed a sentinel site-based surveillance system. This system is designed to collect information regarding the severity and prevalence of foodborne illnesses across Bangladesh[46]. These sentinel surveillance systems capture both epidemiological and laboratory data for disease-specific health conditions[45]. These include surveillance systems for dengue fever, Nipah virus, Japanese encephalitis, rotavirus, foodborne illnesses, and severe acute respiratory infections. Further data is also being collected through web-based and cellular data collection systems from more than 400 sub-districts of the country[47].

Rapid response teams have been deployed to respond to incidences of illness and outbreak investigations. They are also helping to identify hotspots and definitive sources of foodborne pathogens[46]. However, there is a need to create a framework for collaborative operation agreements between BFSA, MoHFW, and other food control agencies to take regulatory actions to minimize food safety risks. According to the foodborne illness surveillance system of IEDCR, there were about 0.28 million cases of acute watery diarrhea, 30,000 cases of enteric fever, and 500 cases of acute hepatitis in 2015[48].

IECDR has well-established diagnostic capabilities for various viruses, including severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), Nipah virus, Japanese encephalitis virus, Middle East Respiratory Syndrome Coronavirus (MERS-CoV), Ebola virus, and Zika virus.

Risk Analysis

Bangladesh's food safety hygiene and food safety administration are weak due to various factors, including the involvement of multiple agencies and the general lack of resources, technical capabilities, and coordination among agencies. Risk analysis is composed of three components: risk assessment, risk control, and risk communication. As per the Food Safety Act, 2013, BFSA is responsible for analyzing scientific and technical information concerning risks to human health; developing methods of risk assessment and cooperating with international organizations in relation to food safety, quality, and testing; and harmonizing safety and quality standards with international food articles. BFSA is also responsible for coordinating risk assessments through various agencies. As a first step, thousands of market samples were collected for eight key food items and tested for heavy metals, pesticides, microbiology, pharmaceuticals, trace minerals, and chemical dyes. The data from these surveys are being used to develop codes of practice as well as appropriate rules and regulations[49]. BFSA has recently initiated a process to review existing standards and draft new standards and codes of practice for implementation throughout the country. BSTI and BCSIR are the main agencies involved in risk assessment. BSTI sets mandatory and voluntary food standards, but BSTI standards do not cover all food products.

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[46] Institute of Epidemiology, Disease Control & Research. (n.d.) Foodborne illness surveillance (FBIS) in Bangladesh. https://www.iedcr.gov.bd/website/images/PDF/foodborne_illness/Prof.%20M.%20Rahman.pdf

[47] Food and Agricultural Organization of the United Nations. (n.d.) *Improving food safety in Bangladesh.* http://www.fao.org/in-action/food-safety-bangladesh/activities/food-borne-illness-surveillance/en/

[48] AWD surveillance 2015, IEDCR. https://www.iedcr.gov.bd/website/index.php/surveillance/133-food-borne-illness

[49] Food and Agriculture Organization of the United Nations. (2017). Bangladesh Food Safety Cluster Evaluation. http://www.fao.org/3/a-bd703e.pdf

Commitment to follow the standards set by the European Union for fisheries, such as the GAqPs, has significantly improved the safety of fish and fish products in Bangladesh (Appendix 1: FIQC, BFFEA Khulna and seafood companies). These regulations are closely monitored in fish products due to the focus on export markets. Indeed, the risk parameters of fisheries and their products are set based on EU standards. The fishery and aquaculture industries are rigorously monitored and inspected because they are export-driven. Besides focusing on the implementation of HAACP, the National Residue Control Plan (NRCP) and Residue Monitoring Plan (RMP) implemented by FIQC are statutory requirements for exporting to EU countries (Appendix 1: FIQC). DOF/FIQC is still conducting on-site inspections and quality assurance, though domestic distribution and marketing are within the ambit of BFSA.

Risk management is performed by various ministries and agencies involved in the food value chain. However, inspections during processing and primary production levels are very limited due to the lack of resources (Appendix 1: BFSA, FAO). For instance, BFSA has set the MRLs for pesticide residue but does not have the resources to inspect products to ensure they meet these compliance standards. BFSA is the responsible authority for risk communication related to food products. However, food safety information is not yet shared widely in the country.

Food Safety Testing and Infrastructure

Public sector testing

Regulatory agencies and departments such as BFSA, BSTI, FIQC, etc. undertake testing of food samples as part of their market surveillance activities to monitor quality standards, food safety, and other mandates, including import and export clearances, by utilizing their own labs or other labs in public institutions. Bangladesh has several public testing labs under various ministries/departments scattered throughout the country (Table 4). However, these labs are underutilized due to shortages in trained human resources and equipment, lack of inter-ministerial coordination, and low industry demand for testing (Appendix 1: BFSA, NFSL, Modern Food Testing Laboratory). Lack of accredited food testing labs in public organizations is another limitation. BFSA has designated 10 public food testing labs under several departments and public institutions, but only a few of them have accreditations for various testing parameters (Appendix 1: BFSA, FAO). Several food testing labs in public organizations do not have a mandate for regulatory testing and hence do not pursue accreditation. Some of the labs in Bangladesh, such as IFST, have bilateral recognition with the EU. However, currently, IFST has limited engagement in food testing (Appendix 1: BFSA, IFST).

To improve food safety management in Bangladesh, the Food and Agriculture Organization of the United Nations (FAO) has established a National Food Safety Laboratory (NFSL) at the Institute of Public Health in Dhaka, which was declared as the national reference laboratory by the MoHFW with a mandate for developing validated methods of analysis that can be routinely utilized by laboratories in Bangladesh, conducting research, and providing analytical services to customers. The Plant Quarantine Wing tests and holds imported plants and plant products. The microbial test methods and test parameters for 10 BFSA designated labs are provided in Appendix 2.

Table 4: Public food testing laboratories under various ministries

Public Food Testing Laboratories	Organization/Department	Ministry/Government Institute
Central Disease Investigation Laboratory (CDIL)	Department of Livestock Services, Dhaka	Ministry of Fisheries and Livestock
Animal Nutrition Laboratory		
Veterinary Public Health and Microbiology		
Fish Inspection and Quality Control (FIQC)	Department of Fisheries labs in Sarvar, Chittagong, and Khulna	
Plant Quarantine Laboratory	Plant Quarantine Wing, Department of Agricultural Extension (DAE), Dhaka	Ministry of Agriculture
Pesticide Analytical Laboratory	Bangladesh Agricultural Research Institute, Gazipur	
Grain Quality and Nutrition Laboratory	Bangladesh Rice Research Institute, Gazipur	
Institute of Food and Radiation Biology	Bangladesh Atomic Energy Commission (BAEC), Dhaka	Ministry of Science and Technology (MoST)
Analytical Chemistry Laboratory		
Health Physics Division Laboratory		
Atomic Energy Centre		
Institute of Food Science & Technology (IFST)	BCSIR, Dhaka	
Institute of National Analytical Research and Service (INARS)		
BCSIR Laboratories	BCSIR labs in Dhaka and Chittagong	
Public health laboratories, including NFSL	Institute of Public Health (IPH), Dhaka	Ministry of Health and Family Welfare (MoHFW)
Central Food Testing Laboratory	Directorate General of Food, Dhaka	Ministry of Food

Environmental laboratory	Department of Environment, Dhaka	Ministry of Environment and Forest
Bangladesh Standards and Testing Institution (BSTI) Chemical Testing Wing	BSTI labs at Dhaka, Chittagong, Rajshahi, and Khulna	Ministry of Industries
Bangladesh Small and Cottage Industries Corporation (BSCIC) laboratories	BSCIC labs in Dhaka, Narayanganj, Chandpur, Chittagong, Cox's Bazar, Khulna, and Jhalokati	
Food Testing Lab and Training Center	Dhaka South City Corporation, Dhaka	Ministry of Local Government, Rural Development & Co-operatives (LGRD)
Modern Food Testing Laboratory	Chittagong City Corporation, Chittagong	
Central Laboratory	Department of Public Health Engineering (DPHE), Dhaka	
DPHE Zonal Laboratory	DPHE labs in Rajshahi, Khulna, Comilla, Mymensingh, Noakhali, Jhenidah, Sytlhet, Barisal, Rangpur, Bogra, Gazipur	
Dhaka University Microbiology Lab	Department of Microbiology – University of Dhaka	Ministry of Education
Dhaka University Chemistry Lab	Department of Chemistry – University of Dhaka	Ministry of Education

Third-party food testing service providers in the private sector

Limited third-party or private food testing centers exist in Bangladesh. The testing services by these private labs can be categorized into the following:

- Testing for regulatory/statutory compliance
- Testing for self-compliance as part of industry's internal quality assurance and HACCP plans
- Third-party testing to meet buyer/customer requirements (mostly for exports)

Few well-established companies also test for shelf life, microbial safety, and for research and product development purposes (Appendix 1: PRAN-RFL). The food industry depends on their own labs or private labs for testing and in some cases, public labs like BCSIR are utilized. For meeting mandatory testing

requirements, as in the case of export or import clearance, the industry utilizes the testing services of public labs in the relevant departments/ministries. Mass adoption of food testing for regulatory compliance and self-compliance depends on the affordability of testing and accessibility of testing facilities. There is also a need for rapid detection kits to reduce the inventory hold time for shipping (products are held until test results are obtained) and reduce the cost of production (Appendix 1: PRAN-RFL).

The private food testing sector in Bangladesh has developed to a decent scale, but the industry demand for food testing has not been very significant, according to stakeholders from private labs. Only a few companies in sectors other than aquaculture/seafood with export consignments reach out to them for testing their products. Though shrimp and fish exports have good potential for testing, these are exclusively tested in FIQC labs for consignment clearance per procedural requirements. For the domestic market, the scope of analysis and testing remains very limited. The few well-equipped private labs are mostly situated in the capital region, while the food industry, dominated by MSMEs, is spread across the country or is located in specific production clusters. The cost of testing and sample shipment has been identified as a major barrier by small and mid-size enterprises (SMEs), which rely primarily on public testing labs.

Some of the well-equipped testing laboratories with technical capabilities in Bangladesh include SGS Bangladesh, Mitra S.K. Private Limited Bangladesh, WAFFEN Research Laboratory, and QIMA (formerly Asia Inspection). SGS (for microbial tests) and Mitra collect the samples in Bangladesh and send them to Kolkata, India, for processing.

SGS Bangladesh is a Swiss-owned inspection, verification, and testing agency that set up a lab for testing in Bangladesh. SGS provides training on certification systems, lab testing, risk assessment, inspections, and monitoring and has so far trained more than 5,000 workers in the country. SGS Bangladesh Food and Microbiology Lab is accredited by the National Accreditation Board for Testing Laboratories (NABL) and BAB. However, rapid and molecular testing is not currently carried out at SGS. Though SGS has capacities for 100 to 400 samples per day based on the infrastructure and human resources in Bangladesh, it is not able to fully utilize that capacity as of now due to limited demand, with price as a barrier for their testing services. SGS charges are far more than the charges levied by national bodies as well as national private sector testing service providers.

The WAFFEN Research Laboratory, a younger establishment, has well-equipped capacity and technical capabilities for testing food, feed, water, and environmental parameters. The lab has advanced testing equipment such as atomic absorption spectroscopy (AAS), gas chromatography (GC), gas chromatography – mass spectrometry (GC-MS), high performance liquid chromatography (HPLC), a protein digester, and polymerase chain reaction (PCR) for bacteria, yeast, and mold, etc., in addition to conventional lab equipment. The lab is planning to introduce research-based equipment, hygiene kits, a water purification system, and other food safety detection tools and devices. Being an early-stage company, they are facing shortages of capital with a lack of venture capital support. They developed a prototype of a hygiene detection kit that can be further refined in design and could be widely deployed by industry as a point of occurrence detection kit.

National conformity assessment system

BAB offers accreditation programs for various types of conformity assessment bodies, such as laboratories, certification bodies, and inspection bodies in accordance with several regulatory standards (i.e., International Organization for Standardization [ISO]). BAB is a member of the Asia Pacific Accreditation Cooperation (APAC), the International Laboratory Accreditation Cooperation (ILAC), the Pacific Accreditation Cooperation (PAC), and the International Accreditation Forum (IAF)[50].

The number of accredited labs in Bangladesh is limited, and test reports from unaccredited labs are not accepted in international markets. The public labs have not made serious efforts to obtain accreditation. Many of the public labs do not have a regulatory or food testing mandate (being part of a research/academic institute), and they also do not want to spend resources on accreditation-related activities at the expense of their core research and teaching work.

Ongoing Food Safety Research and Projects in Bangladesh

Some of the ongoing and recently concluded food safety-focused development projects in Bangladesh are listed below.

USAID/USDA-funded projects

Farmer-to-Farmer Food Safety and Quality (2018-2023): This project is a USAID- and USDA-funded program focused on capacity building and food safety activities facilitated by Land O'Lakes International Development. The aim of the project is to build economies by strengthening local agriculture, helping businesses create jobs, and linking farmers to markets. It will assist and train agribusinesses, processors, associations, and institutions on good agricultural, veterinary, and manufacturing practices to improve local food safety protocols and quality assurance systems from "field to fork" and export markets.

Safe Aqua Farming for Economic and Trade Improvement (SAFETI) Project (2016-2021): This Food for Progress project, funded by the USDA, focuses on alleviating constraints to food safety outcomes within the prawn and shrimp value chains in southern Bangladesh. Project activities include building the capacity of smallholder producers and processors to improve their ability to meet international and U.S. food safety and quality standards for domestic and export markets as well as improving and building an enabling environment for the use of quality, safe, and legal inputs and veterinary services.

Food Safety/SPS program (2012-21): This USAID-funded project is being implemented by the USDA and the overall goals of the work program include:

1. Improving food safety risk identification
2. Training government and private-sector inspectors
3. Evaluating stakeholders' capacities
4. Ensuring better coordination among the various parties working in the field of food safety

Salient project achievements are listed below:

- Between 2017 and 2018, 200 food safety practitioners were trained on essential skills to conduct risk-based inspections following HACCP principles and their application to food operations.

[50] http://www.bab.org.bd/

- Between 2009 and 2014, more than 2,000 individuals were trained on GAqPs. The collaboration involved the USDA, the FDA, the University of Maryland's Joint Institute for Food Safety and Applied Nutrition (JIFSAN), and the Bangladesh Fish and Shrimp Foundation (BSFF).
- Training on the Food Safety Modernization Act's (FSMA) foreign supplier rule compliance and capacity building took place through aquaculture training initiatives.
- Research on Bangladesh food product import rejections (to the U.S. and EU) provided useful data for designing future training and capacity building programs in Bangladesh.
- Plant quarantine system assessment paved the way for a "road map" and action plan.
- Studies on Highly Pathogenic Avian Influenza (HPAI) disease outbreaks and their link to the One Health agenda can help safeguard poultry producers from new outbreaks of avian influenza.
- Improved diagnostic capabilities of the Bangladesh Livestock Research Institute (BLRI) through avian influenza lab training.

In addition to the above, Kansas State University is working with BFSA on a multi-year project related to BFSA staffing and training for capacity building. The primary engagement with BFSA by FAO that was co-invested by the USAID ended in Dec 2019.

Analysis of Bangladesh Food Product Import Rejections (2014-17): This project was implemented by the Center for Agriculture and Food Security and Preparedness (CAFSP) at the University of Tennessee. CAFSP reviewed Bangladesh fish and fishery product import rejections for the three-year period of 2014 to 2017. Of the 137 rejection reasons cited for fish and fishery products over the three-year period, 96 were related to SPS issues. The most significant reasons cited were *Salmonella* and filthy, putrid, and decomposed substances. The number of rejections related to antimicrobials, temperature control, unsanitary conditions, and histamines appears to be insignificant as these accounted for only 12% of total SPS rejections between 2014 and 2017. Among fresh produce, 40% of the rejected Bangladeshi products to EU and U.S. markets were tamarind and mango products, with nearly half of these rejections attributed to misbranding. Training in areas such as GAPs, preventive controls, and HACCP principles could potentially eliminate one-third of the import rejections to the U.S. and EU markets.

Feed the Future Food Safety Innovation Lab (FSIL) (2019-2024): This first-ever Food Safety Innovation Lab of the USAID is jointly managed by Purdue University and Cornell University. As the core management unit of the FSIL project, these U.S.-based institutions of higher learning work to meet the FSIL objectives through their implementation partners in Bangladesh. In 2020, a request for applications was launched to this effect. The overall objectives of the FSIL project are to:

1. Raise awareness of food safety, associated socio-economic impacts, and mitigation measures
2. Build local capacities to conduct food safety research
3. Develop public-private partnerships and networks for effective engagement
4. Translate research outcomes into training, food safety guidelines, and commercialized products

Bangladesh, Kenya, Senegal, and Cambodia are initially targeted for the implementation of these objectives.

Bangladesh Improving Trade and Business Enabling Environment (BITBEE) (2020-2024): This five-year USAID Feed the Future project is being implemented by the International Development Group LLC (IDG). The BITBEE project is aimed at strengthening the institutional capacity of governmental and non-governmental agencies in Bangladesh for the creation of a robust business environment. Through this project, the IDG provides technical assistance to the Ministry of Finance, National Board of Revenue, BFSA, BSTI, and the Ministry of Commerce to ensure these Bangladesh-based departments maximize ongoing

and planned initiatives geared toward creating an enabling business environment. The IDG also promotes inter-sectoral collaboration among private and public sectors, civil society organizations, research facilities, and institutes of higher learning. Through gender-responsive risk management techniques, the BITBEE project aims to mitigate trade costs and delays in ways that enhance local revenue while meeting health and safety requirements.

World Bank-funded projects

Livestock and Dairy Development Project (2018-2023): The project development objective is to improve productivity, market access, and resilience of smallholder farmers and agro-entrepreneurs operating in select livestock value chains in target areas. One of the project components is improving the risk management and climate resilience of livestock production systems by developing the capacity of public sector institutions and private sector partners. This component will support institutional capacity development, a knowledge platform, food safety and quality assurance, livestock insurance, and contingency emergency response.

Bangladesh Sustainable Coastal and Marine Fisheries (BSCMFP) (2018-2023): The objective of this project is to increase coastal and marine fisheries' contribution to the economy, poverty reduction, and environmental stability. One of the project components focuses on improving infrastructure and production practices. This component supports the closing of basic infrastructure and technical capacity gaps to promote integrated value chain development and compliance with standards. This component includes three subcomponents: infrastructure improvements for capture and culture fisheries, value chain and food safety development, and boosting coastal aquaculture productivity.

Projects funded by other donors

Food Safety Project of the British Council: Through multi-stakeholder engagement, this project aims to increase government transparency and accountability in the poultry sector, leading to informed policymaking, safer production and distribution of poultry products, and economic benefits for small-scale farmers (including women farmers). The aim of the project is to support inclusive processes to improve the regulation, monitoring, and enforcement of food safety standards in the poultry sector, increase awareness of and information about food safety and safer production methods of small-scale distributors and producers in the sector, and increase consumer awareness of and demand for safe food. By demonstrating the value of and encouraging more inclusive multi-stakeholder engagement on policy related to the governance and regulation of the poultry sector, there is potential to improve the production of safe inputs in the sector, expand the use of safer farming practices and more hygienic distribution and market provision, increase the knowledge of and access to information for small-scale farmers on safe production practices, and provide citizens with access to information that increases the demand for safer poultry, providing a market that incentivizes safe production.

Support for Modelling, Planning, and Improving Dhaka's Food System (2019-2024): This project is funded by the government of the Netherlands. It is jointly implemented by the Food and Agriculture Organization of the United Nations and the Economic Relations Division of the Ministry of Finance in Bangladesh. Working in collaboration with the Bangladeshi Ministry of Local Government, Rural Development and Co-operatives, the FAO is leading efforts to develop a resilient system for the availability of safe food for the Dhaka area. Specifically, the project seeks to develop a model food distribution system for the Dhaka

metropolis, while ensuring that women and indigenous peoples in the Dhaka area are equipped with sustainable alternative livelihood options that improve their access to safe and nutritious food.

Project for Strengthening Capacity of Bangladesh Food Safety Authority (BFSA): Though not fully operational yet, this project will be supported by the Japan International Cooperation Agency (JICA) to enhance the food safety control system.

Some of the academic research studies being undertaken in Bangladesh have objectives close to those of the project, which is focused on developing improved or rapid testing methods and identifying foodborne illnesses. Those studies are listed below.

- A research group at BCSIR labs has evaluated the rapid molecular testing method (i.e., microplate immunocapture method) for detection of *Vibrio cholerae, Salmonella typhi,* and *Shigella flexneri* from various food samples[51]. The method can be employed for food testing with due validations.
- A study on molecular characterization of *Enterobacter* and *E. coli* pathotypes present in the street food of Dhaka and their resistance to multiple drugs has been conducted and recorded by the research team from the University of Dhaka[52]. The study identified pathogenic *E. coli* with some dangerous virulence traits in street food samples and the corresponding antibiotic resistance of these strains.
- A study was conducted by the research team from WAFFEN Research Laboratory, NFSL, and the University of Dhaka on the prevalence of contaminants such as heavy metals, pesticides, and microbes and their antibiotic resistance in raw salad vegetables in Dhaka markets. The study revealed the presence of *E. coli, Salmonella,* and *Staphylococcus* harboring antibiotic resistance against four to eight different antimicrobials[53].

Pesticide Risk Reduction in Bangladesh (2018-2020): The implementing partner for this Global Environment Facility (GEF)-funded project is the Bangladeshi Ministry of Environment and Forests (MoEF), Department of Environment**.** The main objectives of the project are to mitigate human, animal, and environmental exposure to persistent organic pollutants (POPs) and reduce the excessive use of POPs and obsolete and highly hazardous pesticides in Bangladesh.

Key Challenges in Managing Food Safety in Bangladesh

- Bangladesh has sufficient food testing equipment capacity due to extensive investment by donor agencies to create such capacity. However, it has not been utilized efficiently for a variety of reasons, including a shortage of human resources and lack of leadership. In neighboring countries (Thailand, Vietnam, India, and Malaysia), lab infrastructure with comparable capacity is engaged in testing hundreds of samples every day.
- Few of the food testing labs under various departments/public institutions have accreditations for some of the testing parameters. Many food testing labs in academic organizations do not have mandates for regulatory testing and hence do not pursue accreditation. Moreover, the costs of

[51] Fakruddin et al. (2017). Evaluation of microplate immunocapture method for detection of *Vibrio cholerae, Salmonella Typhi and Shigella flexneri* from food. *BMC Microbiology, 17:* 189.

[52] Rahaman et al. (2017). Molecular characterization of enterobacter and *Escherichia coli* pathotypes prevalent in the popular street foods of Dhaka City and their multidrug resistance. *Bangladesh J Microbiol, 34*(2), 67-72.

[53] Bari et al. (2019). A study on the prevalence of heavy metals, pesticides, and microbial contaminants and antibiotics resistance pathogens in raw salad vegetables sold in Dhaka, Bangladesh. *Heliyon, 5*(2), e01205,

certification, time involved, extensive documentation, and audits also act as a deterrent for academic and research institutes to push for accreditation.

- Time-consuming conventional testing methods for microbiological contamination of food analysis is a key constraint faced by private companies as they incur production loss. Rapid detection kits for microbial testing of heavy metals in shrimp and microbial contaminants in agricultural produce are an immediate necessity. These will significantly improve the quality of produce available to consumers at fresh produce markets, as well as the produce processing entities.
- Currently, rapid kits for food testing are being imported from other countries including India, Israel, and the U.S. There is a need to secure affordable rapid detection kits and adopt molecular methods for pathogen detection.
- Despite the potential for food safety hazards to cause serious food safety issues, BFSA has not yet framed the procedures for product recall in the country. There have been several cases in the recent past wherein the authorities (BSTI, BFSA, and the DNCRP) were unable to recall affected products. As per industry interactions, the recall notices by authorities seem to focus on total product recovery rather than recovery of the affected batch/lot and stopping of further production until mandatory BSTI standards are met. The release of proper guidelines and recall procedures would help the industry in withdrawing the products from the market and protecting consumers from unsafe food.
- Food safety inspection in Bangladesh is moderate. BSTI, which is the responsible body for enforcement, analyzed a total of 22,594 samples of food from the market between 2018 and 2019, an increase of 19.74% over the previous year. The leading private sector players in the fishery, frozen food, and ethnic food export segment have the internal capacity to ensure food safety compliance for U.S. and European standards. Some large players such as Nestlé, PRAN, etc., have in-house food testing laboratories for maintaining internal food safety requirements. These labs also send samples for external testing based on the requirements of exporting countries. However, a significant number of players in the MSMEs have no access to testing support. With BFSA proposing to engage in surveillance and testing of processed food products, the MSME segment will be unprepared for compliance.
- Lack of data on the number of registered food manufacturing facilities and service providers is also a challenge. Some of this data is with BSTI and may not be readily available to BFSA unless mechanisms are built for data sharing and access.
- Real-time data sharing between various agencies is also limited. The absence of any electronic system for surveillance of animal diseases remains a limiting factor for sharing data between the animal and human health sectors on a real-time basis.

Need for rapid detection tests

Because of the longer turnover times of test results, specifically by public testing labs due to the use of conventional methods or infrastructure or personnel limitations, there is a need to develop rapid detection kits for common foodborne pathogens like *Vibrio cholerae*, *Salmonella, E. coli, Campylobacter,* and *Listeria monocytogenes* and common contaminants such as pesticides, heavy metals, and antibiotic residues. The rapid detection kits could be used by the regulators, testing labs as well as food manufacturers, though the sensitivity and validation data for specific users may differ. Regulators may require and use a different set of rapid detection systems, which could be nucleic acid, sensor-based, and high-throughput systems requiring a high capital investment for sophisticated equipment. The development of low-cost detection kits will facilitate mass adoption by the food industry, including MSMEs, and improve food safety compliance, resulting in safe food production.

The low-cost rapid kits could also be widely used in the detection of common adulterants in commodities such as dairy, spices, etc. across their value chains. Such detection and control measures, even at local or procurement levels, can build consumer confidence in the value chains and could be implemented as business measures as well.

Rationale for rapid detection tests:

- Technologies are available globally that Bangladesh can adopt with local validation
- Affordability of the rapid detection kits for wider adoption by industry
- Low-cost detection kits will facilitate mass adoption by the food industry, including MSMEs, and promote affirmative in-house testing in processing plants
- Rapid detection systems will enable regulators to do mass testing
- Domestic capacity development for manufacturing diagnostic kits

Way Forward

Increasing demand for food testing in Bangladesh

From consultations with primary stakeholders in private and public testing labs and the underutilization of their testing capacity, it can be concluded that there is not enough demand for food testing in the country. Poor regulatory enforcement, lack of awareness of food safety management systems and the benefits of safety implementation in the value chain, perceived lack of incentives, and cost of implementation/testing are some of the factors resulting in low demand for food testing at the testing labs. Most of the current testing is limited to mandated testing as per local manufacturing license requirements and related inspections as well as import and export requirements as stipulated by the relevant agencies.

Demand for testing can also be created by improving access to testing labs. Testing labs can reach out to industry/MSME clusters by providing logistics support and sample collection centers. They would benefit from the scales of testing from a larger pool of manufacturers. Public/private partnerships for mobile testing labs can also be explored. Hopefully, the demand for food testing will increase with better coordination among regulatory agencies and stringent implementation of food safety regulations and product standards. Wide-scale implementation of food safety/HACCP systems by food manufacturers will also create the need for in-process or production line testing. The economic development of the country, the increasing middle class, and rising personal disposable income are expected to lead to increased production of processed food and increased consumer awareness for safe food, which will further increase the demand for food testing in the next few years.

Real-time data sharing across agencies

The establishment of one robust, integrated disease surveillance system will result in a concerted effort to tackle emerging complex and zoonotic diseases in the country. Key information includes existing surveillance data for cholera and tuberculosis as well as other segments such as animal health, foodborne disease outbreaks, registered/licensed food facility data, manufacturing facility inspection data, etc.) and data from both public and private sectors.

For better access to data and data sharing, a framework for collaboration between BFSA, MoHFW, DLS, DOF, BSTI, and other food control agencies should be developed so that real-time data access can help in taking timely regulatory actions to minimize food safety risks.

Provision of hands-on training to food testing labs

It is crucial that testing labs are well equipped and have a trained workforce. The skills of existing personnel in handling/use of modern equipment, including equipment for rapid detection, should be upgraded by providing appropriate hands-on training. During primary stakeholder consultations, the private lab SGS expressed its willingness to support initiatives in Bangladesh for increasing testing capabilities. The lab technicians should also be trained on performing validated protocols for the rapid detection kits to ensure the quality of the analytical results.

Development and validation of rapid detection devices/kits

The development of low-cost detection devices and kits will facilitate mass adoption by the food industry, including MSMEs, and improve food safety compliance and safe food production. There have been some attempts by public labs such as FIQC and BCSIR to use or develop rapid molecular detection kits based on PCR/reverse transcription polymerase chain reaction (RT-PCR) technology. However, these were discontinued because there was no demand from the industry for these rapid tests. Lack of acceptance of these rapid test results by the customers (mainly from international markets) was cited as the common reason for this. However, there were no attempts by these labs or industry players to validate the tests/kits and try to convince customers and industries of the scientific evidence and validation data.

It is therefore critical that the test kits and methods developed for use be validated for testing relevant foods by a recognized independent body (such as the Association of Official Agricultural Chemists [AOAC]), Bangladesh regulatory body (BFSA), or International Organization for Standardization (ISO) process. In addition, the method should be validated for the specific purpose and application (e.g., validated for the appropriate food matrix and sample size to detect the appropriate foodborne pathogen). Once validated and approved by the food regulator, these rapid tests can become an integral part of quality assurance and control programs in the food industry and for regulatory and surveillance purposes as well.

Providing wide access for rapid detection devices/kits for target segments/contaminants

There is a need for providing easy and wider access to or developing and manufacturing the kits locally to reduce user costs. Public/private partnerships for translational research in rapid detection systems and/or the transfer of technology developed elsewhere for local manufacturing of rapid detection test kits need to be explored and encouraged. There is strong potential for the use of rapid detection tests in Bangladesh for testing water, meat, poultry, fish and seafood products, dairy, frozen food, snacks, ready-to-eat foods, beverages, etc. The rapid detection tests could be developed for common foodborne pathogens such as *Vibrio cholerae*, *Salmonella, E. coli, Campylobacter, Listeria monocytogenes,* and chemical contaminants such as pesticides, heavy metals, aflatoxins, and antibiotic/drug residues affecting the above product categories.

Addressing industry needs for the availability of reagents and chemicals without overdependence on imports is also crucial. It is expected that with local manufacturing of rapid detection systems and thriving entrepreneurship, international suppliers of reagents and chemicals may start operations in Bangladesh, facilitating easy and faster access to them.

Appendix 1. List of Consulted Stakeholders

Agency/ Organization	Representative/ Team Members consulted	Point of Contact	Date
Bangladesh Council of Scientific and Industrial Research (BCSIR), Chittagong	Dr. Md. Mostafa (CSO & Director) Dr. Dipankar Chakraborty Dr. Habibur Rahman Dr. Saiful Islam	Dr. Md. Mostafa	March 1, 2020
Bangladesh Food Safety Authority (BFSA)	Md. Mahbub Kabir (Acting Chairman and Additional Secretary) Monzur Morshed Ahmed (Member)	Monzur Morshed Ahmed	January 5, 2020
Bangladesh Frozen Food Exporters Association (BFFEA)	Shahadat Ali Khan (CEO)	Shahadat Ali Khan	January 8, 2020
Bangladesh Frozen Foods Exporters Association (BFFEA) Chittagong	Devabrata Barua (Vice President) Morshed Zafar (Secretary)	Devabrata Barua	March 1, 2020
Bangladesh Frozen Foods Exporters Association (BFFEA) Khulna; and seafood companies	S. Humayun Kabir (Former Director, BFFEA) Gopal Chandra Das (Addl. Secretary, BFFEA) Hasan Jamil Md. Ashraful Islam (GM, Rupali Seafoods) Sultan Ahmed (GM, Bionic Foods Export Ltd.) Prabir Kumar Mishra (QA Manager, Fresh Foods Ltd.) Salauddin (Executive Officer, BFFEA)	S. Humayun Kabir	March 4, 2020

	Sk Md. Abdul Baki (VP-BFFEA, Khulna Region)		
Bangladesh Shrimp and Fish Foundation (BSFF)	Md. Rafiqul Islam (Executive Director) Ambassador Liaquat Ali Choudhury (Policy Advisor and Board of Directors) Imtiaz Uddin Ahmad (Policy Advisor and Board of Directors)	Md. Rafiqul Islam	January 6, 2020
Bangladesh Standards and Testing Institution (BSTI)	Md. Muazzem Hossain (Director General) Pankaj Kumar Kundu (Director-Chemical) Md. Sajjadul Bari (Director-Standards Wing) Kbd. Golam Md. Sarwar (Deputy Director & Head-Agriculture & Food Division)	Pankaj Kumar Kundu	January 8, 2020
Central Disease Investigation Laboratory (CDIL)	Dr. A.K.M Golam Kadir (Principal Scientific Officer) Dr. Md. Bazlur Rasid (District Livestock Officer)	Dr. A.K.M Golam Kadir	January 8, 2020
Department of Microbiology, University of Dhaka	Dr. Sabita Rezwana Rahman (Professor & Chairman) Prof. Dr. Md. Abdul Malek (Director, Centre for Advanced Research in Sciences [CARS]) Mahmuda Yasmin Dr. Md. Latiful Bari	Dr. Md. Latiful Bari	January 7, 2020
Fish Inspection and Quality Control (FIQC) Lab, Chittagong	Md. Abdur Razzaque (Deputy Director-QA Manager) A.K Md. Ahmadul Kabir (Microbiologist)	A.K. Md. Ahmadul Kabir	March 2, 2020

	Salma Begum Md. Mezanur Rahman		
Food Analysis & Research Laboratory, University of Dhaka	Dr. Md. Latiful Bari (Professor and Head)	Dr. Md. Latiful Bari	January 7, 2020
Food and Agriculture Organization (FAO) of the United Nations	Md. Imrul Hasan	Md. Imrul Hasan	January 5, 2020
Hifs Agro Food Industries	Syed Shoieb Hasan (CEO)	Syed Shoieb Hasan	March 2, 2020
Horticulture Export Development Foundation (Hortex Foundation)	Kbd. Md. Manzurul Hannan (Managing Director) Mitul Kumar Saha (Assistant General Manager) Dr. Mofarahus Sattar (Monitoring & Evaluation Expert)	Kbd. Md. Manzurul Hannan	January 9, 2020
Institute of Food Science & Technology (IFST), Bangladesh Council of Scientific and Industrial Research (BCSIR)	Dr. Md. Abdus Satter Miah (Director) Dr. Md. Nurul Huda Bhuiyan Dr. Md. Nazrul Islam Bhuiyan	Dr. Md. Abdus Satter Miah	January 5, 2020
Modern Food Testing Laboratory (City Corporation)	Dr. Md. Mohsin Ali (Director & Public Health Analyst)		January 8, 2020
National Food Safety Laboratory (NFSL), Institute of Public Health (IPH)	Prof. Dr. Shahnila Ferdousi (Head & Technical Manager) Dr. Matiur Rahman (Deputy Technical Manager) Dr. Shakila Parveen	Dr. Matiur Rahman	January 7, 2020

PRAN-RFL Group	Dr. S.M. Maruf Kabir (Head of Quality Control) K.M. Ashraful Islam (Manager-QMS)	Dr. S.M. Maruf Kabir	January 6, 2020
Société Générale du Surveillance (SGS), Bangladesh	Yeasmin Akther (Business Manager-Food) Rafiqul Islam (Chemical Lab Manager) Ahad Al Morshed	Yeasmin Akther	January 9, 2020
Suguna Food and Feeds Bangladesh Private Limited	James Amalanathan (Country Head)	James Amalanathan	January 8, 2020
United States Agency for International Development (USAID)	Patricia Orlowitz (Agri Development Officer) John Smith Sreen (Office Director, Economic Growth Office) Tyler Babcock (Agri Attaché, FAS) Taskeen Chowdhury (Nutrition Specialist, Office of Population, Health, Nutrition and Education)	Patricia Orlowitz	January 6, 2020
WAFFEN Research Lab	Abu Zafar Ansary (Managing Director) Md. Abubakkar Siddique	Abu Zafar Ansary	January 7, 2020

Appendix 2. List of BFSA-Designated Labs, Microbial Testing Parameters, Test Methods, and Accreditation

Reference: Directory of food testing labs in Bangladesh. BFSA & FAO, 2016 [54]

Laboratory Name	Samples Tested	Testing Parameters	Test Methods	Accreditation
Institute of Food and Radiation Biology (IFRB), Bangladesh Atomic Energy Commission (BAEC)	Water and food supplements	Total aerobic bacteria (plate count)	Standard microbiological method	Not accredited (accredited for a few parameters: to test for lead in milk, and to test for 15 metals in samples of water, fish, shrimp, feed, and milk)
	Fish and meat	Total fungi		
	Convenience food	Total coliform		
	Spices, etc.	*Staphylococci*		
		Salmonella-Shigella		
		Listeria		
Institute of Food Science and Technology (IFST)	Food and beverages	Molds	ISO/BAM method	Not accredited
		Aerobic plate count	ISO 4833:2003	
		Anaerobic bacteria	In-house validated method	
		Aspergillus	BAM Method	
		Bacillus	ISO 7932:2004, ISO 4833:2003	
		Bacillus cereus	ISO 7932:2004	
		Coagulase *Staphylococcus*	ISO 16649:2005	
		Coliforms	ISO 4831,2:2006	
		E. coli	In-house validated method	
		Enterococci	IO 7899:200	
		Fecal coliform	ISO 4831,2:2006	
		Fecal *Streptococci*	ISO/AS 4276:1995	

[54] Food and Agriculture Organization of the United Nations and Bangladesh Food Safety Authority. (2017). *Directory of Food Laboratories*.

		Microbial load analysis	Selective method	
		Other fungi	In-validated method	
		Pseudomonas	ISO 13720:1995	
		Saccharomyces	BAM method	
		Salmonella	ISO 6579:2002	
		Shigella	ISO 21567:2004	
		Staphylococcus	ISO 16649:2005	
		Staphylococcus aureus	ISO 4833:2003	
		Total coliform	ISO 4821,2:2006	
		Total mesophilic aerobic bacteria	ISO 4833:2003	
		Total plate count	ISO 4833:2003	
		Total viable count	ISO 4833:2003	
		Trichoderma	BAM method	
		Vibrio	ISO/TS 21872:2007	
		Yeasts and molds	ISO 21527-1,2:2008	
Bangladesh Council of Scientific and Industrial Research (BCSIR) Laboratories, Chittagong	Food	Anaerobic bacteria	Selective method	Not accredited
	Fruit/beverage	Acidophilic bacteria	Selective method	
		Coliform	AOAC/BDS	
		Clostridium spp.	Selective method	
		Fungus/mold/yeasts	ICMSF	
		Spore-forming bacteria	Selective method	
		Salmonella	RT-PCR	
		Streptococcus spp.	AOAC/BDS	
		Vibrio cholera presence	AOAC/BDS	
		Yeast activity test	Selective method	
BCSIR Laboratories, Rajshahi	Food, feed, liquids	Total viable count	AOAC/APHA/ASTM/BDS/ICMSF	Not accredited
		Total coliform	AOAC/APHA/ASTM/BDS/ICMSF	
		Colony forming unit	AOAC/APHA/ASTM/BDS/ICMSF	
		Total fungus	AOAC/APHA/ASTM/BDS/ICMSF	

	Poultry, feed, chicken	Bird flu	AOAC/APHA/ASTM/BDS	
		Genetically modified organisms	AOAC/APHA/ASTM/BDS/ICMSF	
		E. coli	AOAC/APHA/ASTM/BDS/ICMSF	
		Salmonella	AOAC/APHA/ASTM/BDS/ICMSF	
		Listeria/Vibrio	AOAC/APHA/ASTM/BDS/ICMSF	
Institute of National Analytical Research and Service (INARS)	NA	NA	NA	Accredited (accredited for 74 parameters for testing water)
Public Health Laboratory (PHL), Including National Food Safety Laboratory (NFSL)	Any type of food, fruits, drinks, water	Aerobic plate count	BAM	Not accredited
		Yeast activity test	ISO 21527-1	
		E. coli	ISO 16649-2	
		Bacillus cereus	ISO 7932	
		Salmonella	ISO 6579	
		Staphylococcus aureus	ISO 6888-1	
		Psychrophilic bacteria	BAM	
		TCC	ISO 4832	
		Total mold count	ISO 21527-2	
		Fungi	ISO 21527-1 & 2	
		Listeria monocytogenes	ISO 11290-1	
		Campylobacter	ISO 10272 -1	
		Fecal coliform	membrane filter	
		Shigella	ISO 21567:2004	
City Corporation Lab in Chittagong	Drinking water	Total plate count (TPC)	BDS 1586:2007, BDS 528:2006, BDS 527:2015, BDS:513:2013, BDS: 1414:2000, BDS 1240:2001, BDS: 1702: 2002, BDS 1309:1990, BDS 860:2001, BDS 517: 2002, BDS 508: 2006, BDS 506:2002, and FDA,	Not accredited
	Carbonated beverages	TPC		
	Ice cream	TPC		
	Pasteurized milk	TPC		

	Fruit/vegetable juice concentrates	TPC	Philippines, 2013, FDA Circular No. 2013-010	
	Sweet products and syrup	TPC		
	Soft drink powder	TPC		
	Sweetened condensed milk	Coliform, *Salmonella*, yeast count, mold		
	Pasta products and noodles, uncooked	Coliform, *Salmonella*, yeast count, mold		
	Baked foods	Coliform, *Salmonella*, yeast count, mold		
	Snack foods	Coliform, *Salmonella*, yeast count, mold		
	Dry mixes for soups and sauces	Coliform, *Salmonella*, yeast count, mold		
	Spices	Coliform, *Salmonella*, yeast count, mold		
	Non-alcoholic beverages	Coliform, *Salmonella*, yeast count, mold		
	Butter	Coliform, *Salmonella*, yeast count, mold		
	Fruit cordial	TPC, TCC		
	Fruit squash	TPC, TCC		
	Milk products	TPC, TCC, *Salmonella*, *Shigella*		
	Jam and jelly	TPC, TCC, yeast/mold		
Bangladesh Standards and Testing Institution (BSTI), Dhaka	Drinking water	TPC	National/international standards	-
	Fruit juice, drinks, tomato ketchup, chutney, fruit squash, edible gel,	TCC	National/international Standards	271 parameters for 28 food products are accredited by BAB

	soft drink powder, carbonated beverages			
	Protein-rich biscuits	TCC, fecal coliform count, yeast and mold count		

Abbreviations: AOAC: Association of Official Agricultural Chemists; APHA: American Public Health Association (Standard Methods for the Examination of Water and Wastewater); ASTM: American Society for Testing and Materials; BAM: Bacterial Analytical Manual; BDS: Bangladesh Standards developed by BSTI; FDA: Food & Drug Administration; ICMSF: International Commission on Microbiological Specifications for Foods; RT-PCR: Reverse transcription polymerase chain reaction; TPC: Total Plate Count; TCC: Total Coliform Count