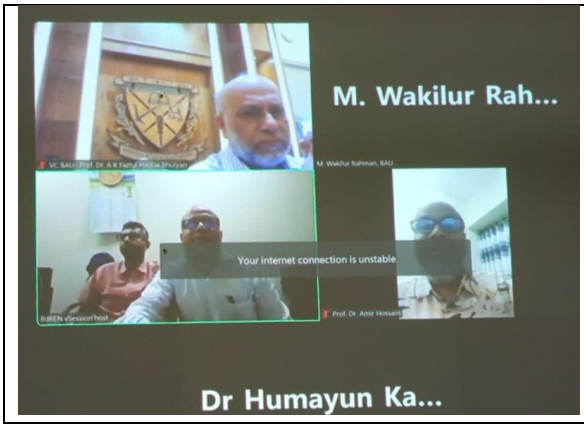
Feasibility Study for Establishing the Food Fortification Center (FFC) at BAU, Bangladesh

Final Report



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Executive Summary

The feasibility study of the Food Fortification Center (FFC) assesses its potential to address widespread micronutrient deficiencies in Bangladesh through strengthened food fortification programs. It evaluates FFC's ability to serve as a laboratory, research, and technical assistance hub that support capacity building, quality control, and regulatory compliance aligned with the National Nutrition Policy (2015), Second Plan of Action for Nutrition (2016–2025), Bangladesh National Food and Nutrition Security Policy Plan of Action (2021–2030), and Sustainable Development Goal 2 (Zero Hunger).

Micronutrient deficiencies in iodine, iron, zinc, vitamin A, vitamin D, folate, and vitamin B12 pose major public health challenges, disproportionately affecting women and children. While mandatory salt iodization and vitamin A fortification of edible oil have shown notable success, voluntary fortification of rice and wheat flour continues to face barriers due to weak institutional coordination, limited testing capacity, and inadequate monitoring mechanisms. The FFC, based at the Professor Muhammed Hussain Central Laboratory (PMHCL) of Bangladesh Agricultural University (BAU), is well-positioned to address these challenges.

The research uses the 5 I's framework to evaluate FFC sustainability through Institution, Investment, Implementation, Integrity and Impediments assessment. The study shows BAU has compact institutional readiness because of its existing facilities and expertise to face problems in expanding operations, securing diverse funding and dealing with consumers' requirements. The proposed governance framework under BAU supervision will bring academic, technical and administrative functions together to achieve sustainability by involving only the cash investment within few years. The financial projections show that a period of 5 Years will bring 72.54 million BDT in annual revenue earnings through testing, training services and grant funding (from BAU cost sharing and other sources) with capital expenses approximately 37 million BDT and operational costs about 34 million BDT annually.

The services of FFC will be extended to food processors, millers, regulators, NGOs and academia to address the 170-250 billion BDT fortified food market. The risk mitigation strategies shall address three main areas of challenge which include legal, operational and institutional aspects to obtain certification of Bangladesh Accreditation Board (BAB) and waste management according to environmental regulations. The stakeholder consultations involving 19 Key Informant Interviews and expert validations workshop confirmed that FFC may function as a potential center to improve fortification status, regulatory adherence and consumer confidence levels.

FFC is viable and strategically vital for advancing nutrition security in the population of Bangladesh. The successful implementation of FFC program will reduce malnutrition rates and enhance public health benefits during the upcoming years with minimum risk.

Key Highlights

- **Urgent need for FFC**: Persistent micronutrient deficiencies in iodine, iron, vitamin A, and zinc affect women and children, with gaps in research, monitoring, and policy enforcement justifying FFC's establishment.

- **Sustainability assessment**: Using the 5 I's framework, the study reveals strong institutional strength (4/5) but weaker performance in impediments (2/5), emphasizing the need for multi-stakeholder collaboration.
- **Operational targets**: FFC aims to test 10,000–15,000 samples and train 300–500 individuals annually, leveraging PMHCL's existing facilities—key sources of revenue generation.
- **Financial outlook**: Projected revenue of 72.54 million BDT by Year 5, with initial capital costs of 37 million BDT and annual operational costs of 34 million BDT, achieving sustainability by Year 3–4.
- **Market impact**: Addresses a 170–250 billion BDT fortified food market, focusing on edible oil, salt, rice, and wheat flour.

Recommendations: FFC needs to focus on in the following areas- i) laboratory equipment modernization, ii) BAB accreditation, iii) workforce expansion, iv) permanent funding acquisition and v) specific marketing initiatives for fortified food products.

1.0 Introduction

Food fortification could be a viable intervention to alleviate malnutrition and hidden hunger in Bangladesh due to high levels of micronutrients deficiencies. Micronutrients, such as vitamins and minerals, are required in minute amounts for overall growth, development, and increased immunity against diseases. Because the body cannot synthesize most of these, it must be obtained from external sources. Malnutrition causes poor physical and mental development in susceptible populations such as young children, pregnant and lactating women, and the elderly people. Worldwide, food fortification is a safe, sustainable and cost-effective strategy for increasing micronutrient consumption.

Bangladesh faces a major public health problem due to malnutrition and micronutrient deficiencies which primarily affect women and children and leads to adverse health results and diminished productivity and elevated healthcare expenses. GAIN functions as a Swiss-based foundation established in 2002 at a UN General Assembly Special Session to combat the challenge through improved access to nutritious and safe food. GAIN works with governmental entities and development partners and UN agencies and private sector entities and academic institutions and civil society groups in Bangladesh to make food fortification programs a sustainable and affordable approach for combating malnutrition. GAIN aims to create a world free of malnutrition because its mission supports both national and global health protection initiatives to enhance nutrition status.

The Bangladesh government has made edible salt and edible oil fortification compulsory, but rice and wheat flour fortification remain voluntary while the country works to expand bio-fortification programs for rice lentils wheat and sweet potatoes. Food fortification implementation faces obstacles from inadequate infrastructure and technical capabilities alongside policy support and monitoring frameworks. The Professor Muhammed Hussain Central Laboratory (PMHCL) at Bangladesh Agricultural University (BAU) which holds topmost analytical facilities and extensive laboratory connections has formed a partnership with GAIN to solve institutional barriers in food fortification programs. Through a cooperation agreement (or MoU), GAIN and PMHCL intend to create the Food Fortification Center (FFC) which will serve as a specialized and dedicated hub for advancing food fortification practices throughout Bangladesh.

The Food Fortification Center (FFC) will operate as a specialized hub to achieve five core objectives which include research and development; technical assistance along with capacity building; policy advocacy and quality assurance; and knowledge dissemination. Through its support the FFC will enable stakeholders from government entities and academic institutions and private businesses to obtain

quality-assured fortified staples while encouraging consumer acceptance. The Centre of Excellence for Food Fortification will establish Bangladesh as a global leader in food fortification by following both national guidelines such as the National Nutrition Policy-2015, Second Plan of Action for Nutrtion (2016-2025), MoHFP, GoB; Bangladesh National Food and Nutrition Security Policy Plan of Action (2021-2030), FPMU, GoB and the UN Sustainable Development Goals (SDGs).

First essential task for this initiative requires executing a detailed feasibility study according to the Terms of Reference (ToR). The study will evaluate the operational capabilities of the FFC through assessments of infrastructure requirements and logistical support and organizational framework & strength and financial stability and social and environmental effects. The study will evaluate technical and economic feasibility and governance systems to establish the FFC's viability before presenting an implementation plan for its successful establishment. The feasibility study approach includes systematic review of policy documents of GoB along with Consultation meeting, and Key Informant Interviews (KIIs) to determine a strong organizational framework.

1.1 Dimension of the Feasibility Study

The establishment of the Centre of Excellence for Food Fortification (FFC) at Bangladesh Agricultural University (BAU), Mymensingh, is a strategic initiative to address the pervasive issue of micronutrient deficiencies in Bangladesh. This feasibility study is important to evaluate the viability, sustainability, and impact of FFC, ensuring it aligns with national nutrition goals, including the National Nutrition Policy documents and Sustainable Development Goal 2 (Zero Hunger). The study is justified by the following three components.

1.1.1 Limitation of Institutional Engagement

Current institutional engagement in food fortification in Bangladesh is fragmented and limited in scope, hindering effective implementation and scalability. The Bangladesh Standards and Testing Institution (BSTI), responsible for regulatory oversight, faces capacity constraints, with only 37.6% of salt and 39.8% of edible oil adequately fortified (National Micronutrient Survey 2019-2020). BAU's Central Laboratory, operational since 2005, processes 2,000–3,000 samples annually but allocates only 10% of its services to external clients, limiting its commercial and regulatory impact. This limited coordination among stakeholders—government, private sector, and international agencies like GAIN and WFP—results in gaps in fortification coverage, particularly for rice (only 4.5% fortified, reaching 7 million beneficiaries). The feasibility study is essential to assess how FFC can bridge these gaps by fostering multi-sectoral collaboration, enhancing institutional capacity, and integrating BAU's expertise into a centralized hub for fortification activities.

1.1.2 Service Diversity (Advocacy, Training, Internship, Test Facilities)

FFC's proposed service portfolio encompassing advocacy, training, internships, and advanced testing facilities—addresses critical gaps in Bangladesh's fortification ecosystem. Advocacy is needed to promote mandatory rice fortification, as voluntary standards (BDS, 2015) have limited reach, covering only 1.65 million MT of rice. Training programs for millers, regulators, and health workers (targeting 300–500 stakeholders annually) will address technical skill shortages, enabling compliance with fortification standards. Internship programs, leveraging BAU's 5,000+ student base, will build a skilled workforce, fostering innovation and long-term sustainability. Advanced test facilities, scaling to 10,000–15,000 samples annually, will ensure quality assurance for fortified foods (e.g., rice, oil, salt), supporting BSTI's regulatory efforts and consumer trust.

1.1.3 Critical Analysis of Institutional Capacity and Sustainability

A thorough analysis of BAU's Central Laboratory's institutional capacity and sustainability is crucial to determine its readiness to host FFC. The laboratory's current infrastructure, including high-performance liquid chromatography (HPLC) and atomic absorption spectroscopy (AAS), supports 2,000–3,000 samples annually, but scaling to FFC's target requires significant upgrades in equipment, staffing, and accreditation from the Bangladesh Accreditation Board (BAB) that can extend support to test 10,000–15,000 samples and train 300–500 individuals annually.

1.2 Scope of the work

The primary objective of the feasibility study is to evaluate the potential for establishing a sustainable and impactful FFC in Bangladesh. Specific objectives include:

i. To determine the need and justification for the FFC by analyzing micronutrient deficiencies and existing food fortification programs;

ii. To assess the potential of BAU Central Laboratory (PMHCL) to establish FFC and deliver the services;

iii. To evaluate the feasibility of the Centre of Excellence for Food Fortification (FFC);

iv. To propose a governance and organizational framework and an operational plan with timelines, activities, and risk mitigation strategies;

v. To estimate the overall sustainability of FFC based on five domains.

2.0 Methodology

2.1 Methodological Framework for Feasibility Assessment

The feasibility assessment of the FFC program follows a structured and systematic approach, integrating both evidence gathering and validation processes. Evidence is collected through a combination of desk review and primary data generated, ensuring a comprehensive understanding of institutional capacity, financial viability, operational readiness, compliance, and contextual constraints. The collected data were then analyzed using the **5 I's** assessment strategy, which evaluates five critical domains: Institutional strength, Investment viability, Implementation capacity, Integrity (reliability), and Impediment (mitigation ability). Each domain provided insights into specific dimensions of sustainability, ensuring a holistic assessment of program feasibility.

Following the assessment, findings were subjected to a validation workshop where stakeholders reviewed and confirmed the evidence, discussed gaps, and proposed corrective measures. Based on this validated evidence, a decision was made regarding the program's feasibility. Programs that met the criteria were classified as feasible, whereas those with gaps were identified as needing improvement, highlighting areas for targeted interventions before full-scale implementation. This iterative and evidence-based framework ensured that decisions are informed, transparent, and geared toward achieving sustainable outcomes.

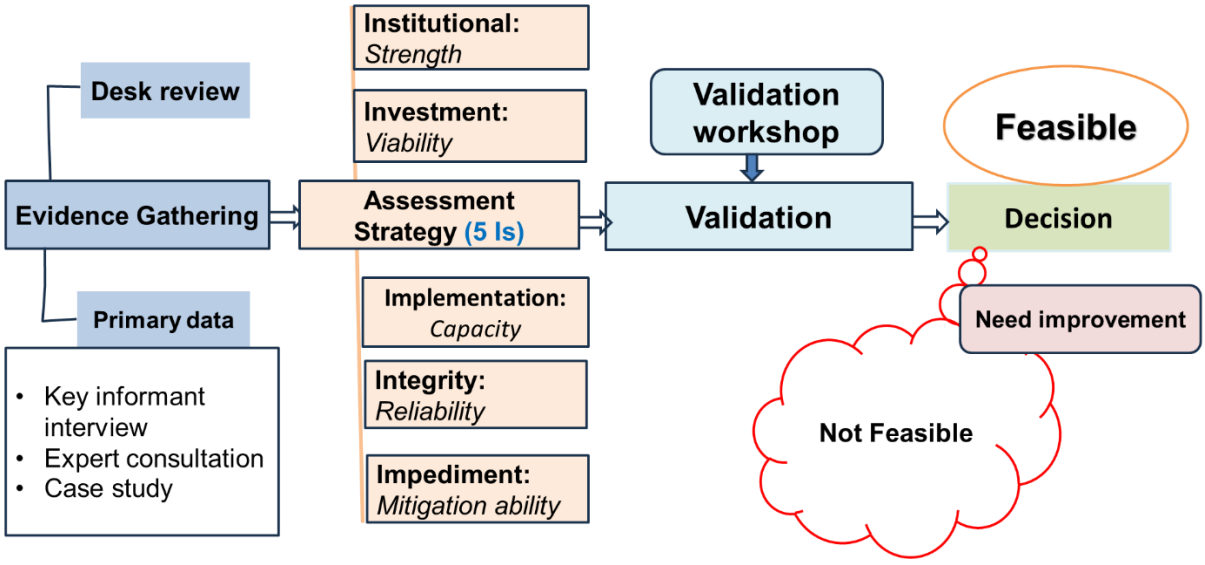


Figure 1: Methodological Framework

2.2 Literature Review

A systematic review of national and international literature conducted to assess micronutrient deficiencies (iodine, vitamin A, iron, zinc) in Bangladesh and globally; evaluate food fortification programs (e.g., salt iodization, edible oil, rice, wheat flour)

in Bangladesh and countries like India; Nigeria; and Indonesia, identify best practices from global Centre of Excellence, and Bangladesh's food fortification policies and stakeholder ecosystems. The sources include the Bangladesh Demographic and Health Survey (2021 -2022), National Micronutrient Survey (2019 -2020), Second Plan of Action for Nutrtion (2016-2025), MoHFP, GoB; Bangladesh National Food and Nutrition Security Policy Plan of Action (2021-2030), FPMU, GoB , WHO, WFP, UNICEF, FAO, GAIN reports, peer-reviewed journals, and policy documents from the Ministry of Health, Ministry of Industries, and Bangladesh Food Safety Authority. Special focus will be given to collect relevant documents from FFC that established in India and Africa with the technical assistance from GAIN.

2.3 Primary Data Collection

To advance in-depth insights into stakeholder perceptions and contextual challenges, the following qualitative methods employed:

2.3.1 Key Informant Interviews (KIIs)

The study team conducted 19 Key Informant Interviews (KIIs) with high-level stakeholders who include senior officials from the Ministry of Industries, Bangladesh Food Safety Authority, and Bangladesh Small and Cottage Industries Corporation, experts in food fortification from the, Professor Muhammed Hussain Central Laboratory, and international organizations, as well as industry leaders and technology providers (Table 2.1). These experts are categorized into three domains including government, private sector and technical experts. In few cases, teams faced difficulties categorizing the participants can be fitted both categories. The KIIs used to collect expert opinions on technical feasibility, funding models, and governance structures for the Centre of Excellence for Food Fortification (FFC). The main issues were the infrastructure and technological requirements for fortification, potential funding sources such as government; donors and the private sector; and strategies for ensuring sustainable operations (Please see details of participants in Annex-1).

Table 2.1 Distribution of the KII participants

Representative	Number	Percentage of total
Government	8	42
Private sector	4	21
Technical expert	7	37
Total	**19**	**100**

2.3.2 Expert Consultation and Validation Meeting

The research plans to conduct three expert consultation and/or validation meetings with different groups that include government officials (from BFSA, BSTI, MoI, DNCRP), private sector representatives (like edible oil and salt producers, rice millers), and researchers (from universities and other institutions). The consultation

aims to investigate food fortification perceptions while determining current program deficiencies and evaluating the FFC potential. The consulting team has presented the inception and progress reports to the expert team, received valuable feedback from the members and incorporated them in the reports. Final validation workshop was organized and the draft report presented in which the experts (government, private and technical) had the opportunity to deliver their inputs for finalizing the feasibility study report.

2.4 Feasibility Assessment using the 5 I's Framework

This feasibility study employed a comprehensive **"5 Is" framework**, which provided a structured approach for evaluating the feasibility, sustainability, and readiness of proposed program and policies. The framework was designed to guide decision-makers through critical dimensions that determine whether an initiative is viable and can be effectively implemented. Each "I" represented a key pillar of assessment, ensuring that no major consideration is overlooked. By systematically examining institutional readiness, investment requirements, implementation capacity, integrity of compliance, and potential impediments or risks, the 5 Is framework supported evidence-based planning and increases the likelihood of successful outcomes. **Table 2.2** presents the domains of sustainability, corresponding indicators, and sources of information or data. All indicators have been specifically developed to assess the sustainability of FFC establishment. The sustainability of the FFC program is underpinned by multiple institutional, investment, implementation, integrity and impedimental factors. These are discussed below:

2.4.1 ***Institutional domain:*** The program will benefit from accredited laboratories (ISO/BSTI), a skilled pool of trained staff and experts, and a well-defined governance structure that ensures accountability and effective decision-making. Active engagement with government agencies, private sector actors, and donors strengthened collaboration and resource mobilization. Integration into BAU's academic and research programs further embedded capacity building, knowledge generation, and practical applications into the institution's core functions.

2.4.2 ***Investment domain:*** Financial sustainability will be supported by funding from government, donors, and private sources, complemented by self-generated revenue from services. Cost-competitive testing, availability of subsidies for premix and equipment, and diversified funding streams—including public-private partnerships, consultancy, and training fees—reduce dependency on single sources and enhance long-term financial resilience.

2.4.3 ***Implementation domain:*** Operational sustainability will be reflected in the number of fortified products validated (rice, wheat, oil, salt), regular participation in ring tests and proficiency assessments, and the volume of samples tested and certified. Offering training sessions and diploma courses annually strengthens human capacity, while adoption of phased product roll-out strategies ensures systematic scaling and operational continuity.

2.4.4 ***Integrity domain:*** Sustainability in this domain was ensured through compliance with fortification standards (BSTI), regular updates of SOPs and standards, and consistent premix quality testing and validation. Transparent reporting of test results and evidence of ethical monitoring, including measures to prevent over-fortification, reinforce accountability and stakeholder trust.

2.4.5 ***Impediment domain***: Contextual challenges may influence sustainability. These include consumer awareness levels, the frequency and reach of advocacy campaigns, and price differences between fortified and non-fortified foods. Policy responsiveness, including revisions informed by FFC evidence, as well as enforcement strength through inspections; proposing penalties and corrective actions, further determined the program's ability to achieve long-term impact.

Overall, the application of the 5 I's framework will ensure a holistic, evidence-based assessment of FFC sustainability, capturing institutional readiness, financial viability, operational capacity, ethical compliance, and contextual constraints. This structured approach enabled informed decision-making and facilitated strategic planning for the continued success of the program.

Table 2.2 Sustainability assessment indicators and data sources

	Description	Measuring indicators	Data source
Institutional	Capacity, governance, organizational readiness, stakeholder roles, market segment	• Accreditation of laboratory (ISO, BAB recognition) • Number of trained staff and experts • Existence of clear governance structure • Level of stakeholder engagement (govt, private, donors) • Integration into BAU's academic and research programs	Document review Organogram Organizational mandate KIIs
Investment	Financial feasibility, cost analysis, funding mechanisms	• Amount of annual funding (government + donor + private) • Share of self-generated revenue from services • Cost competitiveness of testing services • Subsidies available for premix and equipment • Diversification of funding sources (PPP, consultancy, training fees)	Document/report review Expert consultation
Implementation	Technical and operational feasibility, delivery capacity, logistics	• Number of fortified products validated (rice, wheat, oil, salt) • Frequency of ring tests and proficiency testing • Training sessions/diploma courses offered annually • Volume of samples tested and certified • Adoption of phased product roll-out strategy	Existing staff Implementation experience Outreach Guidelines/manual Expert interview
Integrity	Legal and regulatory compliance, ethical considerations.	• Compliance rate with fortification standards (BSTI) • Frequency of SOP and standard updated • Premix quality testing and validation rates • Transparency in reporting test results	Review certificate and registration document Linkages and connectivity

		• Evidence of ethical monitoring (avoidance of over-fortification)	
Impediments (Risk)	Risk identification, mitigation strategies, barriers to success.	• Consumer awareness levels (survey-based) • Number of advocacy/awareness campaigns conducted • Price gap between fortified and non-fortified foods • Policy revisions adopted based on FFC evidence • Enforcement strength (number of inspections, penalties, corrective actions)	Internal risks External risks Mitigation strategies Expert consultation

3.0 Results and Discussion

3.1 A Glimpse of Food Fortification in Bangladesh

Micronutrient deficiencies remain a significant public health challenge in Bangladesh, affecting vulnerable populations, particularly women and children. Deficiencies in iodine, iron, vitamin A, and zinc can lead to serious health consequences, including impaired cognitive development, stunted growth, and increased morbidity. Over the past three decades, Bangladesh has transitioned from small-scale fortification initiatives to nationwide programs, demonstrating strong commitment to improving population nutrition. In this context, the Food Fortification Center (FFC) may establish to coordinate, advance, and monitor fortification initiatives, providing technical guidance, research support, and capacity building across public and private sectors.

3.2 Historical Development of Food Fortification in Bangladesh

The history of food fortification in Bangladesh can be traced back to the late 1980s, beginning with salt iodization, and has progressively expanded to include multiple staple foods.

3.2.1 Universal Salt Iodization (USI)

International organizations, including UNICEF, the Micronutrient Initiative (MI), the Global Alliance for Improved Nutrition (GAIN) and WFP provided technical and financial support. The program upgraded Bangladesh as a global leader in mandatory salt iodization, achieving substantial reductions in iodine deficiency prevalence (Table 2.3).

Table 2.3. Evolution of Salt Iodization in Bangladesh stated below:

1981-82	Iodized oil injections for controlling IDD in 38 districts followed by National Goiter Prevalence Survey.
1989	Iodine Deficiency Disorder Prevention Law.
1990	Control of Iodine Deficiency Disorder (CIDD) Project initiated by BSCIC.
1991	Salt Iodization Plant (SIP) donated by UNICEF to267 salt factories.
1991	Free Cost Potassium Iodate Supply to Salt Millers
1993	National IDD Survey
1994	Prevention of Iodine Deficiency Disorder Regulation 1994
1999	National IDD Survey
2004-5	National Survey on Iodine Deficiency Disorder and USI.
2010	Refurbishment of 200 SIP through Micronutrient Initiative (MI).

2011	National Salt Policy (revised)
2011-2012	National Micronutrient Status Survey by ICDDR'B, UNICEF, GAIN and IPHN.
2012 – 2013	"Estimating Stability of Iodine in different types of iodized Salt used for Human Consumption in Bangladesh" - Micronutrient Initiative (MI), Canada.
2016	National Salt Policy (revised)
2019 - 2020	National Micronutrient Survey, Ministry of Health and Family Welfare Government of the People's Republic of Bangladesh: icddr,b.
2021	Establish Salt Cell at BSCIC
2021	The Iodized Salt Act (Ministry of Law and P.A, 2021)
2022	National Salt Policy (revised)
2022	Bangladesh Demographic and Health Survey (BDHS), National Institute of Population Research and Training, Ministry of Health and Family Welfare.
2023 and 2024	Celebration of World Iodine Day

3.2.4 Fortification of Wheat Flour

Wheat flour fortification was initiated in 2000 through USAID's Vulnerable Group Development (VGD) program, primarily targeting iron and folic acid deficiencies among women and children. This pilot program demonstrated the feasibility of wheat flour fortification in improving micronutrient intake among vulnerable populations, laying the groundwork for scaling up fortification efforts.

Wheat flour is usually fortified with iron, folic acid, zinc, vitamin A and vitamin B12. Voluntary fortification of wheat flour is already allowed in Bangladesh. The standards for voluntary fortification of both Atta and Moida established in 2008 –Fortified Wheat Atta; Fortified flour availability is very much limited. Voluntary fortification is unlikely to lead to a larger coverage or an adequate intake to improve public health nutrition. ACI launched Fortified Wheat flour in the commercial Market in February 2025. The retail chain of ACI, named Shwapno is the distribution hub of fortified flour. IFAD's fortified flour was launched in December 2024. Additionally, a couple of conglomerates showed interest in producing fortified wheat flour in the commercial market.

3.2.3 Rice Fortification

With WFP support, MoFood and MoHFW, the Government of Bangladesh launched the rice fortification program in 2013. In 2016, NI joined with WFP in rice fortification program. In 2013, only 30,000 beneficiaries received fortified rice. At present, 12 rice mills

are producing FRK, and 178 Rice mills are supplying fortified rice (Rice: FRK =100: 1) in Bangladesh. Until 2024, in 205 Upazila under VWB and 276 Upazila under the FFP program, beneficiaries received fortified rice (about 15 million Ultra poor). Bangladesh is now the world's third-largest producer of fortified rice kernels (WFP, 2023). ACI sells fortified rice through a retail chain and has been available in many super shops around Dhaka since the end of 2024. Jahan Food and Agro Pvt. Ltd. launched fortified rice in the commercial market back in 2021.Bondhan Agro Food Industries based in Faridpur, they are commercializing fortified rice all over Bangladesh. United Fortification Ind. Selling Fortified rice under the brand name of "**Astha**. Blossom Agro Private Ltd launched selling FR on the market in the name Blossom in 2021. Nourish Food Limited commercializing fortified rice since 2021. NK Food Private Ltd. and Al-Hera Rice Premix Kernel Ltd are commercializing Fortified Rice in limited capacities.

3.2.2 Edible Oil Fortification

The Government initiated its effort to fortify edible oil with vitamin A in November 2013 (Vitamin A Enrichment in Edible Oil Act (Act No. 65 of 2013). Officially mandated it under the "Oil Fortification Rules 2015" in November 2015 (The Fortification of Edible Oil with Vitamin 'A' Rules, 2015). By 2015, 95% of refined edible oil was fortified, significantly improving vitamin A intake in the population. GAIN and UNICEF cooperate GoB in implementing oil fortification in Bangladesh. Forty (40) refineries (out of 44) operating in Bangladesh have signed MoU with MoInd fortifying edible oil with vitamin A. Based on the result of market assessment in 2017 – 2018 conducted by GAIN and ICDDRB; 95% of total packaged oil is fortified; 69% adequately fortified; 41% of total bulk oil (sold in drums) is fortified; and 7% adequately fortified.

3.2.5 National Strategy for Micronutrient Deficiencies

From 2015 to 2024, the government implemented the National Strategy for Prevention and Control of Micronutrient Deficiencies, which prioritized the fortification of key staples—rice, flour, oil, and salt. The strategy aimed to integrate fortification into national nutrition security frameworks, emphasizing regulatory oversight, program monitoring, and evidence-based policy formulation. The subsequent Iodized Salt Bill 2021 mandated universal salt iodization, reaffirming the government's commitment to eliminating iodine deficiency.

3.2.5 Current Regulatory and Implementation Status

Bangladesh has made significant progress in food fortification, with varying levels of regulatory enforcement across food items (Table 3.1). This regulatory landscape highlights the successes of mandatory fortification (salt, Edible oil) while identifying

opportunities to expand voluntary fortification programs for wheat flour and rice, particularly through pilot initiatives.

Table 3.1 Current Regulatory and Implementation Status

Food Item	Fortification Status	Nutrients Added	Type
Salt	Mandatory	Iodine	Mandatory
Edible Oil	Mandatory	Vitamin A	Mandatory
Wheat Flour	Voluntary	Iron, Folic Acid	Voluntary
Rice	Voluntary (in pilots)	Vitamin A, B_1, B_{12}, Iron, Zinc, Folic Acid	Voluntary

Figure 3.1 illustrates the historical progression of food fortification in Bangladesh, from salt iodization in the late 1980s to the comprehensive multi-staple fortification initiatives of today.

Figure 1: Historical Progress towards food fortification in Bangladesh

3.3 Justification for the Establishment of FFC

Food fortification in Bangladesh has evolved into a comprehensive, multi-stakeholder effort addressing key micronutrient deficiencies. Beginning with salt iodization, the country has expanded its scope to include edible oil, rice and wheat flour supported by both legislative frameworks and international partnerships. The establishment of FFC represents a milestone toward consolidating these efforts, providing technical expertise, regulatory oversight, and strategic guidance. As Bangladesh continues its journey toward improved nutrition security, FFC is poised to play a vital role in ensuring that fortified foods reach those who need them most, thereby contributing to healthier, more productive populations.

The establishment of the FFC at Bangladesh Agricultural University is justified by the diverse evidence gathered from key informant interviews (KIIs) across government, private sector, development partners, and technical experts. Collectively, their perspectives underscore persistent gaps in research, monitoring, policy, and capacity that require an integrated and presented in Table 3.2 and discussed accordingly.

3.3.1. Research and Evidence Gaps

Several experts (**Expert ID 01, 10**) highlighted that current fortification policies in Bangladesh often rely on international trends rather than domestic and evidence-based research. Decisions are made without adequate surveys, dose-response assessments, or community-level studies, leading to risks of under- or over-fortification in different regions. For example, micronutrient deficiencies vary geographically, yet uniform standards are applied nationwide. FFC can serve as a knowledge hub to generate need-based data, conduct demanding research, and ensure that fortification strategies are tailored to the nutritional realities of Bangladesh.

3.3.2 Laboratory and Monitoring Needs

A recurring theme/trend across public and private stakeholders (**Expert IDs 02, 03, 05, 07, 12**) is the absence of adequate independent laboratory facilities for testing fortified products. Current systems/facilities are limited to internal company labs or scattered government facilities that cannot handle the volume or diversity of samples. This weakens quality assurance and undermines consumer confidence. FFC, with modern laboratory facilities, may provide third-party testing, certification, and cross-validation of fortified products. It may also ensure that nutritional content is maintained across the supply chain up to the consumer level.

3.3.3 Policy and Institutional Support

Government officials (**Expert IDs 14–16**) admitted that while laws exist, enforcement remains weak, and universities are not effectively engaged in fortification research or policy processes. FFC can bridge this institutional gap by producing policy-relevant evidence and working alongside regulatory bodies like BSTI, BFSA, BSCIC, and the Ministry of Food. It can also support the revision and/or harmonization (with CAC) of standards, such as those for wheat flour and vitamin fortification, ensuring they are aligned with present nutritional needs and international best practices.

Table 3.2 Summary of the expert reflection on the importance and implication of FFC

Justification	Participant Reflections	Implication for FFC
Research & Evidence Gaps	Policies adapted from abroad without local research; no community-level survey; overdose/deficiency risk varies regionally (**ID 01, 10**)	FFC can generate localized evidence, dose-response studies, and surveys to undertake science-based policy decisions.
Laboratory & Monitoring Needs	Lack of external monitoring; insufficient labs capacity of BSTI & BSCIC; private sector needs third-party validation (**ID 02, 03, 05, 07, 12**)	FFC can provide independent, accredited testing and cross-validation to ensure quality assurance across products and companies.
Policy & Institutional Support	Weak enforcement; lack-of revised standards (e.g., wheat, vit D); limited university involvement; donors' dependency (**ID 14–16**)	FFC can act as a policy support hub, updating standards, offering evidence-based information, and linking academia with ministries (Food, Industry, Commerce).
Private Sector Collaboration	High cost of premix; limited demand; fear of losses; dependence on imports; need for external testing support (**ID 04, 05, 07, 09**)	FFC can foster public–private partnerships, provide affordable testing, training, and help localize premix innovation to reduce costs.
Consumer Awareness & Sustainability	Low awareness; lack of trust on fortified food; subsidy/free food dependency; sustainability beyond donor projects uncertain (**ID 03, 06, 11, 16**)	FFC can promote consumer awareness campaigns, embed fortification into education, and build long-term national capacity for sustainability.

Source: Expert consultation and KII, 2025

3.3.4 Private Sector Collaboration

Private companies (IDs 04, 05, 07, 09) emphasized that despite their interest and investment in fortification, sustainability is hampered by limited demand, lack of affordable testing services, and weak consumer awareness. Many companies rely on imported premixes, which adds costs and reduces flexibility. FFC can play a catalytic role in strengthening public–private partnerships, providing reliable testing services, training, and technology transfer. Organizing industries for premix production locally and scale innovations, FFC can make fortification more affordable and sustainable.

33.5 Consumer Awareness and Sustainability

Multiple participants (**Expert IDs 03, 06, 11, 16)** noted that consumer awareness is still low, leading to limited demand for fortified products. At the same time, sustainability is challenged by substantial reliance on donor-funded initiatives. FFC can address this through developing/undertaking education, advocacy, and outreach programs to build trust and demand among consumers, while also training the next generation of food scientists and technologists. Successfully embedding food fortification into academic curricula and research, FFC can ensure a long-term, nationally owned system that goes beyond donor dependence.

Existing literature and experts evidence demonstrated that food fortification in Bangladesh suffering from fragmented research, weak monitoring, un-updated standards, and poor coordination among stakeholders. The FFC is, therefore, indispensable as a unified platform that combines scientific research, laboratory services, policy engagement, private sector involvement, and consumer awareness. FFC might ensure that fortification efforts are not only technically sound and evidence-driven but also sustainable, affordable, and aligned with the nutritional needs of the people of Bangladesh.

4.0 History of BAU Central Labrotary

4.1 History

The Bangladesh Agricultural University (BAU) Central Laboratory, located on the university's 1,200-acre campus in Mymensingh. The laboratory was conceptualized to support interdisciplinary research across BAU's six faculties. The Central Laboratory began operations in 2005 and by 2010, the laboratory had expanded to a dedicated facility equipped with modern analytical tools, such as high-performance liquid chromatography (HPLC) and atomic absorption spectroscopy (AAS), to support research on soil, water, and food composition.

Over the past two decades, the Central Laboratory has evolved into a hub for advanced agricultural research. The laboratory's infrastructure has been upgraded periodically, with significant investments in 2018 to enhance its capacity for molecular biology and food safety testing, positioning it as a potential cornerstone for the proposed Centre of Excellence for Food Fortification (FFC).

Vision: To become a leading laboratory for agricultural and biological research in the future.

Mission: Its mission is to support a wide range of biological and agricultural research. The lab also aims to enhance scholarly research, contribute to the field of scientific knowledge, and train the next generation of biological scientists and university faculty. In addition, the PMHCL seeks to provide high-quality analytical and instrumental support to the university community and beyond, including students, teachers, and external researchers. The laboratory strives to foster high-quality research across various scientific disciplines.

Mandate: The mandate of the Professor Muhammed Hussain Central Laboratory (PMHCL) is to provide high-quality research, education, and professional service in the biological sciences. The lab was founded with the intent of offering a centralized facility with sophisticated equipment for the entire university, addressing the high cost and inefficiency of having duplicate equipment in multiple departments.

Research support

- To offer common analytical, instrumental, and research support to all university teachers, researchers, and students, particularly those pursuing MS and PhD degrees.
- To accelerate high-quality research across a diverse range of scientific disciplines, including ecological, molecular, and cellular biosciences.
- To promote pioneering and innovative research in the natural sciences.

Educational role

- To train the next generation of biological scientists, agricultural scientists, and teachers.
- To offer cutting-edge laboratory facilities to students in various fields of agricultural science.

Service provision

- To offer a professional service by providing instrumental support to both the internal university community and, where possible, external stakeholders.
- To help advance the university towards its vision of becoming a "Center of Excellence" for research.

4.2 Organogram

The organogram reflects a hierarchical structure designed to ensure efficient management and interdisciplinary collaboration:

- **Director**: The top authority, appointed by the Vice-Chancellor from among the university's professors for a 2-year term, oversees all activities, including those of the Central Laboratory.
- **Associate Director**: The Assistant Director, appointed for a 2-year term from among professors of BAU, coordinates with faculty researchers and external partners, monitors progress on research initiatives, resolves operational issues, and ensures compliance with safety and quality standards
- **Testing Units**:
    - **Additional Chief Engineer**: Manages the food and nutrient analysis unit and ensures the proper functioning and calibration of analytical instruments.

- **Deputy Chief Instrument Engineer**: Oversees instruments, regular maintenance, and contributes to experiment outcomes.
- **Senior Demonstrator**: Leads analysis unit, conducts assessments, integrates findings, and demonstrates techniques for accurate sampling and analysis.

- **Administrative Staff**:
  - **Deputy Director:** Assists in overall administrative oversight, coordinates procurement processes, manages budgeting and documentation, and supports the Director in strategic planning and policy implementation.
  - **Junior Clerk:** Handles daily clerical tasks, including data entry, filing records, managing correspondence, and providing general administrative support to ensure efficient office operations.
  - **Senior Cleaner:** Maintains hygiene and cleanliness across laboratory spaces, offices, and equipment areas, manages cleaning supplies, and ensures compliance with health and safety regulations.

4.3 Existing Service Provisions

4.3.1. Micronutrient Analysis

The Central Laboratory provides analytical services to assess the nutritional composition of food crops and processed foods supporting research on micronutrient deficiencies. Key services include:

- Using high-performance liquid chromatography (HPLC) and atomic absorption spectroscopy (AAS), the laboratory measures levels of vitamins and minerals in samples.
- Determines moisture, protein, fat, fiber, and ash content in food samples to evaluate nutritional quality.

4.3.2. Biotechnology Research Support

- Provides plant tissue culture facilities for developing disease-resistant and nutrient-enhanced crop varieties.
- Limited sequencing services using next-generation sequencing (NGS) equipment.

4.3.3 Soil and Water Testing

The laboratory supports environmental and agricultural research through:

- Tests for macro- and micronutrients using AAS and spectrophotometry.
- Measures pH, salinity, and heavy metal content in irrigation and drinking water.

4.3.4 Training and Capacity Building

The Central Laboratory facilitates training programs to enhance analytical skills:

- Offers short courses on HPLC, AAS, and PCR techniques for postgraduate students and faculty.
- Provides hands-on laboratory access for M.S. and Ph.D. students conducting thesis research.

4.4 Limitations and Opportunities

While the Central Laboratory's services are robust for academic research, its capacity for commercial-scale fortification testing is limited. Current infrastructure supports 4,000-5,000 samples annually. External client engagement is minimal, with only 10% of services allocated to non-BAU stakeholders due to equipment and staffing constraints. The laboratory lacks accreditation from the Bangladesh Accreditation Board for standardized testing. Upgrading equipment, expanding staff, and obtaining accreditation could position the laboratory as a national hub for fortification services.

4.5 Financial Strength of BAU Central Laboratory

This section outlines the laboratory's current financial resources, funding sources, and mechanisms.

4.5.1 Financial Strength

The Central Laboratory's financial strength is derived from BAU's broader budgetary framework. Key aspects of its financial position include:

Annual Operating Budget: The annual operating budget for the Central Laboratory supports a total personnel count of nine and caters to a sample size ranging from 4,000 to 5,000, sourced from BAU, public institutes, and other organizations. This budget encompasses various essential expenses, including equipment maintenance, consumables, and operational costs. The allocated funds are distributed across several key heads: the Annual Personnel Budget stands at 668,954, covering salaries and related expenses for the staff; the Annual Contingency Budget is set at BDT. 385,000, providing a buffer for unforeseen costs; the Annual Equipment Budget amounts to BDT. 754,966, allocated for the upkeep and acquisition of laboratory equipment; and the Annual Other Support totals BDT. 369,966, supporting additional operational needs and miscellaneous

expenses. This comprehensive financial plan ensures the laboratory's ability to conduct research and maintain its facilities effectively throughout the year.

Infrastructure Assets: The Central Laboratory, situated within Bangladesh Agricultural University (BAU)'s campus, occupies a 12,000-square-foot facility equipped with advanced analytical tools valued at approximately 70 million BDT. These assets, funded through government and international grants, support critical micronutrient analysis essential for fortification research. The laboratory benefits from an approximate annual rent of BDT 960,000, providing significant financial support and positioning it as a Food Fortification Center (FFC) to ensure its sustainability.

Revenue from Services: The laboratory generates limited revenue (approximately 6.7 million BDT annually) from BAU, Public Institutions and external clients. This accounts for 25% of its income, with the remainder subsidized by BAU's budget.

International and National Partnerships: Capital investments, such as equipment purchases, are often funded by international partners like FAO.

While the laboratory's financial strength supports academic research, its limited commercial revenue and reliance on BAU's budget constrain its capacity to scale for FFC's nationwide fortification goals.

4.6 Operational Guideline

The operational guidance and guidelines outlined below ensure efficient management, high-quality testing outputs, and alignment with BAU's academic and research objectives.

4.6.1 Governance

The Central Laboratory operates as a standalone institute of BAU upon the consensus of vice-chancellor of BAU. Operational guidelines are governed by:

- **Standard Operating Procedures (SOPs)**: The laboratory follows SOPs for equipment use, sample handling, and data management, developed by the Director, Central Laboratory, and reviewed annually to ensure compliance with BAU's quality standards.
- **Ethical Oversight**: Research involving human-related data is reviewed by BAU's Ethics Committee to ensure compliance with national and international ethical guidelines.

4.6.2. Operational Structure

The laboratory is organized into three primary units, each with defined roles and operational protocols:

- **Food and Nutrient Analysis Unit**: Conducts micronutrient profiling using high-performance liquid chromatography (HPLC) and atomic absorption spectroscopy (AAS).
- **Biotechnology Unit**: Supports molecular analysis using PCR and next-generation sequencing (NGS).
- **Soil and Water Analysis Unit**: Analyzes soil and water samples annually for nutrient and contaminant levels.
- **Operational Coordination**: The Director oversees unit activities, with unit coordinators managing daily tasks and reporting weekly to ensure project timelines are met.

4.6.3. Sample Processing and Analysis Protocols

The laboratory follows structured guidelines for sample handling and analysis to ensure accuracy and reliability:

- **Sample Submission**: Researchers and external clients submit samples through a standardized form and specifying analysis type. Samples are logged into a tracking system by administrative staff.
- **Sample Preparation**: Technicians follow unit-specific SOPs for preparation. Hazardous materials are handled as per safety protocols.
- **Analysis Workflow**: Samples are prioritized based on project deadlines, with academic samples (90% of workload) processed before external requests. Results are validated and cross-checked by the appropriate personnel.

4.6.4. Equipment Management

The laboratory's advanced equipment is critical for its operations. Guidelines include:

- **Usage Protocols**: Only trained staff operate equipment, following manufacturer SOPs. Usage is scheduled via a booking system to maximize efficiency.
- **Maintenance**: Equipment maintenance technicians perform weekly checks and annual calibrations. Major repairs are outsourced to vendors approved by BAU's Engineering Division.

4.6.5. Financial and Administrative Guidelines

Financial operations are guided by BAU's centralized policies:

- **Budget Management**: The laboratory's 10 million BDT annual budget covers salaries, consumables, and maintenance. Expenditures require approval from the VC of BAU and Director, Central Laboratory.
- **Revenue Collection**: External services are invoiced with funds reinvested into operations. Payments are processed via BAU's Accounts Office.
- **Procurement**: Reagents, spare parts, and minor equipment are procured through BAU's tendering process, managed by administrative officers.

4.6.6. Training and Capacity Building

The laboratory supports BAU's training objectives through structured programs:

- **Internal Training**: Annual workshops on analytical techniques for technical staf.
- **Student Access**: Postgraduate students use the laboratory for thesis research, guided by teachers under SOPs. Access is approved by unit coordinators.

4.6.7. Safety and Compliance

Safety guidelines ensure a secure working environment:

- **Laboratory Safety**: Staff follow protocols for handling chemicals and biohazards, including use of personal protective equipment (PPE) and fume hoods.
- **Waste Management**: Chemical and biological waste is disposed of as per BAU's environmental guidelines.
- **Quality Assurance**: The officer responsible oversees compliance with internal standards.

4.5.8 Collaboration and External Engagement

The laboratory collaborates with national and international partners guided by:

- **MoU Protocols**: Partnerships are formalized via memoranda of understanding, approved by the Vice-Chancellor, outlining resource sharing and deliverables.
- **External Client Services**: Limited to 10% of capacity due to resource constraints, with priority given to BAU projects.

5. Feasibility Assessment of FFC

5.1 Capacity of Technical Manpower

The Centre of Excellence for Food Fortification (FFC) aims to advance food fortification research, quality assurance, and capacity building to address micronutrient deficiencies in Bangladesh. FFC requires a technical manpower framework to scale operations beyond the laboratory's current capacity. This section estimates the technical manpower needed for FFC's establishment, specifying full-time and part-time roles, based on the laboratory's existing resources.

5.1.1 Context and Assumptions

The FFC will expand the central laboratory's capabilities to:

- Test 10,000-15,000 samples annually to address compliance gaps.
- Conduct research on fortification technologies and biofortified crops.
- Train 300-500 stakeholders annually.
- Achieve Bangladesh Accreditation Board (BAB) certification for standardized testing.

The central laboratory employs 9 technical and administrative staff sufficient for academic research but inadequate for FFC's scale. The estimation assumes:

- Integration of existing staff into FFC, with additional hires to meet increased demand.
- Access to resource pool BAU.
- Collaboration with partners to fund and train personnel.

5.2 Estimated Technical Manpower Requirements

The Food Fortification Center (FFC) will rely on a diverse team of 24 technical staff, comprising both full-time and part-time personnel, to deliver on its mandate. These professionals will lead research, ensure quality compliance, maintain laboratory operations, analyze data, and provide training. Their combined expertise and structured roles will enable FFC to strengthen national fortification efforts while supporting both industry and policy with evidence-based solutions. The breakdown is as follows:

Table 5.1 Estimated technical manpower requirement for successful operation of FFC

Position	Role	Qualifications	Composition
Research Scientists	• Lead research on fortification techniques and micronutrient analysis • Supervise postgraduate research and publish findings.	• Ph.D. or M.S. in Food Technology, Food Engineering, Chemical Engineering, Biochemistry, Biotechnology, or Agronomy • 5–10 years of research experience.	5 full-time staff 5 part-time staff
Laboratory Technicians	• Prepare and analyze food, soil, and water samples • Handle compliance testing for fortified foods.	• B.Sc. in Chemistry, Biology, or Agricultural Sciences, or Diploma in Laboratory Technology • 3–5 years' experience.	5 full-time technicians 5 part-time staff
Quality Control Analysts	• Ensure results meet standards • Develop SOPs for accreditation • Validate tests and audit lab processes	• M.S. in Food Technology, Food engineering, Nutrition or Chemistry; trained in quality systems • 5+ years' experience.	1 full-time analyst 1 part-time analyst
Equipment Technicians	• Maintain and calibrate instruments • Perform checks, repairs, and support safety protocols	• Diploma in Electrical or Mechanical or chemical Engineering • 3–5 years' experience	2 full-time technicians 2 part-time technicians
Data Analysts	Analyze experimental data, maintain sample databases, support publications, and provide statistical input for policy.	• B.Sc. or M.Sc. in Statistics, Bioinformatics, or Computer Science • 3–5 years' data analysis experience	1 full-time staff 1 part-time staff

5.3 Recruitment and Training Plan

- **Recruitment**: 12 full-time and 12 part-time staff will be recruited BAU guidelines. Part-time roles will prioritize BAU students and faculty, ensuring cost-efficiency.
- **Training**: New staff will undergo 3-6 months of training on fortification-specific techniques supported by partners like GAIN. Existing staff will receive refresher courses to align with FFC's standards.

5.4 Market Size of Food Fortification

Understanding the market size for food fortification in Bangladesh is critical to assess FFC's potential impact, revenue opportunities, and resource requirements. This section estimates the market size for food fortification, focusing on production volumes, consumer demand, industry data, and stakeholder insights.

5.4.1 Overview of food fortification market

The Bangladesh Demographic and Health Survey (2022) underscore the need for fortification due to poor dietary diversity and low socioeconomic status. Key fortified foods include:

- **Edible Oil**: Fortified with vitamin A, with 69% of packaged oil meeting minimum fortification standards, representing 35% of the total oil market (2.6 million MT annually).
- **Salt**: Iodized to prevent goitre, with 37.1% of packages labeled as fortified, though compliance varies.
- **Rice**: Emerging fortification with iron and zinc, currently limited to social safety net programs but with potential for market expansion due to universal consumption (100% of households).
- **Wheat Flour**: Fortified with iron, folate, and other nutrients, with growing adoption in urban markets.

The market for fortified foods is driven by government mandates (e.g., National Strategy for Prevention and Control of Micronutrient Deficiencies 2015-2024), private sector engagement, and international support from organizations like the Global Alliance for Improved Nutrition (GAIN) and World Food Programme (WFP).

5.5 Market Size Estimation

The market size for food fortification in Bangladesh is estimated based on production volumes, market value, and demand for fortification-related services (e.g., testing, certification, training). The analysis focuses on edible oil, salt, rice, and wheat flour, as these are prioritized by national policies and widely consumed.

5.5.1. Edible Oil

The total market for edible oil is estimated at around 2.6 million metric tons (MT) per year, of which packaged oil makes up approximately 900,000 MT, accounting for 35 percent of the overall market. Within the packaged oil segment, about 69 percent,

equivalent to 621,000 MT, is fortified with vitamin A above the minimum standard, while around 5 percent, or 45,000 MT, remains unfortified. Assuming an average retail price of 150 BDT per kilogram for packaged oil, the value of the fortified oil market alone is approximately 93.15 billion BDT. This calculation is based on multiplying the fortified volume of 621,000 MT by the per-kilogram retail price, which translates into roughly 1.1 trillion BDT at scale. This highlights not only the significant role fortified oil plays in the market but also its considerable contribution to the overall value of the edible oil industry.

5.5.2. Salt

Bangladesh produces about 1.8 million metric tons (MT) of salt annually, with iodization mandated since the 1980s to combat iodine deficiency disorders. Despite this long-standing requirement, only 37.1 percent of salt packages are labeled as fortified, reflecting significant gaps in compliance (The daily star, 11 May, 2022). At an average retail price of 40 BDT per kilogram, the iodized salt market, assuming 50 percent compliance or roughly 900,000 MT, is valued at around 36 billion BDT, equivalent to approximately 430 million USD. The other half of the market, which remains non-compliant, presents a considerable growth opportunity for expanding iodization coverage and improving public health outcomes.

5.5.3 Rice

Rice has an annual production volume of 35–40 million MT. Fortified rice, enriched with essential micronutrients such as iron, zinc, Vitamin B1, Folic Acid, Vitamin B12 and vitamin A is still at a nascent stage, primarily confined to social safety net programs. Since 2013, the World Food Programme (WFP) has reached about 13 million people, which translates to less than 1 percent of the market, or about 350,000–400,000 MT. At a retail price of 60 BDT per kilogram, the fortified rice market is currently valued at 21–24 billion BDT, equivalent to about 250–285 million USD (Ahmed et al., 2024). If scaled up to 10 percent of the national market, or 3.5–4 million MT, the sector's value could reach 210–240 billion BDT. For FFC, opportunities lie in expanding fortification into commercial markets, which would require testing 8,000–10,000 samples annually at an estimated cost of 2,000–5,000 BDT per sample, generating revenues of 20–100 million BDT. Additionally, investments in research on fortification technologies such as fortified rice kernels, coupled with training 1,000–2,000 millers, could create further value worth 10–20 million BDT.

5.5.4 Wheat Flour

Wheat flour consumption is steadily increasing in urban areas, with annual production standing at approximately 2 million MT. Of this, 20–30 percent, or 400,000–600,000 MT, is fortified with iron and folate, supported by initiatives such as Millers for Nutrition. At an average price of 50 BDT per kilogram, the fortified wheat flour market is currently valued at 20–30 billion BDT, translating into about 240–360 million USD (FFI, 2020). FFC has additional opportunities in this space through compliance testing, which could involve 2,000–5,000 samples per year, generating revenues of 4–25 million BDT. Furthermore, providing training and certification programs for 500–1,000 millers could add another 5–10 million BDT, strengthening both market capacity and product quality.

5.6 Prospective Service Recipients

This section identifies prospective service recipients, detailing their roles, needs, and how FFC's offerings align with fortification ecosystem and public health goals, including the National Strategy for Prevention and Control of Micronutrient Deficiencies 2015-2024. The stakeholder's perspective has also been incorporated into the discussion. The relative importance of different stakeholders is presented in Table 5.1.

5.6.1 Food Industry Stakeholders

Large-scale food processors and manufacturers such as ACI Limited, City Group, and Pran-RFL Group (ID 05 & 09) are at the core of producing fortified edible oil, iodized salt, and fortified wheat flour. Their primary concern is maintaining compliance with BSTI standards while managing the high costs of fortification. For instance, Pran-RFL highlighted that fortification increases flour prices by nearly 2 taka/kg, creating a significant demand gap in the local market where consumer acceptance remains low (see Appendix). Export markets sustain part of their business, but long-term sustainability requires government subsidies, awareness campaigns, and enforcement of mandatory laws to expand domestic consumption. At the same time, IFAD Multi Products Limited (ID 04 & 07) has pioneered fortified wheat-based products since 2009, including biscuits, noodles, and whole wheat flour, with some distribution in premium outlets. They have also invested in developing their own premix capacity to reduce reliance on costly imports. IFAD emphasized the importance of public–private partnerships and the role of third-party testing by institutions like BAU FFC to validate compliance and build consumer trust. Complementing these large processors are numerous rice and wheat flour millers—from local rice mills to mid-sized companies such as Nourish Foods—who are critical in expanding fortification but face barriers including limited technical know-how, high premix costs, and weak compliance monitoring systems. Finally, premix

suppliers such as BASF and DSM, often working through local distributors, provide essential inputs like vitamin A, iodine, iron, and zinc. Their priorities remain quality assurance, regulatory approval, and expanding supply chains to meet growing demand. However, several participants noted that imported premixes are often used without proper local validation, underscoring the need for stronger cross-checking and context-specific formulation before large-scale adoption (see ID 01, 10 for concerns on premix quality).

5.6.2 Government and Regulatory Agencies

The Bangladesh Standards and Testing Institution (BSTI) (ID 16), as the national standards body, is mandated to enforce fortification regulations, including mandatory iodization of salt and vitamin A fortification of edible oil. While BSTI reports that 100% oil is technically fortified, persistent issues such as weak monitoring of open/unsealed oil, lack of clear Vitamin A standards, and production-level violations undermine compliance. BSTI has the technical capability to test fortification, but requires stronger enforcement mechanisms, additional manpower, and standardized protocols to ensure product integrity and sustainability.

The Ministry of Industry (ID 14 & 15) plays a critical role in standard-setting and enforcement. Despite significant progress, challenges remain: monitoring gaps, insufficient collaboration with private sectors, and low consumer awareness. Officials emphasized the importance of partnerships with universities (like BAU), updated standards (particularly for vitamin D), and stronger awareness campaigns. The Ministry of Food and Commerce also coordinates with development partners and industry associations (e.g., Millers for Nutrition) to promote fortification. However, scaling requires subsidy mechanisms to reduce premix costs, enhanced external monitoring (e.g., BAU FFC validation), and long-term strategies for consumer demand creation.

5.6.3 International Organizations and NGOs

The Global Alliance for Improved Nutrition (GAIN) has been instrumental in oil fortification (ID 16) and supports standard formulation, industry training, and evidence generation. However, participants noted uncertainty about the sustainability of donor-led funding once GAIN phases out.

The World Food Programme (WFP) (ID 06 & 13) leads rice fortification in Bangladesh, particularly through social safety net programmes such as the Vulnerable Women Benefit and Food Friendly Program, reaching more than 250 sub-districts. WFP also provides technical support, training for laboratories, and validation through ring tests, but

emphasized that demand creation and market uptake are crucial for commercial sustainability.

UNICEF (ID 08), once a pioneer in salt iodization, has reduced its direct involvement but remains a key advocate for nutrition programs, particularly targeting vulnerable populations. Other NGOs such as Nutrition International and Technoserve (ID 08) provide technical support, awareness-building, and private-sector engagement. Their effectiveness depends on reliable data, consumer research, and close collaboration with government and academia.

5.6.4 Academic and Research Institutions

Bangladesh Agricultural University (BAU FFC) is positioned as a future knowledge hub for fortification, offering third-party testing, research, and training opportunities. Multiple stakeholders (ID 04, 05, 07, 09, 08, 16) stressed that BAU could serve as a neutral validator of fortified products, enhance awareness through training and certification, and integrate fortification modules into its curriculum.

Other research institutions, including the Institute of Food Science and Technology, BCSIR (ID 01 & 10), the Bangladesh Institute of Nuclear Agriculture (BINA), and icddr,b, are engaged in fortification and nutrition research. However, participants highlighted the lack of need-based, evidence-driven studies and called for joint surveys, community-specific deficiency mapping, and shared analytical resources. Collaborative research, particularly on zinc and vitamin D deficiencies, could help update the existing fortification standards.

5.6.5 Consumers and Community Organizations

Consumer awareness and affordability remain significant barriers. According to private-sector stakeholders (ID 05 & 09), fortified flour costs 2 taka/kg more, limiting uptake among low-income households. Without subsidy programs, free distribution, and strong awareness campaigns, fortification will struggle to gain traction in the domestic market.

Community-based organizations (CBOs) and NGOs play a vital role in bridging this gap. By leveraging local cooperatives and contract farming networks (ID 05, 09), fortification awareness can be mainstreamed into rural nutrition and livelihood programs. CBOs require training on nutrition messaging, technical support for small-scale fortification, and advocacy tools to build consumer trust. Over time, positive consumer experiences and peer-to-peer promotion may create/facilitate the cultural shift necessary to sustain fortified food consumption.

5.6.6 Relative importance of different stakeholders

In Bangladesh's food fortification landscape, government agencies and the private sector are the most critical stakeholders: governments set the rules and enforce compliance, while industries implement fortification at scale. International organizations and academia play enabling roles, providing funding, technical support, training, and validation. Consumers and community groups, while less influential in policy or production, ultimately determine the demand and sustainability of fortified foods through their purchasing behavior and awareness levels.

Table 5.2 Relative importance of different stakeholders

Stakeholder Group	Importance	Contribution
Government & Regulators (BSTI, BFSA, MoFood, MoHWA, Ministry of Industry, BSCIC, Consumer Directorate)	🔴 **High**	Core authority for setting and enforcing standards. Without strict regulation, monitoring, and subsidies, fortification cannot scale.
International Orgs. & INGOs (WFP, GAIN, UNICEF, Technoserve, NI)	🟠 **Medium**	Provide technical support, funding, and global expertise. Their role is catalytic but sustainability depends on government uptake.
Academia & Research (BAU FFC, BCSIR, BINA, icddr,b)	🟠 **Medium**	Act as neutral validators, knowledge hubs, and trainers. Their role is growing, especially for independent testing and evidence-based policy advice.
Private Sector (IFAD, Pran-RFL, ACI, City Group, Premix suppliers)	🔴 **High**	Primary implementers producing fortified foods. Their investment and compliance decisions directly affect availability, affordability, and consumer trust.
Consumers & Community Organizations (Households, NGOs, CBOs)	🟢 **Supportive**	Final beneficiaries; uptake depends on affordability and awareness. Though not decision-makers, their acceptance is crucial for sustainability.

5.7 Service Charge Manual

This service-charge manual outlines the pricing structure for FFC's services, designed to cater to prospective recipients including food processors, millers, government agencies, NGOs, and academic institutions. The charges are set to ensure affordability, operational cost recovery, and sustainability.

5.7.1 Service Categories and Charges

FFC's services are categorized into analytical testing, training and capacity building, research and technical assistance, and certification/consultancy. The following tables detail charges, service descriptions, and estimated demand.

Analytical Testing Services

FFC will test 36,000-72,000 samples annually for micronutrient content, quality, and compliance in fortified foods (e.g., rice, wheat flour, oil, salt) and premixes, using advanced equipment (HPLC, GC-MS, AAS, PCR). Charges reflect sample complexity, equipment usage, and turnaround time.

Table 5.3 Annual demand for different services and estimated costs

Service	Description	Charge (BDT/ Sample)*	Turnaround Time	Estimated Annual Demand
Micronutrient Analysis (Basic)	Tests for single micronutrient using AAS or UV-Vis spectrophotometry	2000	3-5 days	1000
Micronutrient Analysis (Comprehensive)	Tests for multiple micronutrients using HPLC or AAS.	2000	5-7 days	1000
Premix Quality Testing	Verifies composition/stability of fortification premixes	20	5-7 days	5000
Proximate Analysis	Measures moisture, protein, fat, fiber, ash in food samples.	50	3-5 days	5000
Molecular Analysis	PCR-based tests for biofortified crops	40	7-10 days	500
Rush Analysis	Priority testing for any service above, with expedited results.	+50% base charge	1-2 days	500

***Subject to change with time**

Training and Capacity Building Services

FFC will train 500-1,000 stakeholders annually (e.g., processors, millers, regulators, health workers) to enhance fortification compliance and awareness, addressing gaps in industry capacity and consumer knowledge.

Table 5.4 Demand and estimated charge for training and capacity building services

Service	Description	Charge (BDT/Participant)*	Duration	Estimated Annual Demand
Basic Fortification Workshop	3-day training on fortification basics (e.g., premix handling, quality control) for millers/processors.	4,000	3 days	50
Advanced Technical Training	5-day course on analytical techniques (e.g., HPLC, AAS) for industry technicians/regulators.	6,000	5 days	50
Nutrition Education Program	2-day workshop for health workers/CBOs on fortified food benefits and advocacy.	2,000	2 days	100
Customized Training	Tailored programs for specific needs (e.g., rice fortification for WFP partners).	5,000	3-7 days	50
Online Short Course	10-hour virtual training on fortification standards/compliance.	1,000	2 weeks	50

- **Subject to change with time**

Research and Technical Assistance Services

FFC will provide research and technical support to develop fortification technologies, optimize processes, and inform policy, supporting 6-11 projects annually.

Table 5.5 Estimated demand and support for research project implementation

Service	Description	Charge (BDT/Project)	Duration	Estimated Annual Demand
Fortification Research	R&D on fortification methods	500,000-1,000,000	6-12 months	2-3 projects
Technical Consultancy	Process optimization for producers	200,000-500,000	1-3 months	3-5 projects
Market Analysis	Studies on fortified food demand/supply for industry/government.	300,000	2-4 months	2-3 projects

Certification and Consultancy Services

FFC will offer BAB-accredited certification and regulatory support to ensure compliance with national and international standards.

Table 5.6 Estimated annual demand and earning from certification and consultancy services

Service	Description	Charge (BDT/Service)	Duration	Estimated Annual Demand
Fortification Certification	BAB-accredited certification for fortified products	50,000/product	2-4 weeks	10
Compliance Audit	On-site audit of fortification processes for producers/millers.	100,000/facility	1-2 weeks	5
Policy Consultancy	Policy briefs for government/NGOs on fortification strategies.	200,000/brief	1-2 months	5

Payment Terms and Conditions

- Issued by FFC's Financial Officer, payable within 30 days via bank transfer to BAU's Accounts Office.
- 50% deposit required for projects >100,000 BDT or rush services.
- Discounts:
  - Bulk testing: 10-20% for >100 samples/month or annual contracts.
  - Training: 15-25% for groups >10, public sector, or NGOs.
  - Long-term clients: 10% for contracts >1 year.
- 2% monthly penalty for overdue invoices.
- Government/NGO clients may receive subsidized rates via grants (e.g., GAIN, MoHFW funding).
- Non-refunded for completed services; partial refunds (50%) for canceled projects with 7-day notice.

5.8 Financial Sustainability

This section estimates FFC's financial inflows (revenue and grants) and outflows (operational and capital costs) for the first five years.

5.8.1 Financial Inflows

FFC will serve food processors, millers, regulators, NGOs, and academia. Supported by government grants from the University Grants Commission as well as international partnerships, FFC projects total annual inflow of 72.54 million BDT, with different capacity in different years in resource use and revenue earning and full capacity by Year 5. The following table details the projected inflow sources.

Table 5.7 Estimated financial inflow and sources

Revenue Source	Estimated Annual Inflow(million BDT)				
Service Charges	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Analytical Testing	1.00	1.50	3.00	4.25	5.00

Training and Capacity Building	0	0.45	0.90	1.28	1.50
Research and Technical Assistance	0	6.00	12.00	17.00	20.00
Certification and Consultancy	0	0.12	0.24	0.34	0.40
International Partnerships					
Global Alliance for Improved Nutrition (GAIN)	1	1.50	3.00	4.25	5.00
BAU Internal Allocations					
Central Laboratory Resources	50.00				
Staff Salaries	8.30	22.97	25.33	29.32	35.64
Total	**60.3**	**34.04**	**47.47**	**60.69**	**72.54**

5.8.2 Financial Outflows

To establish and sustain its operations, the Centre for Excellence in Food Fortification (FFC) will incur both capital and operational expenditures, carefully planned to support its mission of enhancing food safety and nutrition. In Year 2, one-time capital costs for laboratory upgrades, facility renovations, IT infrastructure, and accreditation are estimated at 37 million BDT, funded by government grants and international partners. Ongoing operational costs, including staff salaries, equipment maintenance, consumables, training programs, administrative overheads, and outreach efforts, are projected at average 34 million BDT annually, with Year 1 slightly lower without considering the equipment that already available in the PMHCL (9 million BDT). The following table outlines FFC's expenditure plan to ensure efficient resource allocation and operational success.

Table 5.8 Estimated financial outflow and sources

Expenditure Category	**Estimated Outflow (million BDT)**				
Capital Expenditures	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Laboratory Upgrades		20			
Facility Renovation		10			
IT Infrastructure		5			
Initial Training and Accreditation		2			
Operational Expenditures					
Staff Salaries	8.30	22.97	25.33	29.32	35.64
Equipment Maintenance	0.03	1.25	2.50	3.75	4.00
Consumables	0.38	1.25	2.50	3.75	4.00
Training Programs	0.00	0.75	1.50	2.25	1.92
Administrative Overheads	0.00	0.75	1.50	2.25	2.40
Marketing and Outreach	0.00	0.50	1.00	1.50	1.60
Office space rent	0.96	0.96	0.96	0.96	0.77
Utilities	0.24	0.24	0.24	0.24	0.19
Sub Total	**9.91**	**65.67**	**35.53**	**44.02**	**50.52**

5.8.3 Financial Projections

FFC's financial projections outline inflows and operational outflows. The table and figures summarize a project's financials over five years including Fixed Costs, Operating Costs, Revenue and Benefit-Cost Ratios (BCR) for operating and cash costs (cash costs include Equipment Maintenance, Consumables, Training Programs, Administrative Overheads, and Marketing and Outreach). Fixed Costs are incurred only in the first two years, then drop to zero, indicating early capital investments. Operating Costs rise steadily, while revenue grows significantly. The BCR (Operating Cost Basis) improves from 0.20 to 0.63 but remains below 1, showing the project isn't yet profitable overall. The BCR (Cash Cost Basis) ranges from high to moderate values, indicating revenue consistently exceeds these specific costs.

Table 5.9 Financial Projection over five-year period

Category	Estimated Amount (million BDT)				
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Fixed cost	50.00	37.00	0.00	0.00	0.00
Operating cost	9.91	28.67	35.53	44.02	50.52
Revenue	2.00	9.57	19.14	27.12	31.90
BCR (Operating Cost Basis)	0.20	0.33	0.54	0.62	0.63
BCR (Cash Cost basis except salary)	4.94	2.13	2.13	2.01	2.29

Cash costs, derived from the BCR (Cash Cost Basis), are a small fraction of operating costs, explaining the higher BCR values. The project is efficient on a cash cost basis, as revenue surpasses these costs, but high operating costs prevent full profitability. The upward BCR trend suggests potential for future profitability if revenue growth continues to outpace operating costs.

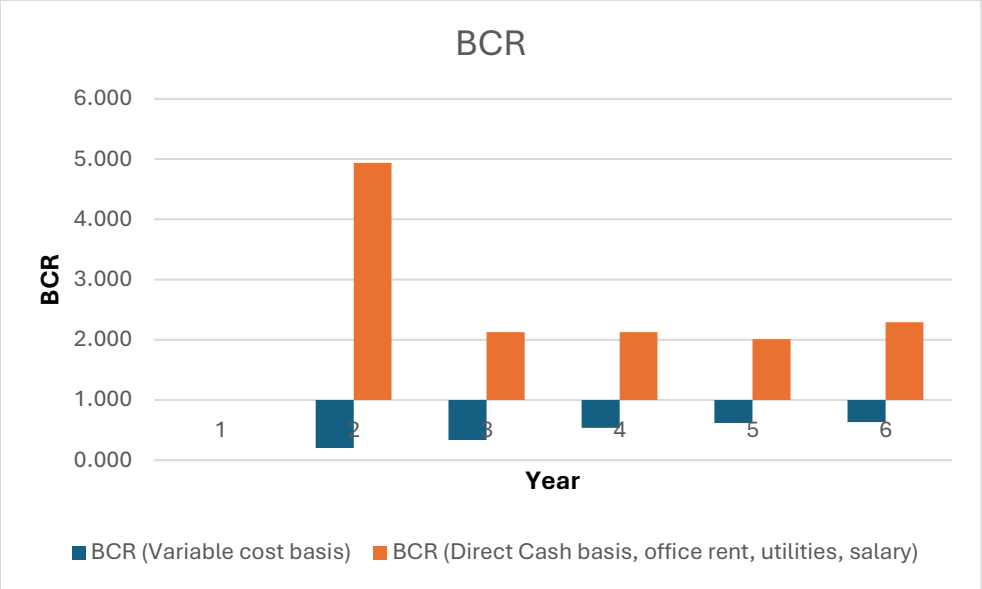


Figure 5.1 Estimated BCR overtime

5.9 Environmental/Waste Management

FFC's operations will generate chemical, biological, and solid waste. Effective environmental and waste management is critical to ensure compliance with Bangladesh's Environmental Conservation Rules (2023), minimize ecological impact, and maintain a safe working environment. This section outlines FFC's waste management strategy, including waste identification, handling, disposal, and monitoring, leveraging BAU's infrastructure and aligning with national and international standards.

5.9.1 Waste Generation and Classification

FFC's operations will produce various waste types due to expanded testing and research activities, scaling from the Central Laboratory's current capacity. Estimated annual waste generation includes:

- **Chemical Waste**: 1,000-2,000 liters of liquid waste (e.g., solvents, reagents like acetonitrile, methanol used in HPLC) and 50-100 kg of solid chemical waste (e.g., contaminated containers) from micronutrient and proximate analyses.
- **Biological Waste**: 200-500 kg of biological samples (e.g., food, plant tissue from biofortification research) and 50-100 kg of biohazardous waste (e.g., microbial cultures from PCR-based testing).
- **Solid Waste**: 500-1,000 kg of general waste (e.g., packaging, paper, plastic) from laboratory operations and training programs (300-500 participants/year).

- **Hazardous Waste**: 100-200 kg of mixed hazardous waste (e.g., sharps, contaminated PPE) from sample preparation and equipment maintenance.

These estimates are based on a tenfold increase in sample processing (20,000-40,000 samples) and align with typical waste outputs from analytical laboratories handling food and molecular testing.

5.9.2 Waste Management Strategy

FFC's waste management plan adheres to Bangladesh's Environmental Conservation Rules (2023), WHO laboratory safety guidelines, and BAU's existing protocols, ensuring environmental protection and worker safety.

1. Waste Segregation and Storage

Segregation at Source: Waste is categorized at the point of generation using color-coded bins:

- **Red Bins**: Hazardous chemical waste (e.g., solvents, reagents).
- **Yellow Bins**: Biological and biohazardous waste (e.g., food samples, microbial cultures).
- **Blue Bins**: Recyclable solid waste (e.g., paper, plastic).
- **Black Bins**: Non-recyclable general waste.

Storage Facilities: FFC will utilize a dedicated 500-square-foot waste storage area within the Central Laboratory's 10,000-square-foot facility, equipped with:

- Leak-proof, labeled containers for chemical waste, stored in ventilated cabinets.
- Autoclavable biohazard bags for biological waste, stored in refrigerated units (4°C) to prevent decomposition.
- Secure bins for solid waste, segregated for recycling and disposal.
- **Standard Operating Procedures (SOPs)**: Technicians (10 full-time, 8 part-time) follow SOPs for segregation, updated from the Central Laboratory's protocols (Operational Guidance), ensuring compliance with environmental regulations.

5.9.3 Waste Handling and Treatment

Chemical Waste:

- **Neutralization**: Acidic/basic reagents are neutralized on-site using pH buffers in a designated fume hood, reducing 50% of liquid waste volume.

- **Recycling**: Solvents (e.g., methanol) are distilled for reuse where feasible, recovering 20-30% of chemical waste.
- **Storage**: Remaining chemical waste is stored in sealed drums, labeled with hazard details, and transferred monthly to licensed vendors.

Biological Waste:

- **Autoclaving**: Biological samples and biohazardous waste are autoclaved at 121°C for 30 minutes to sterilize, reducing 90% of biohazard risks.
- **Incineration**: Sterilized waste is incinerated off-site by licensed vendors, ensuring no environmental release of pathogens.

Solid Waste:

- **Recycling**: 60-70% of solid waste (e.g., paper, plastic) is sent to BAU's recycling partners, aligned with campus sustainability initiatives.
- **Landfill**: Non-recyclable waste is disposed of at municipal landfills via BAU's waste management contractor.
- **Hazardous Waste**: Sharps and contaminated PPE are collected in puncture-proof containers and incinerated off-site, following WHO guidelines.

Waste Disposal

- **Licensed Vendors**: FFC will contract licensed waste management vendors (e.g., PRISM Bangladesh, approved by the Department of Environment) for monthly collection and disposal of chemical, biological, and hazardous waste, costing 2-3 million BDT/year.
- **Municipal Coordination**: General and recyclable waste is managed through BAU's existing partnership with Mymensingh City Corporation, leveraging the campus's waste disposal framework.
- **Documentation**: Disposal records are maintained digitally, audited quarterly by FFC's Quality Control Officer to ensure compliance with Environmental Conservation Rules (2023).

Safety and Training

- **Staff Training**: 24 staff (12 full-time, 12 part-time) receive annual training on waste handling, PPE use, and spill response, costing 0.5-1 million BDT/year.

Training is integrated into FFC's capacity-building programs (Service Charge Manual).

- **Safety Equipment**: FFC will install 5 additional fume hoods, 10 spill kits, and 20 PPE sets (gloves, masks, gowns), costing 1-2 million BDT in Year 1, funded by UGC grants.
- **Emergency Protocols**: SOPs for chemical spills and biohazard incidents, adapted from WHO guidelines, are enforced, with drills conducted biannually.

Environmental Monitoring and Compliance

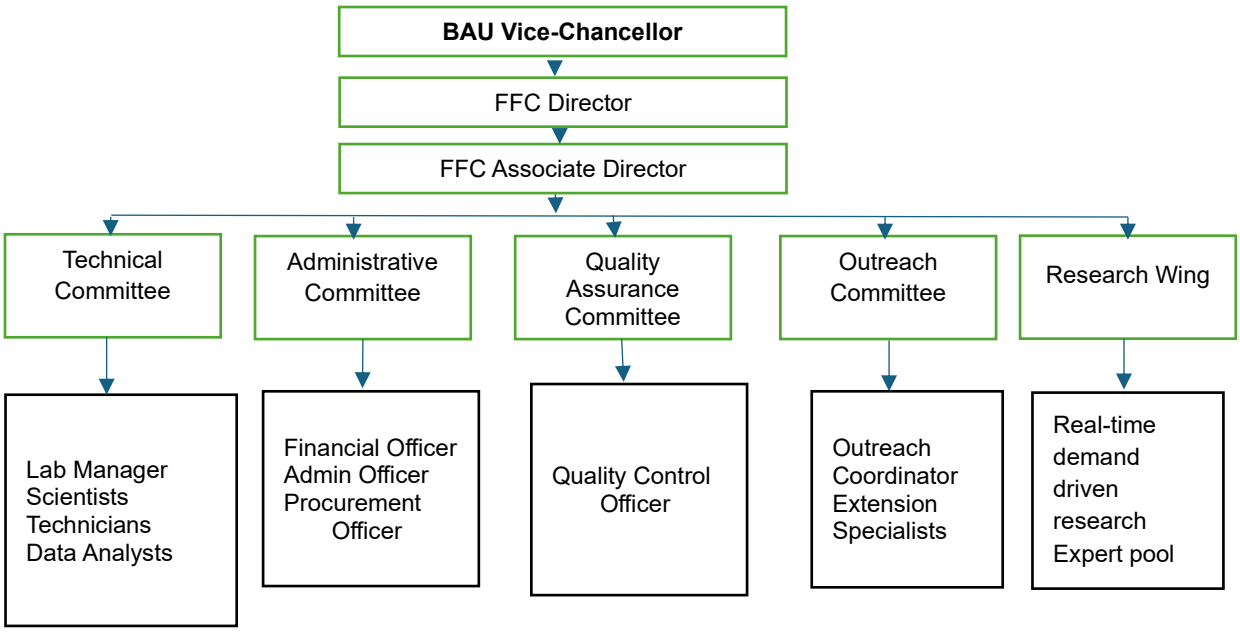
- **Internal Audits**: The Quality Control Officer conducts monthly waste management audits, ensuring segregation and disposal compliance, with reports submitted to BAURES.
- **Regulatory Compliance**: FFC will obtain an Environmental Clearance Certificate from the Department of Environment within 12 months, aligning with BAB accreditation goals.
- **Effluent Monitoring**: Wastewater from laboratory processes is treated via BAU's effluent treatment plant (ETP), ensuring no release of untreated chemicals into local water systems.
- **Sustainability Metrics**: FFC will track waste reduction (target: 20% reduction in chemical waste via recycling by Year 3) and recycling rates (target: 70% of solid waste), reported annually to stakeholders.

6.0 Proposed Governance System

A governance system is essential to ensure operational efficiency, financial sustainability, and stakeholder alignment within the 170-250 billion BDT fortified food market. This section proposes FFC's governance structure, including an organogram, duties, and responsibilities, aligned with BAU's statutes.

6.1 Proposed Organogram

FFC's governance structure integrates academic, technical, and administrative roles, with oversight from BAU's leadership. The organogram reflects a lean hierarchy to manage 24 staff (12 full-time, 12 part-time) and ensure scalability.



6.2 Organizational Structure and Responsibilities

6.2.1 Oversight Level

The BAU Vice-Chancellor serves as the Chief Executive Officer of Bangladesh Agricultural University (BAU) and ensures the Food Fortification Center (FFC) aligns strategically with BAU's mission. The Vice-Chancellor approves FFC's annual budget and major policy decisions, represents FFC in national and international and ensures compliance with BAU statutes. The BAURES Director, as head of BAU's research system supervises FFC's research projects, facilitates grant, coordinate interdisciplinary collaboration, review quarterly performance reports, and ensure alignment with research priorities.

6.2.2 Executive Level

The FFC Director is the operational and academic leader of FFC, reporting to the Vice-Chancellor. They oversee FFC's operations, including sample testing, training programs, and product certifications. The Director chairs the Technical, Administrative, Quality, and Outreach Committees, represents FFC in stakeholder consultations, approves budgets and staffing decisions.

6.2.3 Operational Committees

Technical Committee

The technical committee oversees laboratory operations, equipment maintenance, and supervises technicians and scientists to ensure compliance with standard operating

procedures (SOPs). Scientists conduct micronutrient analyses, develop fortification technologies, train industry stakeholders, and publish research papers. Full-time and part-time technicians perform sample preparation and testing, maintain equipment, handle chemical and biological waste as per SOPs, log samples in FFC's database, report equipment issues to the lab manager, and undergo annual waste management training. Data analysts analyze testing data, develop stakeholder dashboards, ensure GDPR-compliant data storage, deliver compliance reports per the service charge manual, and train staff on data management tools annually.

Administrative Committee

The administrative committee includes the financial officer who manages FFC's budget, processes invoices, and ensures audit compliance. The administrative officer manages facility logistics such as waste storage and laboratory space, ensures facility safety with equipment and reports operational issues to the FFC Director monthly. The procurement officer procures reagents, consumables and equipment. He also manages vendor relationships for waste disposal, lab supplies, maintains inventory, and submits quarterly procurement reports to the financial officer.

Quality Committee

The quality committee conducts monthly audits of testing, waste management, and SOP compliance. He also develops quality assurance protocols for product certifications. The officer ensures full compliance with WHO lab safety and Codex Alimentarius standards, reports audit findings to the FFC Director. In addition, he trains staff in quality standards to maintain high operational integrity.

Outreach Committee

The outreach committee coordinates industry workshops for stakeholders and builds partnerships with organizations. They develop marketing materials for FFC's services and report outreach metrics, such as campaign reach, to the FFC Director quarterly. Full-time and part-time extension specialists deliver training to community-based organizations and collect stakeholder feedback for service improvements, and support consumer acceptability studies for fortified foods.

Research Wing

A dedicated Research Wing is established as a core operational unit of FFC, following recommendations from the validation workshop with government, private-sector, and technical experts. Headed by a Senior Research Coordinator (reporting directly to the FFC Director) and supported by full-time research scientists, postdoctoral fellows, and an Expert Pool of food

fortification specialists drawn from academia, relevant ministries (MoInd, MoFood, MoHFW, BFSA, BSTI), and development partners (GAIN, WFP, UNICEF, Nutrition International), the Wing will focus on generating high-quality, demand-driven evidence to strengthen national food fortification policies. Its key functions include conducting micronutrient deficiency mapping, dose-response and efficacy studies, stability and bioavailability trials, cost-effectiveness analyses, and consumer acceptability research; providing scientific justification for updating or introducing fortification standards (e.g., rice, wheat flour, oil, salt, and emerging vehicles); supporting evidence-based and region-specific policy formulation; and facilitating rapid response to emerging policy questions from regulators and industry. The Wing will collaborate closely with the Technical Committee for laboratory-based validation and with the Outreach Committee for dissemination of findings through policy briefs, peer-reviewed publications, and stakeholder workshops. By institutionalizing an independent, multi-stakeholder Expert Pool, the Research Wing ensures that all evidence remains scientifically robust, locally relevant, and free from sectoral bias, thereby enhancing FFC's credibility as the national knowledge hub for food fortification.

6.3 Income/Earnings Distribution Mechanism

This section proposes a mechanism to allocate FFC's earnings and FFC's strategic objectives, including break-even by Year 2-3 and reinvestment for growth.

6.3.1 Proposed Distribution Mechanism

The income distribution mechanism allocates earnings across operational costs, partner returns, BAU contributions, and reinvestment. The mechanism is managed by FFC's Financial Officer, overseen by the FFC Director.

Operational Cost Coverage

The Food Fortification Center (FFC) allocates 60-70% of its annual income to cover recurring expenses, ensuring operational continuity. This includes funding for staff salaries, equipment maintenance involving weekly checks and annual calibrations, and consumables such as reagents and supplies essential for laboratory operations. Additionally, this budget covers waste management for the disposal of chemicals, training programs, and administrative overheads which account for approximately 10% of the budget.

BAU Contribution

To support shared infrastructure and institutional sustainability, FFC allocates 10-15% of its total income to BAU. This contribution funds the Central Laboratory for shared

equipment and staff cover administrative fees, which constitute approximately 10% of the budget.

Reinvestment and Surplus

FFC reserves 20-30% of its income for reinvestment and surplus to drive growth and sustainability. This allocation supports equipment upgrades to enhance testing capacity by 20-30%. Research expansion enhances consumer outreach to increase demand for fortified foods among households, and training scale-up to address industry skill gaps by training additional stakeholders by Year 5.

Table 6.1 Distribution Breakdown of requirement investment

Category	Allocation (% of Income)	Amount (BDT Million/Year)	Source	Disbursement
Operational Costs	60-70%	42-65	Service Revenue, Government Grants	Monthly/Quarterly
BAU Contribution	10-15%	10-33	Service Revenue, Grants	Semi-Annually
Reinvestment/Surplus	20-30%	20-66	Service Revenue, International Grants	Annually

Based on the current operational setup, projected financial inflows, strategic planning, and institutional support from BAU and external partners, FFC is expected to achieve full sustainability by Year 3–4 of its establishment.

6.4 Phased Development Plan

To ensure a structured transition toward independence, FFC's development will follow a phased approach:

Table 6.2 Phase development plan

Year	Objective	Key Activities	Financial Outlook	Sustainability Status
Year 1: Establishment and Capacity Building	Establish infrastructure, recruit key personnel, procure essential equipment, and initiate baseline operations.	- Finalize governance framework. - Recruit core technical and managerial staff. - Procure laboratory for analytical testing. - Begin analytical testing of fortified food samples. - Launch pilot training programs for millers, processors, and regulators.	High reliance on initial grants and internal BAU allocations.	Not yet financially independent; relies heavily on startup funding and institutional support.
Year 2: Operational Expansion and	Scale up operations, expand service offerings, and	- Increase sample testing capacity to 5,000–10,000 annually. - Expand training programs to 100–300 participants annually.	Revenue generation begins to offset	Partially self-sustaining; still reliant on grant top-ups for

Year	Objective	Key Activities	Financial Outlook	Sustainability Status
Revenue Generation	begin generating significant revenue.	- Initiate research collaborations with national and international institutions. - Formalize certification services for fortified foods and premixes..	operational costs (~50% cost recovery).	capital investments.
Year 3: Financial Break-Even and Institutional Strengthening	Achieve break-even point where revenue covers operational and maintenance costs.	- Reach full operational capacity: 10,000–15,000 samples tested annually. - Train 300–500 stakeholders annually. - Generate significant revenue through diversified streams (testing, training, research, and certification). - Reinforce governance system and quality assurance protocols for BAB accreditation. - Develop partnerships with private sector and international agencies.	Expected to reach break-even or near-surplus status.	Financially viable and operationally independent; minimal dependency on external grants.
Year 4–5: Full Sustainability and Market Integration	Consolidate FFC's position as a leading national hub for food fortification.	- Expand outreach through regional collaboration. - Reinvest surplus funds into innovation and infrastructure upgrades.	Surplus revenue supports reinvestment in growth initiatives.	Fully independent, financially sustainable, and integrated into the national nutrition and food safety ecosystem.

6.4.1 Key Enablers for Timely Sustainability

- Ensures transparent decision-making, accountability, and efficient resource allocation.
- Service fees, grants, training, and research contracts reduce dependency on single sources.
- Collaboration with private companies, NGOs, and global organizations ensures market relevance and funding stability.
- Pursuit of BAB and ISO certifications enhances credibility and attracts premium clients.
- Availability of trained scientists, technicians, and administrative staff ensures high-quality output and service delivery.

6.4.2 Challenges in Establishing FFC

The establishment of the Centre of Excellence for Food Fortification (FFC) at BAU) presents a promising opportunity to address widespread micronutrient deficiencies through analytical testing, research, training, and certification. However, the journey toward setting up a sustainable, and impactful institution is not without challenges. The

following outlines key challenges across legal, operational, institutional, and conflict-of-interest domains:

Legal Challenges

- FFC must obtain accreditation from the Bangladesh Accreditation Board (BAB) and align with international standards like ISO/IEC 17025, which require rigorous documentation, standard operating procedures (SOPs), and quality assurance systems.
- Delays in BAB recognition could hinder its ability to offer legally recognized testing services, affecting client trust and revenue generation.
- Collaborative research with private sector partners may lead to disputes over ownership of data, formulations, or innovations.
- Lack of clear policies on intellectual property rights may deter industry participation or create legal ambiguities.
- FFC's laboratory operations involve handling hazardous chemicals, requiring licenses from multiple regulatory bodies such as the Department of Environment (DoE) and Fire Service & Civil Defence.
- Non-compliance or delays in obtaining these permits can stall lab operations and sample testing.

Operational Challenges

- While BAU Central Laboratory provides a foundational infrastructure, scaling operations to handle 10,000–15,000 samples/year will require significant upgrades in laboratory space, equipment, and waste management systems.
- Procurement delays due to bureaucratic processes or budget constraints can delay service rollouts.
- Increased testing volume leads to higher chemical and biological waste generation, necessitating a compliant effluent treatment system.
- Contractual arrangements with certified waste vendors are essential but may face logistical or cost barriers.
- Ensuring timely delivery of test results (within 3–7 days per Service Charge Manual) requires efficient workflow management, skilled manpower, and advanced data systems.
- Inadequate staffing or poor coordination between departments may lead to bottlenecks.

Institutional Challenges

- Delayed approvals for hiring, procurement, or financial decisions could hamper operational agility.
- Attracting and retaining qualified scientists, technicians, and administrative staff with expertise in food chemistry, nutrition, and quality control is crucial.
- Competitive salaries and career growth opportunities may be limited compared to private sector labs, leading to high turnover.
- Effective collaboration with ministries, NGOs, and private companies is necessary for policy alignment, market access, and funding.
- Differing priorities among stakeholders may result in misalignment of objectives or duplication of efforts.

6.5 Conflict of Interest Challenges

- Faculty members involved in both academic duties and FFC operations may face conflicts in time allocation, resource utilization, and prioritization of responsibilities.
- This dual role may also raise concerns about impartiality in research findings or consultancy services offered by faculty.
- Private sector partners might seek preferential treatment in research outcomes or pricing, undermining the center's credibility.
- International donors or agencies providing grants may exert influence on research directions or policy advocacy, potentially compromising scientific independence.
- Transparent governance mechanisms are needed to ensure that external funding does not distort FFC's public health mission.

6.6 Risk Mitigation Strategies

Establishing the Centre of Excellence for Food Fortification (FFC) at BAU involves navigating various risks across legal, operational, institutional, and financial domains. To ensure long-term success and minimize disruptions, FFC must implement a comprehensive risk mitigation framework. The following strategies are designed to address key vulnerabilities identified during the feasibility study:

6.6.1 Legal Risk Mitigation

- Initiate early engagement with the Bangladesh Accreditation Board (BAB)
- Allocate dedicated staff for documentation and SOP development.
- Develop clear IP-sharing agreements with research partners and private sector collaborators.

- Ensure full alignment with Bangladesh Environmental Conservation Rules (2023).
- Submit all required documentation in advance to relevant authorities.
- Maintain safety protocols and staff training programs to expedite approvals.

6.6.2 Operational Risk Mitigation

- Secure advance funding from UGC, GAIN, and WFP for lab upgrades.
- Prioritize procurement through pre-approved vendors.
- Implement a color-coded waste segregation system.
- Contract certified waste management services.
- Train staff regularly handle hazardous materials.
- Adopt digital workflow systems (e.g., LIMS – Laboratory Information Management System).
- Standardize testing procedures to improve efficiency.
- Maintain buffer stock of critical supplies.
- Develop relationships with multiple local and international suppliers, explore domestic alternatives where possible.

6.6.3 Institutional Risk Mitigation

- Secure advance approval for key processes such as hiring and procurement.
- Offer competitive stipends and performance-based incentives.
- Leverage BAU's large student pool for part-time staffing needs.
- Hold quarterly coordination meetings with ministries, NGOs, and private sector partners.
- Create cross-functional teams linking FFC with BAU faculties.
- Promote joint research projects and shared resources.

6.6.4 Financial Risk Mitigation

- Diversify income streams (testing, training, consultancy, grants).
- Maintain a contingency fund (5–10% of annual budget).
- Secure multi-year funding commitments from donors and government agencies.
- Launch targeted marketing campaigns to attract millers, processors, and regulators.
- Offer subsidized rates for small-scale producers.
- Monitor expenditure monthly and adjust allocations as needed.
- Source equipment and reagents locally were feasible.

- Hedge against currency risks where possible.

6.6.5 Conflict of Interest Risk Mitigation

- Clearly separate academic and FFC roles, and establish time allocation policies.
- Implement a transparent peer-review process for research outputs.
- Define revenue-sharing mechanisms in partnership agreements.
- Involve neutral third parties for dispute resolution if necessary.
- Maintain donor independence by diversifying funding sources.
- Adopt a policy of transparency in funding and reporting.
- Align research priorities with national public health goals.

6.5.6 Technical & Quality Assurance Risks

- Use secure cloud-based data storage systems compliant with GDPR standards.
- Calibrate instruments regularly.
- Invest in continuous training and capacity building.
- Collaborate with international institutions for knowledge transfer.
- Incentivize skill certifications.

7.0 Sustainability of FFC: Reflection from the Expert

The proposed Food Fortification Center (FFC) at Bangladesh Agricultural University (BAU) demonstrates a strong foundation for sustainability, though its long-term success depends on strategic investments, stakeholder collaboration, and overcoming systemic impediments. The sustainability of FFC can be better understood by applying measurable indicators across the five domains of the 5 I's framework—Institutional, Investment, Implementation, Integrity, and Impediments.

7.1 Institutional Sustainability

The institutional sustainability is assessed based on five measuring indicators. The BAU Central Laboratory already possesses advanced infrastructure and technical expertise, and stakeholders widely recognize FFC's potential role as a neutral knowledge hub and third-party validation body (Figure 7.1). Participants from both public (ID 02,; ID 03) and private sectors (ID 04; ID 05) endorsed FFC as a credible consortium platform capable of bridging gaps in governance, research, and monitoring. With appropriate accreditation and staff expansion, FFC can become a nationally recognized hub, ensuring evidence-

based fortification standards and stronger public-private-academia linkages. Participants consistently highlighted high costs of premixes and fortification machinery as barriers (ID 05; ID 09,). Testing fees in private labs are also prohibitive, making BAU's subsidized services an attractive alternative (ID 08). While FFC may initially rely on BAU subsidies and donor support, gradual income diversification through testing, training, and consultancy is viable. Private firms noted the need for government subsidies to equalize prices of fortified and non-fortified products (Participant 05, Pran; Participant 04,). Donor organizations (GAIN, NI, WFP) already fund premix imports and training programs. Long-term grants and public-private partnerships were identified as critical for sustainability (Participant 06, WFP). The investment domain is moderately strong. Sustainability requires balancing welfare-oriented subsidies with pathways to commercial viability.

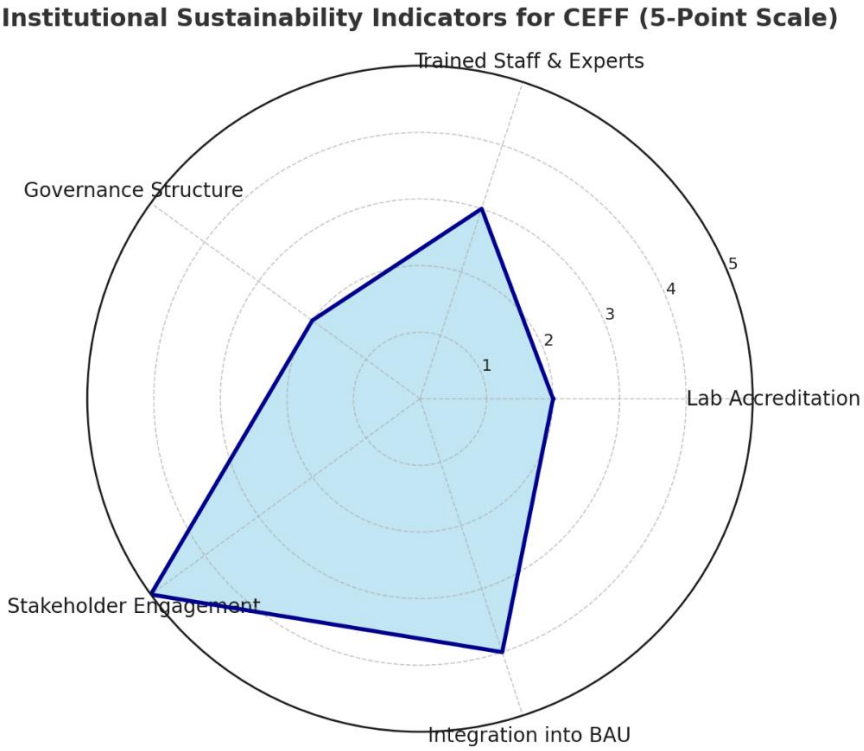


Figure 7.1 Institutional strength based on five indicators

7.2 Investment Perspective

Investment sustainability is moderately strong but requires careful planning. Stakeholders repeatedly highlighted high costs of premix, fortification machinery, and testing fees as barriers (ID 05; ID 09,). However, donor organizations (GAIN, NI, WFP,

Technoserve) and government subsidies already play pivotal roles in subsidizing costs and financing laboratory operations. FFC's long-term viability will depend on diversifying revenue through testing services, training, consultancy, and international collaborations, while leveraging donor and public support during its formative years. FFC could pioneer prototyping, validation, and cross-validation of fortified products. WFP emphasized the importance of training and ring tests for laboratory validation (ID 06,). Stakeholders recommended phased rollout—beginning with rice and wheat, later expanding to oil and salt (Expert 08). IFAD stressed diversification of lab services for sustainability (ID 04). Monitoring weaknesses in packaging and storage were identified as critical (Expert ID 03). Nutrient loss in open oil is particularly concerning, with only 7% of samples meeting vitamin A standards. Implementation feasibility is moderate; structured training, phased piloting, and logistics management will be crucial for scaling FFC operations.

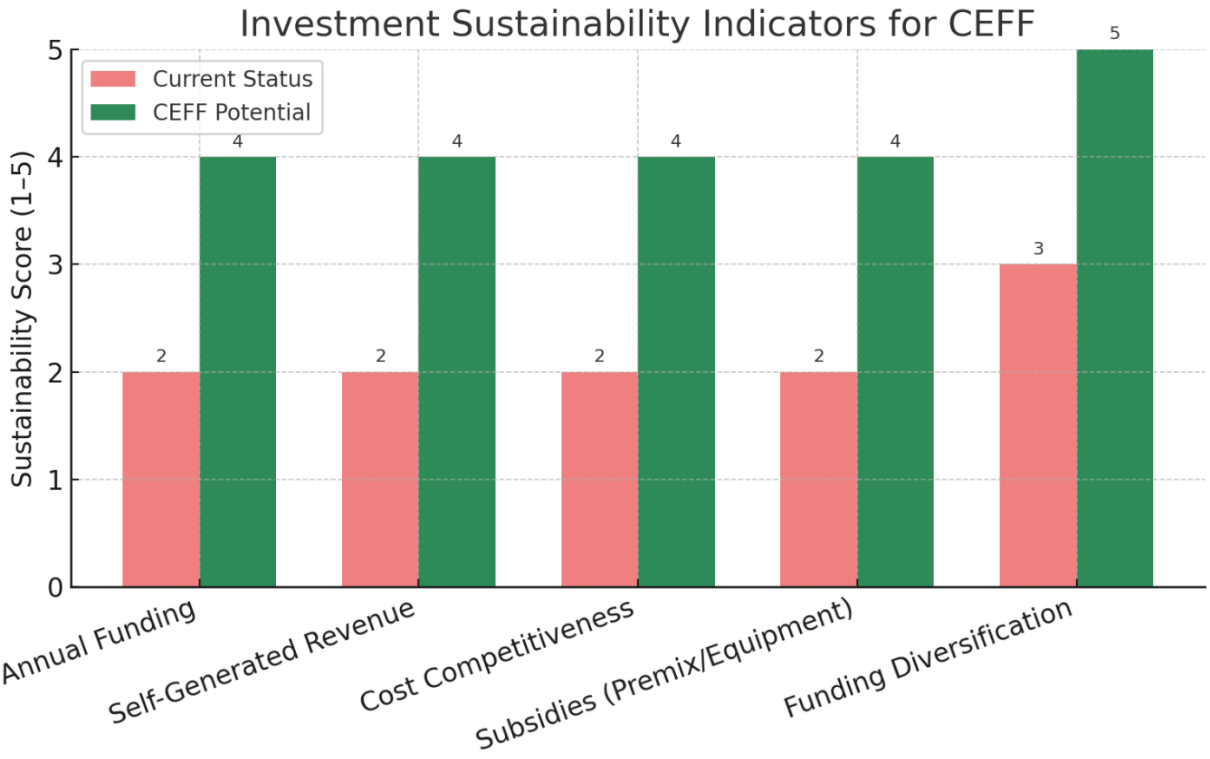


Figure 7.2 Current status and FFC potential for investment sustainability

7.3 Implementation Feasibility

The implementation status is promising but gradual. Stakeholders emphasized the need for phased expansion, beginning with rice and wheat, followed by oil and salt fortification (ID 06; ID 08). BAU's existing facilities and expertise allow for product validation, curriculum integration, and training modules that would enhance the

fortification ecosystem. However, operational efficiency and logistics—particularly packaging, storage, and nutrient retention—require focused attention (ID 03).

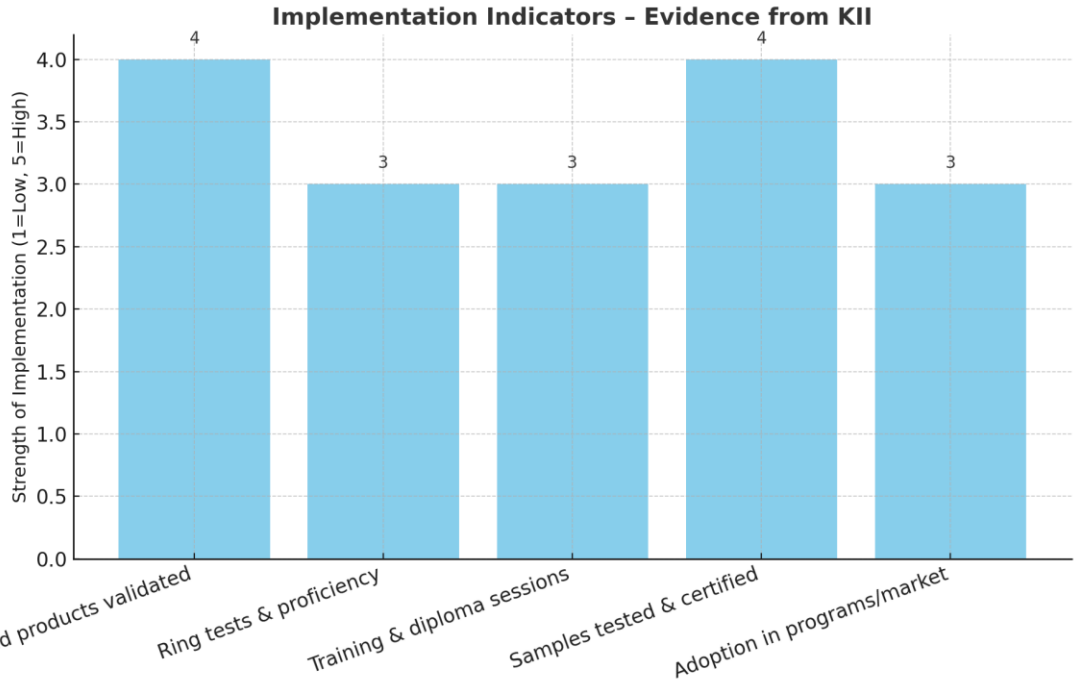


Figure 7.3 Implementation strength based on five indicators

7.4 Integrity

Integrity remains a moderate domain. While Bangladesh has mandatory laws for salt and oil fortification, outdated standards for rice and wheat, often borrowed from other countries, undermine credibility (ID 01). Ethical concerns—especially regarding over-fortification and uneven nutrient needs across regions—further highlight the need for FFC to act as a scientific watchdog. By ensuring premix testing, transparent validation, and location-specific fortification strategies, FFC can build trust and legitimacy in the national fortification landscape. Current standards are outdated (wheat standard: 2008) and often adopted from other countries without local adaptation (Participant 01, BCSIR). FFC can play a role in revising evidence-based standards in partnership with BSTI. Participants warned of over-fortification risks, particularly iodine and vitamin D, in regions where deficiencies are not uniform (Participant 01, BCSIR). They also stressed the need for premix testing and long-term monitoring of human health outcomes (Participant 10, BCSIR). FFC could ensure transparent validation of premix, enforce SOPs, and establish location-specific dosage standards to prevent nutrient overdose. Integrity is moderately strong, but sustainability requires FFC to act as a scientific watchdog ensuring evidence-based, ethical fortification.

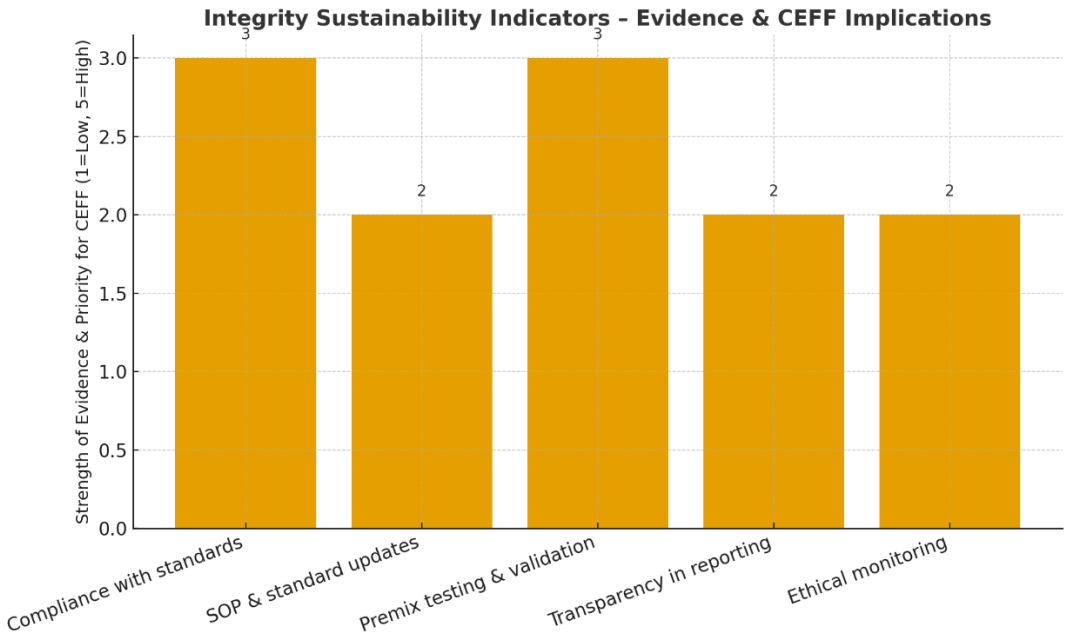


Figure 7.4 Integrity strength based on five indicators

7.5 Impediments

Participants emphasized systemic weaknesses including low consumer awareness, high production costs, weak regulatory enforcement, and limited monitoring capacity (ID 05; ID 02,). Without strong demand creation, private companies face financial risks in scaling fortification, and policy decisions remain vulnerable to political rather than scientific influence. Addressing these barriers will require a national communication strategy, targeted subsidies, policy reforms, and increased monitoring capacity—areas where FFC can play a catalytic role. Lack of public understanding and willingness to pay for fortified products remains the single largest barrier (Participant 05; Participant 09). Decision-making is often political, with limited scientific input, leading to generalized standards that ignore local needs (Participant 01). Private companies face significant risk of financial losses due to low demand and high costs (Participant 04, IFAD; Participant 05, Pran). Weak enforcement capacity and limited accredited laboratories exacerbate risks (Participant 03; Participant 02,). Impediments remain the weakest domain. Overcoming these requires targeted awareness campaigns, subsidies, updated standards, and stronger monitoring frameworks. The bar diagram illustrates the strength of positive enablers that influence the sustainability of food fortification efforts in Bangladesh, reframed from the impediment perspective. Each bar represents how strongly these factors are currently performing, on a scale of 1 (low) to 5 (high).

- Consumer demand and cost efficiency of fortification scored the lowest, reflecting weak market uptake and high production costs. This indicates that despite export opportunities, local consumer acceptance and affordability remain critical challenges.
- Regulatory enforcement strength and laboratory & manpower capacity received mid-level scores, showing partial progress but highlighting the need for stricter monitoring and improved technical manpower to ensure compliance with fortification standards.
- Updated standards & SOPs also sit at a moderate level, suggesting that although some progress has been made (e.g., the 2021 update of salt standards), many fortification standards remain outdated.
- Awareness & education show similar mid-level strength, reflecting government and NGO efforts in awareness-building, yet consumer understanding and acceptance of fortified products are still limited.

Overall, the graph highlights that while enabling structures such as regulation, standards, and labs exist, they are not yet strong enough to overcome consumer-side barriers like low demand and cost inefficiency. For FFC, this means prioritizing demand creation, awareness campaigns, and advocacy for cost-reducing policies alongside capacity strengthening.

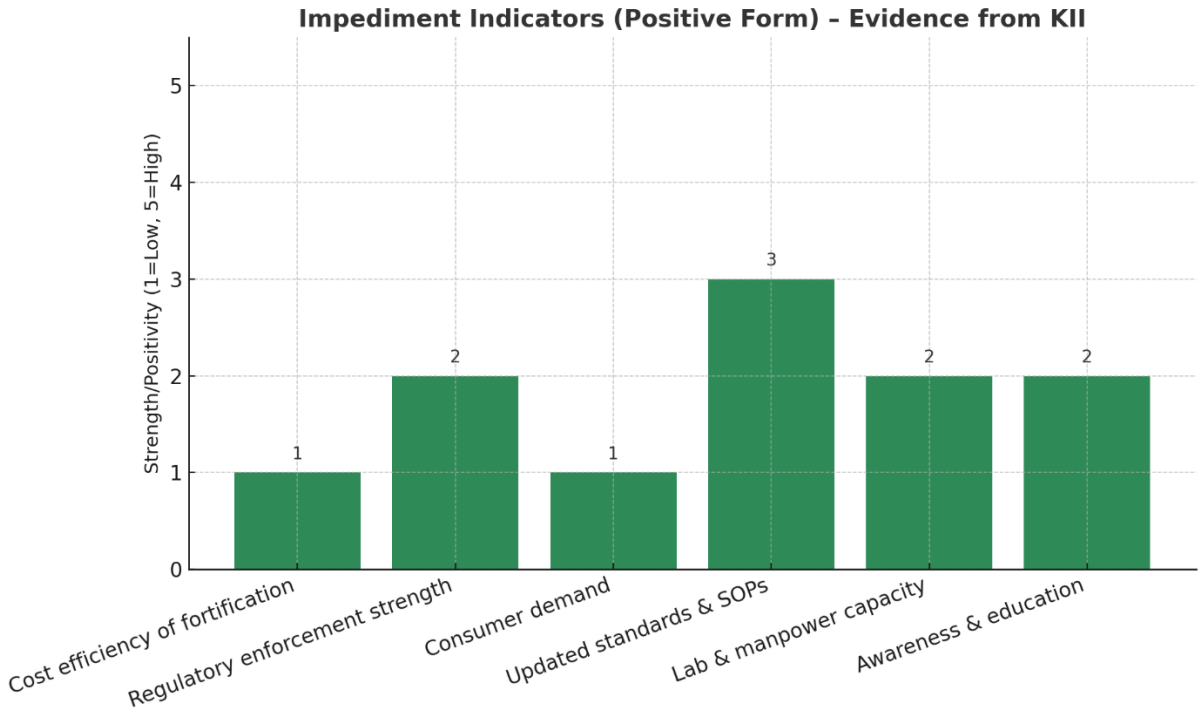


Figure 7.5 Impediments strength based on six indicators

Overall sustainability status is presented in Figure 7.6 which illustrates the relative strengths across domains, with Institutional capacity emerging as the strongest, while Impediments remain the weakest. FFC demonstrates high institutional readiness (4/5), moderate investment, implementation, and integrity (3/5 each), and weak performance in overcoming impediments (2/5). Its sustainability therefore depends not only on BAU's technical and institutional strengths but also on multi-stakeholder partnerships, long-term donor and government support, and a deliberate strategy to build public trust and market demand. If these conditions are met, FFC can evolve into a regional leader in fortification, significantly improving nutrition security in Bangladesh over the next three decades.

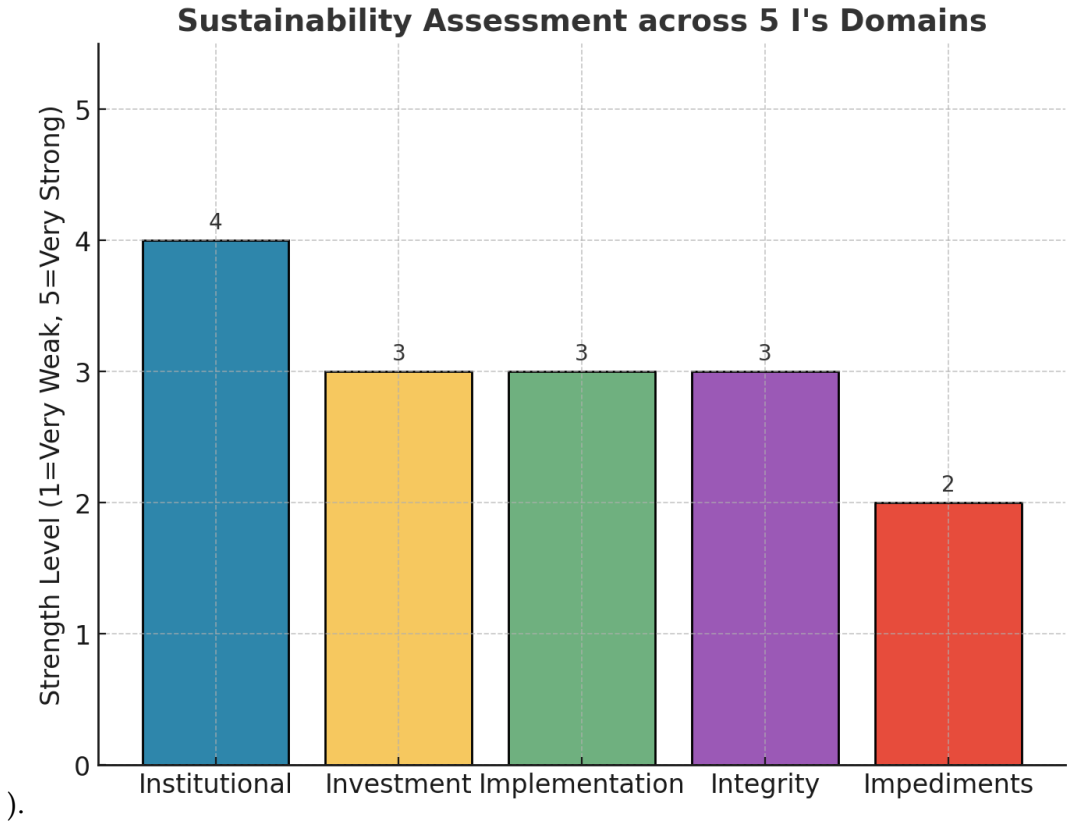


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Figure 7.6. Sustainability assessment of FFC across the 5 I's domains

7.7 Sustainability Indicators wise Achievement

Table 7.1 shows the consolidates both indicators and the current status of achievements, drawing on BAU's existing capacity, stakeholder consultations, and participant feedback.

Institutionally, FFC demonstrates a relatively strong base. The BAU Central Laboratory is equipped with advanced testing facilities and a pool of trained staff, while stakeholders from government, private sector, and donors acknowledge FFC's potential as a neutral hub. However, the absence of formal accreditation and a structured governance mechanism remain gaps.

In terms of investment, the center is moderately sustainable. Current operations rely heavily on government and donor subsidies, with BAU covering many hidden costs. Although self-generated income streams such as testing services and training programs exist, they remain underdeveloped. Achieving financial resilience requires diversification into consultancy, partnerships, and service-based models.

Implementation progress is evident but incomplete. While rice and wheat fortification testing has been initiated, oil and salt remain less developed. Training workshops and product validation efforts are promising, though institutionalized ring tests and systematic phased rollout strategies have yet to be operationalized.

Integrity indicators highlight moderate capacity with significant weaknesses. Although FFC has the technical ability to test premixes and validate standards, Bangladesh's wheat fortification standard is outdated, and standard operating procedures are not routinely updated. Ethical oversight, particularly in avoiding over-fortification, is limited but essential for public trust.

Impediments remain the weakest domain. Low consumer awareness, high relative costs of fortified products, limited evidence-based policy reforms, and weak enforcement capacity significantly hinder scaling. Without stronger monitoring frameworks and demand-side interventions, private industry risks disengagement due to financial unviability.

Overall, the table shows that FFC holds a strong institutional foundation but requires significant strengthening in investment diversification, structured implementation, ethical monitoring, and above all, tackling systemic impediments. Tracking these indicators over time will allow policymakers and stakeholders to monitor progress, identify gaps, and ensure FFC evolves into a sustainable national hub for food fortification.

Table 7.1 Sustainability Indicators and overall achievement

Domain	Key Sustainability Indicators	Status / Achievement
Institutional	• Accreditation of laboratory (ISO, BSTI recognition) • Number of trained staff and experts • Existence of clear governance structure • Level of stakeholder engagement (govt, private, donors) • Integration into BAU's academic and research programs	Accreditation pending; skilled staff available; governance structure informal; strong stakeholder interest; partial integration into BAU research
Investment	• Amount of annual funding (government + donor + private) • Share of self-generated revenue from services • Cost competitiveness of testing services • Subsidies available for premix and equipment • Diversification of funding sources (PPP, consultancy, training fees)	Current funding largely donor/government; limited self-generated income; BAU subsidizes costs; subsidies available for salt/oil; diversification under discussion
Implementation	• Number of fortified products validated (rice, wheat, oil, salt) • Frequency of ring tests and proficiency testing • Training sessions/diploma courses offered annually • Volume of samples tested and certified • Adoption of phased product roll-out strategy	No formal ring test system yet; training workshops piloted; phased rollout proposed but not institutionalized
Integrity	• Compliance rate with fortification standards (BSTI) • Frequency of SOP and standard updates • Premix quality testing and validation rates • Transparency in reporting test results • Evidence of ethical monitoring (avoidance of over-fortification)	Compliance inconsistent; wheat standard outdated (2008); SOPs not updated regularly; premix testing capacity exists but underutilized; ethical monitoring limited
Impediments	• Consumer awareness levels (survey-based) • Number of advocacy/awareness campaigns conducted • Price gap between fortified and non-fortified foods • Policy revisions adopted based on FFC evidence • Enforcement strength (number of inspections, penalties, corrective actions)	Awareness low; limited campaigns; fortified foods often costlier; few policy revisions based on evidence; enforcement weak due to limited accredited labs

8.0 Conclusions

The feasibility study for the establishment of the Centre of Excellence for Food Fortification (FFC) at Bangladesh Agricultural University (BAU) demonstrates its potential to address Bangladesh's critical micronutrient deficiencies through a robust, sustainable, and multi-stakeholder platform. The Professor Muhammed Hussain Central Laboratory (PMHCL) at BAU enables FFC to strengthen food fortification initiatives through its advanced testing capabilities, research activities, training programs and policy support functions. The study confirms the urgent need for FFC given the persistent gaps in research, monitoring, policy enforcement, and consumer awareness that hinder effective fortification programs.

The 5 I's framework assessment shows BAU has strong institutional readiness because of its established infrastructure and expert personnel though the study reveals difficulties with investment diversification, implementation scalability, standard integrity, dealing with consumer resistance and high product costs. The proposed governance framework of FFC together with its development timeline and risk management approaches will solve existing problems through public-private partnerships and financial stability through multiple revenue sources and BAB accreditation.

FFC needs to focus on three main objectives, which include laboratory equipment modernization, workforce expansion, permanent funding acquisition and specific marketing initiatives for fortified food products. The implementation of these priorities will transform FFC into a leading national and regional food fortification center which supports both Bangladesh's National Nutrition Policy (2015) and Sustainable Development Goal 2 (Zero Hunger). Strategic investments combined with stakeholder dedication will enable FFC to deliver substantial improvements in nutrition security and reduce malnutrition throughout Bangladesh during the upcoming decades.

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Appendix

Appendix 1: Respective role of the survey stakeholders

Category	Participant IDs	Key Roles	Challenges	Needs
Government & Regulatory Agencies	**BSTI (ID 16)**	National standards body; enforces mandatory fortification (salt, oil); tests samples	Weak monitoring of open/unsealed oil; no clear Vit A standard; low consumer awareness; insufficient manpower	Strengthened enforcement, standardized testing protocols, manpower, sustainable monitoring systems
	Ministry of Industry (ID 14, 15)	Sets standards; oversees oil, salt, rice fortification; coordination with Food Safety Authority	Weak enforcement, outdated standards, limited private sector cooperation, low awareness	Updated Vit D survey & standards; partnerships with universities (BAU FFC); stronger awareness campaigns; subsidy strategies
	Directorate of National Consumers' Rights Protection (ID 03, 11)	Monitors consumer-level compliance, awareness building	Limited labs, inadequate monitoring capacity, high sample load	Expanded product-specific labs; awareness campaigns; stronger collaboration with academia
	BSCIC Salt Cell (ID 02, 12)	Oversees salt iodization; 8 labs operate for monitoring	Outdated practices, impurities in imported salt, lack of marketing-level monitoring	BAU FFC support for external validation; innovation in testing methods; dedicated QC teams
International Orgs & NGOs	**WFP (ID 06, 13)**	Leads rice fortification through safety nets (VWB, FFP); provides lab training, technical support	High costs; limited commercial uptake; risk of reducing rice focus if wheat expands	Demand creation, scaling private-sector rice fortification, third-party lab validation, awareness campaigns
	GAIN (ID 16)	Supports oil fortification; funds research, training, and standards formulation	Sustainability concerns post-donor exit	Evidence-based advocacy; long-term institutionalization of support
	UNICEF (ID 08)	Early leader in salt iodization; nutrition advocacy	Reduced direct involvement	Data for advocacy; focus on vulnerable groups
	Technoserve (ID 08)	Technical support for wheat millers;	Outdated wheat standards; limited	Updated deficiency mapping; cross-

		promotes private-sector trials	investment in policy	validation of labs; support for BAU FFC
	Nutrition International	Advocacy, policy support	Funding-dependent, fragmented roles	Support for updating standards; capacity-building partnerships
Academic & Research Institutions	**BAU FFC**	Potential knowledge hub; testing, training, third-party validation	Not yet operational; limited infrastructure	Advanced analytical facilities; training modules; integration into curriculum; partnerships with regulators
	BCSIR (ID 01, 10)	Research on standards, premix, fortification methods	Not need-based; weak impact on policy; lack of validation	Evidence-driven, community-specific surveys; stronger govt–academia links
	BINA, icddr,b	Nutrition & biofortification research	Limited cross-institutional collaboration	Shared lab facilities, collaborative research platforms, data exchange
Private Sector (Food Industry)	**IFAD Multi Products Ltd. (ID 04, 07)**	Produces fortified wheat flour and snacks, developing local premix	Limited production due to demand fears; high costs	Public–private partnerships; BAU FFC third-party validation; awareness-building
	Pran-RFL Group (ID 05, 09)	Large-scale processor: exports fortified products; contract farming	High cost of premix (+2 taka/kg); low domestic demand; weak consumer awareness	Subsidies to equalize price; govt enforcement; awareness campaigns; BSTI validation
	ACI Ltd., City Group (noted by others)	Large processors of oil, wheat, rice	Financial losses from low demand for fortified foods	Govt subsidies, demand creation, consumer education
	Premix Suppliers (BASF, DSM)	Supply vit A, iodine, iron, zinc premixes via distributors	Imported premix used without local validation	Local cross-validation; regulatory approval; market expansion
Consumers & Community Organizations	**Consumers (general)**	End-users of fortified products	Low affordability; lack of awareness; taste preferences (white vs. brown rice)	Subsidized prices; awareness campaigns; assurance of safety/quality
	Community-based Orgs (CBOs, local NGOs)	Promote nutrition, livelihoods in rural areas	Limited technical knowledge; lack of advocacy tools	Training in nutrition messaging; technical support for small-scale fortification; community advocacy materials

Appendix 7.1 Expert based opinion of the feasibility of established food fortification center

Participant ID	Type	Feasibility of FFC
ID 01	Technical (BCSIR)	Need Improvement
ID 02	Public (BSCIC - Salt Cell)	Feasible
ID 03	Public (Consumers' Right Directorate)	Need Improvement
ID 04	Private (IFAD)	Feasible
ID 05	Private (Pran-RFL)	Feasible
ID 06	Technical (WFP)	Feasible
ID 07	Private (IFAD -2)	Feasible
ID 08	Private/NGO (Technoserve)	Need Improvement
ID 09	Private (Pran-RFL - repeat)	Feasible
ID 10	Technical (BCSIR -2)	Need Improvement
ID 11	Public (Consumers' Right Directorate -2)	Need Improvement
ID 12	Public (BSCIC -2)	Feasible
ID13	Technical (WFP -2)	Feasible
ID 14	Govt Policy (Ministry of Industry)-1	Need Improvement
ID 15	Govt Policy (Ministry of Industry)-2	Need Improvement
ID 16	Technical (BSTI)- Individual and consultation	Need Improvement
ID 17	SGS	Need Improvement
ID 18	Public (FPMU)	Feasible
ID 19	BAU	Feasible

Appendix 7.2 Reflection of participating expert on sustainability domains

Participant ID	Institutional	Investment	Implementation	Integrity	Impediments
01 (BCSIR)	Moderate	Weak	Weak	Weak	Weak
02 (BSCIC)	Strong	Moderate	Moderate	Moderate	Moderate
03 (DCRP)	Strong	Moderate	Moderate	Moderate	Moderate
04 (IFAD)	Moderate	Moderate	Moderate	Moderate	Weak
05 (Pran)	Moderate	Weak	Weak	Weak	Weak
06 (WFP)	Strong	Moderate	Strong	Moderate	Moderate
07 (IFAD-2)	Moderate	Moderate	Moderate	Moderate	Weak
08 (Technoserve)	Strong	Moderate	Moderate	Moderate	Moderate
09 (Pran-2)	Moderate	Weak	Weak	Weak	Weak
10 (BCSIR-2)	Moderate	Moderate	Moderate	Weak	Weak
11 (DCRP-2)	Strong	Moderate	Moderate	Moderate	Moderate
12 (BSCIC-2)	Strong	Moderate	Moderate	Moderate	Moderate
13 (WFP-2)	Strong	Moderate	Strong	Moderate	Moderate
14 (Govt)	Moderate	Moderate	Strong	Moderate	Weak
15 (Govt)	Strong	Moderate	Strong	Moderate	Moderate
16 (BSTI)	Strong	Moderate	Moderate	Moderate	Moderate

Appendix 7.3 Reflection of expert on investment sustainability

Indicators	Experts' Reflection	Status	Implication for FFC
Accreditation of Laboratory (ISO, BSTI recognition)	• *ID 02 & 12:* stressed external validation is missing, BAU could fill this role with accredited lab facilities. • *ID 03 & 11:* need for product-specific labs beyond BSTI's limited capacity. • *ID 06 & 13*: highlighted reliance on certified labs; cross-validation needed. • *ID 08:* stressed cross-validation, reagent supply, and accreditation are crucial. • ID 16: claimed capacity exists but compliance gaps remain; 3rd party validation is essential.	Weak	FFC laboratory needs to pursue **ISO accreditation** and **BSTI recognition** to be credible for national-level testing and cross-validation.
Number of Trained Staff and Experts	• ID 01 & 10: noted inadequate, unskilled manpower in monitoring agencies. • ID 06 & 13 (WFP): demonstrated success of training lab technicians; FFC can replicate. • ID 08 (Technoserve): highlighted lack of experts as a barrier; universities expected to supply skilled graduates. • ID 04, 05, 07, 09 (Private companies): requested BAU training, certification, and internships.	Moderate	FFC must ensure a pool of **trained staff, food technologists, and lab technicians**, linking to BAU's faculty and student pipeline.
Existence of Clear Governance Structure	• ID 14 & 15: admitted enforcement weaknesses; limited collaboration with universities. • ID 16: National Fortification Unit exists but gaps remain in oversight. • ID 03 & 11: called for long-term labs with 30–40 years sustainability plan.	Weak-moderate	FFC can institutionalize a **governance framework** within BAU, with a steering committee involving **govt, private, donors, and academia** to guide fortification.
Level of Stakeholder Engagement (Govt, Private, Donors)	• ID 02, 12: offered collaboration if BAU sets up labs. • ID 03, 11: endorsed BAU knowledge hub role. • ID 04, 05, 07, 09: committed to partner for testing and awareness. • ID 06, 13: supported knowledge hub and technical linkages. • ID 08: willing to provide technical and cross-validation support. • ID 16: highlighted role of multi-ministry collaboration (Commerce, Food, Industry).	Very strong	FFC enjoys strong **multi-stakeholder demand**; engagement from public, private, and donors indicates readiness for **PPP model sustainability**.

Integration into BAU's Academic & Research Programs	• ID 08: suggested inclusion of fortification in curriculum and training modules. • ID 03, 11: called BAU more credible in presenting fortification evidence nationally. • ID 04 & 05: requested BAU-led training, certification, and internships for company staff. • ID 06, 13: proposed FFC as knowledge hub for storing fortification data and linking research with implementation.	Strong	FFC can be **institutionally embedded** in BAU's teaching and research agenda, ensuring long-term sustainability beyond project funding.

Appendix 7.4 Reflection of expert on investment sustainability

Indicators	Participants' Reflection	Implication for FFC
Amount of Annual Funding	• ID 06, 13 (WFP): safety net rice fortification financed by government & donors; commercial scaling needs more funds. • ID 11 (Consumer Directorate): expansion depends on donor (GAIN) funding. • ID 14–16 (Ministry & BSTI): acknowledged reliance on external donor resources for continuity.	FFC can secure core govt funding while leveraging donor support during establishment. Long-term, BAU needs to institutionalize an annual budget line.
Share of Self-Generated Revenue from Services	• ID 02, 12 (BSCIC): suggested BAU labs could test externally for industries. • ID 04, 05, 07, 09 (IFAD, PRAN, private sector): ready to pay for reliable testing and certification. • ID 08: Companies expect fast, cost-effective services from universities.	FFC can generate revenue through testing fees, certification, consultancy, and training services, reducing donor dependency.
Cost Competitiveness	• ID 08 (: current commercial testing charges very high (e.g., Tk 5,500–6,000 per sample). • ID 05, 09: stressed affordability and pricing gap between fortified and non-fortified food as barrier.	FFC should ensure affordable, competitive pricing of lab services to attract private sector while maintaining quality.
Subsidies for Premix and Equipment	• ID 05, 09: high cost of premix and equipment is the biggest barrier; subsidies critical. • ID 04: import premix increases costs; local production with technical help from BAU is more sustainable. • ID 15 : acknowledged subsidy/price stabilization role of govt.	FFC can advocate for government subsidies and partner with industries to explore local premix development and reduce dependence on imports.
Diversification earnings	• ID 04, 07: interested in training, internship, certification programs from BAU. • ID 06, 13: endorsed FFC as a knowledge hub to attract international collaboration. • ID 08 : willing to support cross-validation and consultancy.	FFC can diversify income through PPP models, consultancy services, donor-funded projects, training modules, and BAU-integrated programs.

Appendix 7.5 Reflection of expert on investment sustainability

Indicators	Participants' Reflection	Implication for FFC
Number of fortified products validated (rice, wheat, oil, salt)	Salt iodization (1989) and oil fortification (2013) are mandatory and scaled nationally; rice fortified under SSNPs in 250 upazilas; wheat fortification emerging but limited to modern retail outlets (IFAD, Pran). Validation done but uneven across products.	FFC can serve as an independent validation hub across multiple product lines (rice, wheat, oil, salt). Can ensure product-specific standards, cross-validation, and strengthen consumer trust.
Frequency of ring tests and proficiency testing	WFP conducted ring tests before certifying labs; some labs (e.g., Waffen) failed cross-validation initially; BSCIC runs 8 salt labs but lacks external validation; overall weak routine proficiency testing.	FFC can institutionalize annual ring tests among national and private labs, develop SOPs, and ensure international accreditation standards for testing fortified foods.
Training sessions/diploma courses offered annually	Training provided by WFP, GAIN, Technoserve; companies train promoters for awareness but not technical diploma-level staff; stakeholders suggested BAU could institutionalize training, internship, and certification.	FFC can launch structured diploma/certificate programs in food fortification (technical, lab, and quality assurance), plus refresher courses for regulators and industry staff.
Volume of samples tested and certified	Current capacity is insufficient: NFS tests ~60–80 rice samples/year; BSTI handles 200–250 oil samples per batch though demand is >2000; wheat testing mostly at Waffen; salt testing across 8 BSCIC labs focuses on iodine only.	FFC can expand sample testing throughput with modern lab capacity and serve as a third-party certifier for BSTI, ensuring higher annual testing volume across all products.
Adoption of phased product roll-out strategy	Salt and oil fortification phased successfully over years; rice fortification is phased (SSNP rollout, nationwide planned by 2026); wheat fortification being piloted in premium outlets before wider distribution.	FFC can support evidence-based phased roll-outs through pilot evaluation, demand-creation research, consumer studies, and providing technical evidence for government scaling strategies.

Appendix 7.6 Reflection of expert on integrity sustainability

Indicators	Participants' Reflection	Implication for FFC
Compliance rate with fortification standards (BSTI)	- BSTI has testing capacity but weak enforcement (ID 16) - Producers bypass compliance, selective testing (ID 01)	FFC can act as an **independent third-party validator** to cross-check samples and ensure compliance integrity.
Frequency of SOP and standard updates	- Salt standards updated in 2021, but wheat flour standard from 2008 still used (ID 08) - Vitamin D deficiency (70%) not yet integrated into standards (ID 16)	FFC can provide **evidence-based advocacy and research** to regularly update SOPs/standards aligned with local nutritional needs.
Premix quality testing and validation rates	- Imported premix often untested in Bangladesh (ID 01) - IFAD conducts independent stability tests (ID 04) - WFP trained SGS & other labs for validation (ID 06, 13)	FFC can establish a **premix validation hub** ensuring cross-validation, harmonized testing, and quality control of premix.
Transparency in reporting test results	- BSCIC publicly shares salt company performance (ID 02) - Oil survey (2013) found 93% open oil failing Vit A retention (ID 03) - Companies often keep results internal (ID 01)	FFC can create **open data platforms** and publish **annual fortification integrity reports** for accountability and competition.
Evidence of ethical monitoring (avoidance of over-fortification)	- Risks of vitamin overdose acknowledged but little systematic monitoring (ID 03, 11) - Uniform enforcement ignores area-specific deficiencies, risk of overdose (ID 01)	FFC can develop an **ethical monitoring framework** linking dosage with demographic, geographic, and consumption data to prevent harm.