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What Influences the Implementation and Sustainability of Nutrition-Sensitive Agriculture Interventions? A Case Study from Southern Bangladesh

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Abstract: Nutrition-sensitive agriculture (NSA) provides a promising pathway for addressing malnutrition. Fulfilling this promise needs a better understanding of the implementation and sustainability of NSA interventions because of their highly complex nature. This study aimed to explore the factors affecting the implementation and sustainability of NSA interventions. A case study design was employed using two focus group discussions with beneficiaries (n = 15), semi-structured interviews with beneficiaries (n = 13), and actors involved in implementation (n = 18). Factors were thematically analyzed using both deductive and inductive approaches adapting the consolidated framework for implementation research. A complex interaction of the factors across the five domains was found: outer setting—nutrition sensitivity of policies, institutional framework; inner setting—culture, social and economic environment, biophysical environment, local capacity, other programs or projects; characteristics of actors—beneficiaries, family members, household capacity, implementers; intervention characteristics—adaptability, design quality, cost of interventions; and, implementation process—fit-to-context, integration and multisectoral collaboration, continuous motivation through engagement, monitoring. Implementing and sustaining NSA needs consideration of multiple factors, with careful analysis of the absorptive capacities of local institutions and beneficiary households. Future studies should explore which mechanisms created for adoption can be continued beyond the project funding cycle, and how.

Keywords: multisector nutrition; factors; scaling-up; case study; qualitative study; food system; facilitator; barrier

1. Introduction

There is growing awareness that malnutrition is one of the main challenges to global health and development [1]. Malnutrition affects health and results in a loss of productivity and reduced educational attainment, eventually slowing overall national development [2,3].

The agricultural sector plays an important role in addressing malnutrition, mainly through increased production and access to nutrient-rich diets. This sector, however, needs to become more nutrition-sensitive to maximize its contribution by going beyond the conventional approach of food production. This can be achieved through nutrition-sensitive agriculture (NSA) which incorporates nutrition objectives and actions in agricultural interventions [4,5]. The NSA interventions have the potential to address multiple determinants

at multiple levels [6]. NSA is considered a promising approach to address inadequate diet and malnutrition in low and lower-middle-income countries.

Past studies have highlighted the need to consider relevant contextual factors during the design and implementation of interventions [6,7]. Investigating such contextual factors is crucial because of the highly complicated nature of NSA, as it integrates multiple interrelated and complex components at different levels. Furthermore, the traditional food system where NSA interventions are implemented may feature a complex combination of several factors that influence food production, consumption and resulting health and nutritional status [8]. Understanding such complexity helps gain practical insights and maps potential factors for their appropriate and timely address. Some of these factors can be the adaptability of the intervention, knowledge and perception of individuals; the process of planning, execution, engagement and monitoring; the setting where implementation occurs; and the external context [9]. The factors that affect the implementation of NSA interventions are, however, inadequately researched. The studies that go one step beyond the implementation and explore the influence on sustainability are even scarcer, as they focus on a specific funding cycle of the interventions. This article, therefore, focuses on the factors that influence the implementation and sustainability of NSA interventions.

Bangladesh, the setting of this study, has been a fertile ground for NSA [3,10–16]. Bangladesh is one of the few countries that made laudable progress in economic development by significantly dropping poverty levels [17]. Despite this development, malnutrition remains a significant problem [17]. As reported by the Bangladesh Demographic Health Survey 2017–2018, the proportion of stunting, underweight and wasting among children less than five years of age is 31%, 22% and 8%, respectively [18]. Furthermore, micronutrient deficiencies are highly prevalent in Bangladesh. For instance, 40% of women of reproductive age are anemic [19] and a high proportion of pre-school aged children are deficient in vitamin A, zinc, vitamin D, iron, and suffer from anemia [20].

Inadequate food production diversity seems to be a barrier to addressing malnutrition in Bangladesh. The food system in Bangladesh has traditionally focused on rice as the main staple crop [3,21] with some production of other crops such as pulses, vegetables, fruit and oil seeds [21] or non-crop products such as fish (aquaculture), and livestock [3]. Home gardens are also important sources of food consumption and income in rural Bangladesh [22]. Although the country has experienced increased production of nutrient-rich foods, such as meat, milk, aqua products, vegetables and fruit, the growth is not sufficient to meet dietary requirements [23]. While the production of vegetables and fruit is increasing, the produced quantity is insufficient to meet the dietary requirements of the Bangladeshi population [21,23]. Meeting the daily WHO requirements for vegetables and fruit needs either a significant increase in production in the country, or large net imports [23]. Therefore, it is evident that the agriculture and food system in the country has not fulfilled adequate production diversity. Even though production diversity could increase, translating it into consumption within the local food system is linked to, besides agricultural production, multiple aspects such as nutrition-related knowledge and education, income, empowerment of women, and strengthened local institutions [6]. As a result, the government of Bangladesh has prioritized an integrated response to addressing food insecurity and malnutrition [24]. This calls for strengthening the mainstreaming of nutrition components into the local agriculture and food system to diversify food production and enable the consumption of diverse nutrient-rich foods. NSA can play an important role in diversifying food production and diet by tapping into the food system, such as the traditional homestead food production system.

This study aims to explore the factors that influence the implementation and sustainability of NSA interventions. To that end, the Integrated Agriculture and Health-Based Interventions (IAHBI) Project implemented in Bangladesh was studied as a case within the local food system in Southern Bangladesh. The objective of the IAHBI project was to improve household food security and nutritional status of children under five years of age, and pregnant and lactating women, in Southern Bangladesh [25,26]. The project focused

on diversifying the traditional food production system as well as incorporating nutritional education or behavior change activities to enhance nutrition-sensitivity. The project targeted 50,000 households to use an innovative method that involved integrating nutrition activities within agricultural production and health services to make the interventions nutrition sensitive. From the perspective of the impact on nutritional status, the project can be considered a success as it contributed to significantly reduced underweight [25]. The results of this case study are particularly relevant for countries such as Bangladesh where small-scale community-based programs are rarely scaled-up, and systems to deliver nutrition-related services are inadequate [27]. The findings can facilitate policy makers and implementers to design and implement strategies for enhancing the implementation and sustainability of NSA projects to improve diets and nutrition.

2. Materials and Methods

2.1. Study Design and Context

This study used a qualitative approach to investigate the factors influencing the implementation and sustainability of the IAHBI Project. The case study design helped the authors gain in-depth information on the processes and mechanisms of interventions [28]. The data covered national, province/district, sub-district and union levels.

This study investigated the implementation of the IAHBI project mostly based on the local agriculture and food system of Kamarkhola and Sutarkhali unions of the Dacope sub-district situated in the Khulna district of the greater Khulna region in Southern Bangladesh (see Figure 1). Food production in the region is dominated by rice and fish and has the lowest crop diversity index in the Dacope sub-district [29]. Frequent natural disasters have further adversely affected the system. The country's unique geographical position has made it more vulnerable to natural disasters such as floods, cyclones, storms, drought, and landslides [30]. The selected unions in the sub-district are highly vulnerable and exposed to climate extremes because of rainfall, natural disasters and high temperature [31]. One such disaster was cyclone Aila that hit the southwest coast of the country on 25 May 2009 [30], which had adverse effects on not only the lives of people but also on the production of rice crops, vegetables, aquaculture, and livestock [30]. These unions have the lowest adaptive capacity to such disasters in terms of income, infrastructure, roads, and agriculture [31].

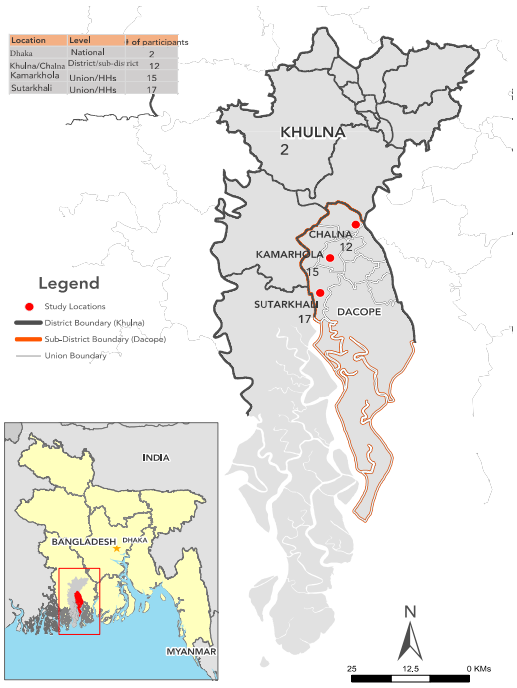


Figure 1. Study location.

2.2. Description of the IAHBI Project

IAHBI is a multisectoral project under the Feed the Future initiative, led and funded by the United States Agency for International Development (USAID), implemented in Bangladesh from September 2012 to September 2015 by the Government of Bangladesh, partners, and an NGO partner, Sheba Manab Kallyan Kendra [25]. Implemented in close partnership with the Department of Livestock Services of the Ministry of Fisheries and Livestock, the project also involved the Department of Agricultural Extension of the Ministry of Agriculture; Food Planning and Monitoring Unit, and the Directorate General of Food, of the Ministry of Food; Institute of Public Health Nutrition and National Nutrition Services of the Ministry of Health; and the district and sub-district administrations of the Ministry of Public Administration [25]. The Food and Agriculture Organization of the United Nations (FAO) provided technical support for NSA activities, whereas the United Nations Children's Fund (UNICEF) supported nutrition-specific interventions [25]. The project was implemented in five sub-districts: Dacope and Koyra of Khulna district, Muladi of Barishal district, and Assasuni and Shyamnagar of Satkhira district.

The agricultural interventions focused on the provision of training on improved technologies and inputs for three sub-sectors—horticulture, livestock and aquaculture—that incorporated explicit nutrition objectives and actions [25]. The project used FAO's group-based approach by forming farmers' field schools (FFSs) where, "farmers with common interests engage together in a season-long study program with weekly meetings and practical demonstrations . . . . . to improve the productivity of their crops, livestock, and fishery operations but also how to specifically improve nutrition" (p. 7) [25]. The FFS members received input and training on food production techniques, and messages on optimal nutrition. The members later rolled out similar training to women farmer groups (WFGs) [25].

The project delivered integrated homestead food production gardens, training materials, nutrition education or behavior change materials, demonstration of healthy and diverse cooking, and community-based food preservation and processing [25]. Along with the provision of knowledge, skills and inputs, the project had also planned strategies to sustain the adoption of the promoted practices through formal registration of FFS groups into cooperatives, follow up of the FFS by government extension workers, and handover of input packages at Union Parishad to the FFS. The project also delivered nutrition-specific components to increase the coverage and outreach of iron-folic acid supplementation for pregnant women and de-worming for children six to 23 months old [32]. The project has contributed to the significant reduction in underweight, from 30% in the baseline to 24% in the endline [25]. The details of the project interventions are published elsewhere [25].

2.3. Participants and Recruitment

To maximize the diversity of perspective, participants were recruited from multiple levels with multiple roles. They represented implementers at the national, district and sub-district, or union levels; members involved in implementation in the union level; and beneficiaries. The Dacope sub-district and Kamarkhola and Sutarkhali unions were selected for the research. Beneficiaries were from either FFSs or WFGs. Participants were identified through two methods: a list of implementers and FFS leaders provided by the implementing organizations; and also, the snowball method. With the snowball method, the FFS leaders assisted in identifying other beneficiaries, and implementers linked the researchers to other implementers or community members involved in the implementation. Forty-six individuals participated in the research of which 28 were beneficiaries (see Table 1). As the project targeted women, all beneficiaries included in the study were female. The beneficiaries' ages ranged from 23 to 48 years (average age was 33 years) and their educational attainment ranged from no education to secondary school certificates. The abbreviations indicated in Table 1 were used to identify the participants for reporting the respective quotes and continue to be used in the results section.

Table 1. Study participants.

Participants' Level and Characteristics	Data Collection		
	Method	**Number**	**Number of Respondents**
Implementers at the national level (IN)	Interview	2	2
Implementers at district and sub-district level (ID)	Interview	12	12
Implementers or members involved in implementation at Union Porishad (IUP)	Interview	4	4
Beneficiaries:	Interview	13	13
Farmer Field School (FFS) leaders (BL); FFS and WFG members (BM)	Focus Group Discussion (FGD)	2	15
Total			**46**

2.4. Data Collection

Data was collected from October 2018 to January 2019, three years after the project ended. Thirty one semi-structured interviews were conducted with both implementers or community members involved in implementation (*n* = 18) and beneficiaries (*n* = 13), and two focus group discussions (FGDs) with the beneficiaries (*n* = 15) (see Table 1).

Separate semi-structured tools for interviews and FGDs explored three aspects: their participation in the project, perceived effects on nutrition outcomes (what effects and how the effects or pathways), and the factors affecting implementation and sustainability (barriers and facilitators). The tools guided the data collection and were flexible enough to explore the details. Separate tools were applied for implementers and beneficiaries. Key themes included in the implementers' tools were background questions about the project and their participation, perceived effects on food security and malnutrition, and facilitators and barriers to implementation and scaling-up as well as sustainability. The tools for beneficiaries explored background information on their participation in the project, perceived changes in malnutrition and food security, facilitators and barriers to implementation, and sustainability of the project interventions (see Supplementary File S1). While this article focuses on the factors influencing implementation and sustainability, a separate paper will present the pathways from the interventions to nutrition outcomes. Trained researchers conducted the interviews, and FGDs and a note-taker also accompanied the FGDs. The duration of interviews and FGDs was around 20–70 min and 51–62 min respectively. All FGDs and interviews were recorded with permission and transcribed by research assistants and supplemented with field notes. Data saturation determined the number of interviews [33]. Recruitment of participants stopped when no new information on the factors could be derived, which led to a total of 46 participants.

2.5. Data Analysis

Both inductive and deductive approaches were used to analyze the data. First, the transcripts were read in detail to openly code the factors that affected implementation or sustainability. Then the open codes were assigned to five categories of factors by applying the consolidated framework for implementation research (CFIR) [9] which outlines implementation across the following domains: outer setting, inner setting, characteristics of individuals, intervention characteristics, and implementation process. This article theorized that within the given enabling context at the global or national level (outer setting), and with consideration of the implementation setting (inner setting) and the characteristics of involved actors, the NSA interventions with specific characteristics were implemented to achieve the project objective (see Table 2). In the third phase, different factors within the domains were grouped into concepts. The concepts within the five domains were adapted from the CFIR framework [9], and partly based on Di Prima et al. [34], which is under review.

Table 2. Adapted concepts of the CFIR framework [9], partly based on Di Prima et al. [34] under review.

Domains	Adapted Definition
Outer setting	Factors across global and national levels, which are beyond the implementation area [9], e.g., nutrition sensitivity of existing policies and national legislative environment, [34], under review.
Inner setting	Aspects of the local agriculture and food (agri-food) system where the implementation occurred [9], e.g., cultural and social environment, local capacity, and biophysical environment, [34], under review.
Characteristics of individuals	Those who either implement or receive the interventions also influence the project implementation, e.g., individual characteristics of beneficiaries and their family members as well as household capacity and characteristic of implementers [9].
Intervention characteristics	The attributes of the intervention itself that affect its implementation or sustainability, e.g., adaptability, design quality and cost [9].
Implementation process	The essential activities of the implementation process are planning, engagement, execution, and reflection and monitoring [9].

Factors were defined as the attributes that aided (facilitators) or hindered (barriers) the capacity of the implementing institutions to implement or sustain the interventions or practices [35]. Data was managed and analyzed using ATLAS ti software version 8.4.4 and Microsoft-Excel software 16.16.25.

2.6. Ethics

Ethical approval was obtained from the Institutional Review Board of BRAC James P Grant School of Public Health, BRAC University, Dhaka, Bangladesh (reference number: 2018-019-ER).

3. Results

The factors affecting the implementation and sustainability of NSA interventions across five domains—outer setting, inner setting, characteristics of actors, intervention characteristic and implementation process—are illustrated in Figure 2. Although these domains are described separately, these factors seem to be related in several sections reported hereafter. Some of these connections are: the institutional frameworks in the outer setting and existing projects and programs; the biophysical environment in the inner setting and fit-to-context in the implementation process; and household capacity in the characteristics of actors and the cost of interventions in intervention characteristics.

3.1. Outer Setting

The factors in the outer setting mentioned by the respondents concerned nutrition sensitivity of existing policies and institutional framework.

Nutrition sensitivity of existing policies in terms of the overarching multisector policies, and nutrition in agriculture policies, are important facilitators. These constituted the multisector nutrition plan (National Plan of Action on Nutrition), agriculture sector specific policies such as the National Agriculture Policy 2018, and the Country Investment Plan. Such policies shaped project design and implementation and/or sustainability through the existence of other projects that built on such policy environment. While agricultural policies are nutrition-sensitive due to their focus on increased production of nutrient-rich products, there is also a need to expand the horizon of such policies beyond food production to translate production diversity into consumption diversity. According to an implementer:

"Different sectors have their own agenda. Like, agriculture has its own agenda i.e., based on the recent agriculture policy 2018, they will try to ensure food and security through the sustainable increase in production of nutritious food [. . .] there is an important challenge to make it nutrition-sensitive [consumption aspect]". [IN1]

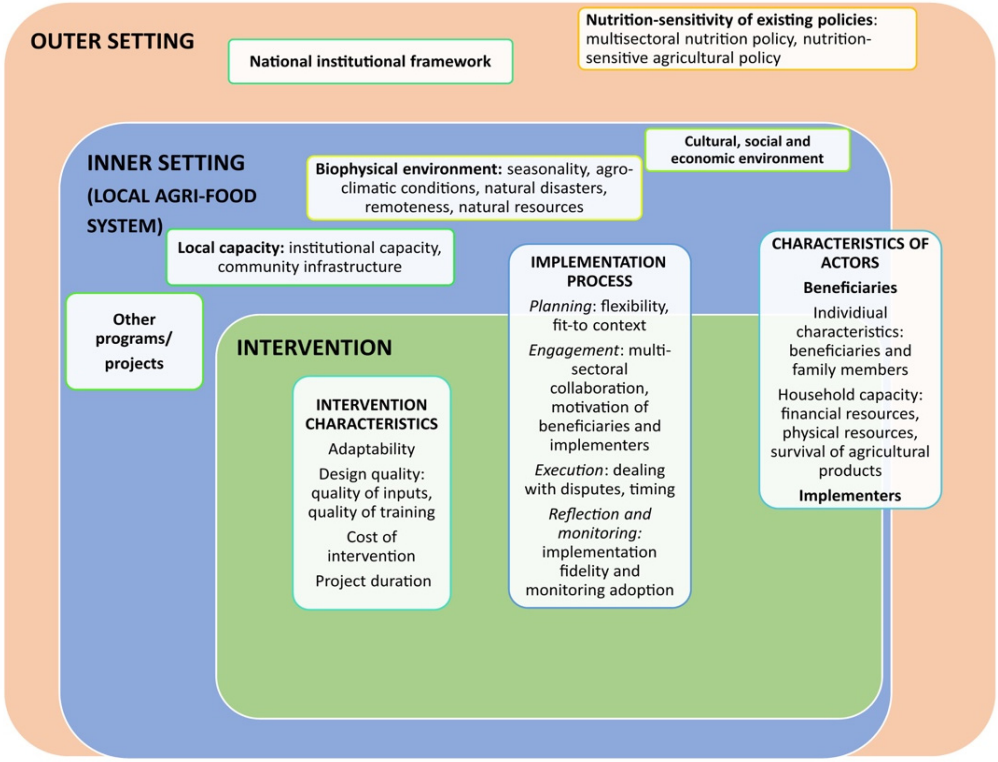


Figure 2. Factors affecting implementation and/or sustainability of NSA interventions as reported by this study, adapting to the Consolidated Framework for Implementation Research (CFIR) [9], partly based on Di Prima et al. [34] under review.

The national institutional framework affected the institutional capacity at the local level. Bangladesh has a largely top-down vertical service delivery environment, and the existing public institutional arrangement is structured such that access to the grassroots level is inadequate. In line with this arrangement, local institutions have limited capacity to implement and sustain the interventions, as indicated by the following quote.

"Below sub-district, there are some activities [staffs] only in the agriculture department, but fisheries [and livestock], are only up to sub-district or district level. [. . .] in health, there are some points, Upazila [sub-district] health [. . .] [and] around 13,000 community clinics, but most of the department has no office below sub-district level. [. . .] it is not possible to only want government sectors [to follow-up]". [IN1]

Nevertheless, non-governmental organizations (NGOs) try to fill this gap:

"The involvement of local NGOs was [is] high in the root level up to the sub-district level in Bangladesh". [IN1]

The country features a large network of NGOs that assist the government to implement its policies and strategies to achieve nutrition and food security outcomes. Such assistance is mostly time-bound and provided through several programs and projects on nutrition, which will be explained in the inner setting.

3.2. Inner Setting

The factors at the inner setting, the local agri-food system of the Dacope sub-district, consisted of cultural, social and economic environment; local capacity; other programs and projects; and the biophysical environment.

Cultural, social and economic environment influenced access to resources. Persistent cultural and social norms such as gender inequality and food-related traditional beliefs were prevalent in the communities. While the project contributed to financial empowerment among women through increased access to finance obtained by selling agricultural commodities, deeply rooted gender beliefs hindered their self-empowerment and decision-making. According to an implementer:

> "*They [women] are not supposed to go outside or to the market to sell or buy things [. . .] they mostly stay at home whereas men go to the market for selling or purchasing*". [ID2]

Their confinement to household chores and less control over decision-making affected their access to resources and nutrition-related decision making. Food-related beliefs, such as the tradition of not consuming sheep's milk, in a few households, affected their diet.

The factors within the economic environment mainly concerned the income opportunities available to beneficiaries beyond the agriculture sector, such as wage labor, and small businesses, such as a furniture shop or saloon. While the income opportunities generally increased purchasing capacity, an implementer also highlighted trade-offs in the time that beneficiaries from very low-income households spent in wage labor instead of participating in project activities.

Biophysical environment-related factors constituted seasonality, agro-climatic conditions, natural disaster, remoteness, and natural resources. Seasonality was not a direct factor, but practices varied across the season. The project had acknowledged seasonal effects that led to the design of strategies in the intervention that facilitated implementation. Delivery of season-specific inputs (seeds or fingerlings) or the execution of FFS sessions are examples of how this consideration translated to implementation. The seasonality still affected production, access to water, food price volatility, and delivery of project activities.

Agro-climatic conditions such as salinity, rainfall variability, and soil quality also influenced the implementation and/or sustainability. The project used strategies to supply inputs based on the salinity of water, which facilitated production, for example, through the provision of salt water friendly aqua products. However, salinity had adverse effects on access to safe drinking water and agricultural production, with beneficiaries stressing the high mortality of ducks due to salinity. An implementer also mentioned that the chickens in the coastal belt were severely affected by the salinity. Some participants also stated that they coped against mortality by selling their poultry just before the flood season when the salinity of the water would be high. According to an interview with a beneficiary:

> "*From them [IAHBI, we got] 8 hens. Every day hens were laying 5–6 eggs. In the flooding, saltwater came, they drank that salty water, and they died [. . .] Out of 8 ducks. 2 died. We ate some, some were lost. Most of the time in our pond when the salty water comes, that times ducks don't stay alive. [. . .] Now, in the sweet [fresh] water the ducks gave 11 babies. So, when the salty water comes, before that I sell them. [. . .] Yes. I sold all*". [BM8]

Salinity, however, had mixed effects on the survival of aquaculture products. Aqua products such as shrimp and lobster required salty water, whereas some others needed fresh or less-salty water.

The frequent occurrence of natural disasters, such as cyclones (Aila) and flooding, was a significant barrier to production in Southern Bangladesh, including the local agri-food system. A few beneficiaries reported flooding during the implementation. Cyclone Aila, that occurred before the project started, devastated the local food and agriculture system and infrastructures with the effects seen during the project phase and beyond, as indicated by the following quote.

"*After the cyclone Aila, all the lands here got salty. And the amount of rainfall was too poor. That's why farming on a large scale was not possible. What they did after learning the techniques was that they arranged the outer space of their home nicely and then they implemented the methodology in that piece of land*". [IUP1]

Remoteness hindered the execution of project interventions, follow up of post-project cycle, and development of infrastructure for market and transportation systems. This was compounded by a lack of road connection, with only water as a means of transport to reach the sub-district from the two unions. According to an implementer:

"*The place was near to the Sundarbans. So, you can easily realize how remote the place was. If you start for the place even early in the morning, you cannot come back here on the same day. So, there was some interruption in the training*". [ID5]

The availability of *natural resources*, particularly agricultural products from forests or canals, or water availability for irrigation or drinking, affected implementation and sustainability. While access to natural resources, for instance, fish or crabs from water streams in the forest, facilitated consumption and selling, limited access to water for irrigation and drinking was a persistent barrier to production and WASH practices, as indicated in the following quote.

"*The problem of food security [in this area] will not be addressed unless the problem of drinking and irrigation water is solved*" [ID4]

Local capacity concerning institutional capacity as well as community-based infrastructure affected implementation and sustainability. The inadequate institutional capacity of government institutions in terms of human resources and monitoring systems was a barrier to implementing interventions but mostly affected sustainability. During the implementation, institutions sometimes delegated tasks to different people for different activities of the same project, as indicated in the following quotes.

"*During the project days, a single person whatever is his/her post has to do a lot of jobs. Budget is not a problem. [. . .] but a shortage of human resources becomes the main issue.*" [ID4]

"*Sometimes, a sub-assistant agriculture officer needs to deliver training for livestock and fisheries because of lack of livestock and fisheries staffs at field level because there were no livestock and fisheries field-level staff*". [ID10]

The shortage of human resources affected sustainability, in terms of following-up activities in the post-funding cycle. While implementers from NGOs stated that it was the role of the government to follow up during the post-project phase, government implementers highlighted a lack of feasibility to follow up within the given institutional arrangement, with limited human resources. Following up project activities was rarely reported except in the case where grassroots level staff followed up health and hygiene practices or the government followed up through other projects implemented in the area.

Implementation was also affected by the capacity of local institutions in terms of community infrastructure such as road transport and market access. Some trainers had to train beneficiaries located in remote areas with no proper road access. Especially in the rainy season, this led to delays in the delivery of training activities. This is reflected in the following quote.

"*The transport system is very bad there. [. . .] If the system was good then I would have given them [beneficiaries] more training. I had to stay there and wouldn't return the same day. It is a backward place, near to the Shundarban, need to go there by a trawler*". [ID5]

High local taxes on transportation, in addition to poor transportation, also deterred the transportation of vegetables, which can be highlighted as another infrastructural barrier. According to an implementer:

> "*The transport system is so poor [in the Dacope sub-district]. Taxation is the problem. A bus has to pay 120 takas to cross the bridge, but a small pickup carrying vegetables should pay 800 takas*". [ID4]

Although beneficiaries could sell vegetables in the local market due to an increase in demand, a lack of access to the external market affected not only access to and selling of food items, but also food price, as beneficiaries were either getting a lower price for their products or had to pay a high price to buy food for poultry, as indicated in the following quote.

> "*No, [the ducks the project gave are not alive] [. . .] no, they did not die because of disease, they died because they were not fed with the proper food. [. . .] Because none had rice before, now 1 kg broken rice costs 10 takas [per kg] in this month, but it increases in other months, it costs 15–20 takas per kg. That's why not everyone could feed them.* " [BF2]

A few beneficiaries indicated the availability of unhealthy foods in the local market, such as, packaged and processed foods high in fat and sugar and unsafe vegetables that used chemicals. However, an implementer believed that the lack of market facilitated food consumption, as beneficiaries had no choice but to consume their products. Similarly, the perception of unsafe vegetables in the market facilitated homestead production of vegetables.

The existence of other programs or projects implemented in the implementation area during or after the project cycle generally facilitated the implementation and sustainability by contributing to addressing malnutrition. Such interventions included publicly delivered health and agriculture extension services as well as time-bound programs or projects on credit support, livelihood improvement, water quality improvement, provision of water filters, and disaster management. According to a beneficiary:

> "*During that time [Aila, the cyclone], our situation was so bad, we got this home and also [support for] a toilet with it [from another project]*". [BM1]

Several other projects were implemented after the IAHBI funding cycle. One such project was National Agricultural Technology Project which incorporated nutritional messages within agriculture. Likewise, Nabojatra Project delivered multisectoral interventions such as nutrition, agriculture, water, sanitation and hygiene, and livelihoods. Post project cycle also included several other sectoral programs that could contribute to improving nutrition. Notably, an FFS leader stated that food supplementation was a barrier to adopt or sustain food production among low-income households, as indicated in the following quote.

> "*Those people [poor] had organizations from which they received the rice, many agencies are supplying foods such as rice and oil, so they ate those things and store some foods and say that let it [production] be*". [BL2]

3.3. Characteristics of Actors

This domain mainly concerns the attributes of two types of actors involved in the implementation. Most of the characteristics cover the first category, the actors in the inner setting that benefited from the interventions, labelled as beneficiaries. This included individual characteristics of beneficiaries and their family members as well as household capacity. The second category was the actors providing interventions to the beneficiaries, labelled as implementers.

Beneficiaries' demographics, self-motivation and perception affected the implementation and/or sustainability. Women who were young and relatively educated, participated more in the project activities, as implicit in the following quote.

> "*At the beginning, people did not join, they gave us excuses; they did not come timely etc. However, after a few days, young women started to join, aged women did not. Young women were educated so they felt interested*". [ID5]

Beneficiaries' self-motivation or interest also affected implementation and sustainability. While training design and delivery were interactive, an implementer stressed that training (in general) was affected as women were distracted by their small babies who tagged along with them, or were interested in tangible support instead of information. Lack of interest was also one of the reasons why beneficiaries did not continue the meetings post-project cycle. However, some beneficiaries were interested in continuing the adoption of production techniques such bed-making or continuity in the production of poultry. According to an FFS Leader:

> "*Some people try to do like me, but they can't. My hens were 5–6 kg each. [. . .] They ask me how you do this. [. . .] If I see that they are sick, I take them to the [veterinary]. I bring Napa for them and give them. They don't, they come to me and ask do you have the medicine for ducks and hens. They want to take in free*". [BL2]

Notably, self-motivation was also dependent upon income level, access to resources and/or dependency upon projects for inputs.

Beneficiaries' perceptions also influenced the implementation. The perception that food purchased at the market contained chemicals enabled household production of vegetables.

Three characteristics of family members that influenced implementation or sustainability were: perception of gender norms, traditional beliefs, and food preferences. While some family members facilitated the implementation by permitting women to participate in project activities, some did not allow them to participate. Because of traditional beliefs, mothers-in-law influenced food consumption, as stated by an FFS Leader.

> *"The mothers-in-law say that we didn't eat those before, first those things were not here. [. . .] from my opinion in the families with mothers-in-law, [it is difficult to do anything]. The neighbor beside me I can't make them understand*". [BL2]

Food preference among children affected their dietary diversity. Specifically, their preference for packaged and processed foods and beverages high in sugar, that was readily available in the local markets, hindered the consumption of nutrient-rich foods among children. According to a beneficiary:

> "*Children insist on eating foods [such as] tea-biscuit, juice, tiger [drink high in sugar] . . . . I tell them not to eat these . . . still, if they get the money, they eat those, they do not listen to us*". [BM6]

Household capacity to adopt and sustain the resources was a significant factor, which mainly concerned access to financial and physical resources, and the survival of agricultural products. The project had considered poverty by targeting poor households and integrating messages that encouraged the selling of surplus and/or high-value aqua products to increase income, which facilitated the implementation. Inadequate access to financial resources, however, was a persistent barrier as it limited access to household resources required for production, food consumption and water, sanitation and hygiene (WASH) practices. Insufficient land and limited power to afford water infrastructure and the purchase of nutritious foods, were the main effects. Due to this, a few beneficiaries practiced a trade-off between nutrition and other household needs. According to an implementer:

> "*To ensure that my child has a better diet, I should have either a space for farming or enough money to buy whatever I need. So many people do not have space to do farming [. . .] They do not even have the money to purchase rice, pulse, or vegetables to make khichuri for their children*". [IUP2]

Access to physical resources at the household level, such as land and water, sanitation, and hygiene-related facilities and resources, also affected adoption and sustainability. The land inadequacy hindered food production as some beneficiaries could not use vegetable seeds, grow vegetables, or raise livestock due to lack of space for shelter or grass, or cultivate fish due to lack of space for ponds. According to an implementer:

> *"They don't get grass the right way. They buy grass or they buy straws and feed. They have less affordability to buy those. They have their own homes like maybe they have 2–3 hectares of land or they have 5 hectares of land. In those [lands], they can't cultivate [grass for cattle]. And if they give then it doesn't grow grass because this is salty territory. The main problem is if we go to cultivate cattle then we have lack of food*". [ID10]

The lack of water facilities hindered WASH practices and food production. The project had provided awareness on WASH and training to establish *tippy-tap*, an arrangement to preserve water, made up of an empty bottle and a rope to serve as a hand-washing station. However, the persistent lack of water hindered access to safe drinking water, as some beneficiaries had to depend on rainwater and pond water for household purposes.

The survival of agricultural products was an important factor within physical resources. The death of ducks, hens, goats, sheep and vegetables were the barriers. Several beneficiaries reported high mortality of poultry due to disease, the salinity of water, lack of food or proper shelter, and poor adaptation or sickness during transportation. Less than a couple of beneficiaries reported mortality of vegetables, as beneficiaries had continued preparing and applying the pesticides, whereas one beneficiary stated loss of gourd. The mortality mainly occurred in livestock, mostly poultry, as indicated in the following quote.

> *Only 2–3 out of 7–8 babies survived [. . .] traditional shelter was too wet that the bacteria could cause disease. Also, they were putting hens or ducks together [despite we taught on coop maintenance].* [ID8]

Characteristics of implementers, diversity of implementation team, and availability of nutrition experts involved in the agricultural production interventions, facilitated the implementation as stated by the following quote.

> "*For the first time in this locality, some nutrition experts came to train the people specifically only on nutrition*". [ID3]

The capacity of implementing organizations in terms of human resource adequacy was an important factor. A shortage of human resources led to task shifting, described as limited institutional capacity in the inner setting. It was not indicated by the respondents whether and how this may have constrained implementation.

3.4. Intervention Characteristics

This domain possessed the design-related characteristics of interventions that were aimed at addressing food insecurity and malnutrition within the context of the inner and outer setting explained in previous sections. Such factors included adaptability, design quality, and feasibility.

Adaptability is the extent to which the project interventions were adaptable to the needs of the local context, facilitated the implementation. The implementation area was highly affected by cyclone and salinity, an important factor in the outer setting. The interventions were, therefore, designed accordingly; for instance, through the provision of aquaculture products tolerant to salinity and high temperature, or consideration of soil quality that aimed to address some of the barriers in the outer setting. For example,

> "*The lobster was cultured considering saline water. Besides this, mono sex tilapia was cultured for its high productivity and temperature tolerant nature*". [ID3]

A few participants highlighted the challenges of low adaptation of poultry, either due to transit problems or adaptation to biophysical factors, as indicated in the following quotes from an interview with implementer and beneficiaries FGD, respectively.

> "*They were bringing them [poultry] from outside, after bringing here, there was travelling tiredness, the ducks became sick*". [ID3]

> "*When they gave the ducks, they were small and they were from sweet water, those ducks which are from sweet [fresh] water can't be alive in saltwater*". [BF2]

Design quality, the perceived quality of how the intervention was assembled and presented, was an important factor that mainly concerned nutrition integration in agriculture, quality of training sessions, quality of inputs, and project duration. The integration of nutrition in agriculture was a facilitator as it allowed beneficiaries to improve not only the production of food, but also change behavior, through nutrition-related activities. According to an implementer:

> "*While agriculture generally concerns about production [. . .] this project worked to increase production and [consumption] in an integrated way, [as it] had BCC [behavior change communication] activities such as the cooking demonstration*" [IN1]

Regarding the quality of training, the provision of interactive and practice-oriented training was an important facilitator. Beneficiaries recalled the practice-oriented activities such as production using vegetable bed-making, preparation and application of fertilizers and pesticides, rearing techniques, and cooking demonstrations. According to a beneficiary:

> "*[I liked] things they showed and cooked. [. . .]. Other projects tell in the mouth, this project showed the design by cooking which we didn't know before. By this training, many children's mothers became aware*". [BM7]

While training design and delivery were interactive, an implementer stressed that in many cases, the effectiveness of training targeted to women (in general) was hindered as they became distracted by their small babies who were also present.

The quality of inputs, especially, the provision of varieties with high-yield production was an important facilitator, as indicated in the following quote.

> "*Ducks were growing and laying eggs fast. So, the outcome was rapid*". [IUP1]

A couple of participants reported low quality of some inputs supplied by the vendors, such as fruit saplings, hens, and small fish.

Participants also mentioned the duration of the project. Several participants highlighted the need for a longer project duration to enhance its effects on nutrition.

The cost of intervention affected its implementation and sustainability. The cost of intervention concerned two levels—the cost incurred for implementing organizations, and the cost required for beneficiaries to adopt and sustain. The cost of interventions incurred for organizations determined the prioritization of interventions and targeting of beneficiaries, as indicated in the following quote.

> "*[Horticulture costs] very less price, maybe just [. . .] but for aqua livestock, it is about 5000 6000 taka per beneficiary [. . .] both aquaculture and livestock require more money. So lesser bit number [of beneficiaries]*". [ID9]

The second was the cost required for beneficiaries to adapt and/or sustain the techniques promoted by the project. Applications that required none or lower financial inputs such as knowledge, or practices of vegetable production techniques (fertilizer and pesticide making, bed-making), some fish production techniques, or to some extent the techniques countering poultry disease, were more feasible to adopt or sustain than those requiring a comparatively high cost. This attribute was also related to household capacity concerning financial resources described in the 'characteristics of actors' domain. According to a beneficiary:

> "*That time it was seen that they gave 10 ducks and 10 kg foods [for the ducks], so it [the food] ran for 20 days. [. . .]. For them, it is too hard to collect their own foods. Then how they will buy ducks food? [. . .]. No, no, they can make the foods [using the techniques taught by the project] but they have to buy [ingredients] with money. [Therefore], they mixed some rice and some chaff. The ducks' condition became so bad*". [ID10]

3.5. Implementation Process

The aspects of planning that facilitated implementation of the NSA interventions were flexibility and fit-to-context. Although there existed a general guideline to design

and implement the activities, the flexibility in planning the activities based on local needs in line with the available resources facilitated the implementation. This flexibility also allowed the planning of activities and strategies as per the local context, as indicated in the following quote:

> "*Although the project objectives were not possible to change, we did the priority setting under each activity to match the local context and needs. [. . .] For example, we first allocated a budget for providing one goat to a farmer but when we went to actual implementation, we learned that we should deliver at least two goats per household otherwise they will not survive*". [ID10]

A few participants highlighted the need to address persistent problems related to household capacities such as poverty through the provision of income-generating activities. According to an implementer:

> "*You must be more practical when you are working on a rural level. I can assure you that they would have been truly satisfied if they were given sewing machines as per their need. It could create an opportunity of earning money for them*". [IUP2]

The factors within the engagement sub-domain were multisectoral coordination, and motivation of beneficiaries and implementers for their continuous engagement. The multisectoral collaboration between agriculture and health sectors to deliver integrated interventions was an important facilitator to implement. However, the continuation of the collaboration between sectors was mostly confined to specific projects' scope. Several projects implemented in the area enhanced sustainability as they contributed to achieving the common nutrition outcome. An implementer also mentioned that nutrition was incorporated within agriculture in projects such as the National Agricultural Technology Project, wherein some of the lessons learnt from IAHBI were applied. In the project, agriculture, fisheries and livestock departments collaborated and were responsible for providing awareness about the consumption of products promoted by the respective departments, such as meat, milk and egg, by the department of livestock services. However, the health sector was not involved in the project. Notably, the project had an objective to increase income and reduce extreme poverty, a significant factor noted in the household capacity within 'characteristics of actors' domain. Multisectoral action was also recommended to sustain some of the activities. An implementer suggested mobilizing community clinics to conduct follow-up sessions with beneficiaries after the project cycle.

Increasing the motivation of beneficiaries and implementers to ensure their continuous engagement was another factor. The motivation of beneficiaries acquired through knowledge and skills contributed to the adoption and sustainability of the practices. The beneficiaries had knowledge of nutrition, and continued using some of the techniques acquired during the project, such as vegetable production technologies, illustrated in the following quote.

> "*Women were not so motivated. Now women are motivated behind this and they say that they have to do this. If we don't then our child also will not get nutrition. That's why we always plant vegetables*". [BM3]

The withdrawal of the project led to the reduced motivation of beneficiaries to sustain production practices such as poultry rearing, or to continue the mechanisms established for long-term learning through FFS. Some of the FFS members were also part of groups created by other nutrition-related projects implemented after the IAHBI funding cycle. The reasons to not continue the FSS meetings by the beneficiaries, were lack of meeting initiation, incentives, interest or time. According to a beneficiary:

> "*First when the dada [meeting/training facilitator-male] was coming, we were told that they will teach us these things for our good [so] we have to go, and if we don't go it won't work. [..] We could learn, and they were giving some money for our snacks. [..]. And now they are not coming so what will you go for? Before they used to go but now no one sits together. [. . .] But it's not that they are only interested in money*". [BM9]

Concerning implementers, the influence of supervisors and the provision of incentives affected the motivation for continuous engagement. The presence of agriculture extension officers during training motivated the officers to implement project activities, as indicated in the following quote:

> "*Had they [supervisors] not been invited, they would have later not allowed their staff to work on these project activities*". [ID10]

While the incentives for execution during the project cycle facilitated the implementation, the consequent withdrawal, compounded by workload, hindered continuation of the activities, as the following quote illustrates.

> "*Government sectors are also included in many projects and they also get some of the benefits directly or indirectly and they conducted the training, they get some [budget]. But when project support withdraws, this is gradually losing the [motivation]*". [ID9]

An implementer also recommended a strategy to provide incentives to the staff to enhance continued motivation to sustain the activities.

The factors concerning the execution sub-domain included dealing with disputes and timing of the execution of the exit strategy. Some communities faced disputes while conducting project activities, especially during the distribution of inputs. The participants provided varying reasons for the conflict. While some mentioned that the distribution was politically biased, others stated that the beneficiaries who did not receive the inputs created the disputes. An implementer noted that:

> "*We tried to summarize the yearly activities. And most importantly, there were some unwanted situations we had to face. [..] had to arrange Salish to solve these issues [..] tried to settle the issues on our own [..] Again, this went up to the Upazila level*". [ID4]

Concerning the influence of timing, an implementer perceived that a delay in executing exit strategies hindered sustainability as indicated by an implementer as follows.

> "*We need to start [planning about] the sustainability, such as any cooperative or something from the starting or middle of the project so that [. . .] we can find [identity] the challenges and [identify] problems to sustain. [. . .] Because, we give all the things, and we disappear [because] we don't know what is happening now*". [ID10]

With regard to the reflection and monitoring sub-domain, a few implementers highlighted the role of implementation fidelity and monitoring adoption as a facilitator to implement. The implementers monitored the quality for early detection of deviation from the project design and subsequent correction, as indicated in the following quote.

> "*Hens supplied by a supplier were a little bit undersized. That time I was into a big problem. When I measured and matched, I saw that 1–2 kg weight was less. Then I asked them to give 2–3 more hens. They were obliged to give*". [ID8]

The project also monitored household practices such as cooking procedures, including monitoring of adding salt at a precise time. While the implementation fidelity and monitoring of adoption facilitated the implementation, the lack of a system to follow-up continued adoption hindered sustainability.

4. Discussion

NSA is recommended as a promising approach to improve nutrition outcomes. However, implementing and sustaining this multifaceted intervention package in a local agri-food system is subject to a complex interaction of factors acting as either facilitators or barriers. To gain better insight into these factors, the IAHBI Project was studied, which was a unique NSA exercise that incorporated nutrition in agricultural production through linkages of service delivery structures amongst community-based farmer field schools and women farmer groups. Although the domains of the factors were presented separately according to the CFIR [9], the factors across domains featured a complex interaction amongst

the outer setting, inner setting, characteristics of actors, intervention characteristics and implementation processes.

Implementation of NSA projects within the local agri-food system in Southern Bangladesh was shaped by the outer context. Bangladesh has an enabling political environment, such as the National Agricultural Policy 2018 that aims to achieve sustainable food and nutrition security. Achieving the aspired nutrition security requires strategies to translate the production diversity into consumption diversity, for instance, by incorporating nutrition education [5,6]. Bangladesh has an extensive network of NGOs that assist the government to implement policies by designing and implementing several models. These facilitate materialization of NSA for the benefit of communities, especially when government actors work actively in partnership during implementation to enhance service delivery, as was the case in the IAHBI. However, these projects are generally time-bound and dependent on donor funding which makes it hard to harness innovative models to scale up. Sustaining and scaling up such projects within the public delivery system is further constrained by limited institutional capacity and lack of dedicated resources beyond the project funding cycle. Past studies also emphasized that the country has inadequate systems to deliver nutrition-related services, and also that small-scale community-based programs are rarely scaled [24,27,36]. It can be said that Bangladesh has an enabling environment to initiate small-scale projects but seems to have inadequate capacity to sustain and scale them up within the public delivery system. Sustaining and scaling projects may be achieved by aligning and embedding them with public service delivery institutions during and beyond implementation, enhancing institutional capacity to scale up the interventions, and improving coherence between these projects. This may require collaboration between all relevant stakeholders such as government, non-government, communities, and donors during the design, implementation and execution of exit strategies.

This analysis shows that the inner setting and characteristics of actors related to household capacity feature several barriers that span the agri-food sector and beyond. These barriers mainly include natural disasters [30,37], seasonality and climatic conditions [30,38], institutional capacity [15,39], household capacities [40], remoteness, and, access to water, transport and market. The IAHBI Project was also able to partly address some of the effects of such barriers through the fit-to-context approach. Nevertheless, climatic conditions, lack of infrastructure and household and institutional capacities were important barriers. Addressing these barriers may need a multisectoral response that addresses not only multiple determinants of nutrition [5,6,41] but also the contextual barriers or their effects. However, the question remains on how to combine multisectoral activities within the agriculture sector. One past study also raised the question as to whether the integration of sectoral activities is required to address malnutrition, or whether co-targeting of the same beneficiaries would also bring similar effects [5]. Given the limitation of public institutional capacity, Bangladesh could benefit from a strong coherence between projects, ensuring that they are not implemented *in silo*, and that future projects use established platforms such as FFS.

Addressing barriers related to household capacities, which is a significant factor within the characteristics of actors, requires a tailored approach. Although the IAHBI project and NSA interventions in general are effective in supporting poor communities, it is argued that NSA may not be a silver bullet for the ultra-poor households that do not have minimum resources to absorb the practices. Consistent with a past study [40], this study highlights the lack of household resources as a significant barrier to adopt and sustain interventions. Ultra-poor households that severely lacked household resources, such as income and land, were significantly constrained to adapt and/or sustain NSA practices such as food production, WASH, and food consumption. Thus, even within poor communities, the ultra-poor require additional arrangements, such as minimum income, and/or land, that are critical to adopt NSA interventions. NSA projects, therefore, need to acknowledge and thoroughly reflect on such capacities with tailored strategies for poor and ultra-poor households. Addressing the needs of the ultra-poor may require widening the scope of the NSA-income-nutrition pathway in two ways. The first could be the provision of income-generation activities

beyond own production such as establishing microentrepreneurs through involvement in school feeding programs, food-processing, or as collectors or traders to connect food production to market. The second is to acknowledge that such ultra-poor beneficiaries need primary interventions beyond NSA's direct pathways to nutrition. In the latter case, NSA projects can play a crucial role to collaborate with co-located projects that focus on ultra-poor populations through income generation activities beyond agriculture, or social protection actions such as nutrition-sensitive food supplementation or cash transfer. Explicit consideration of household contexts affects the success of interventions, and hence there exists a need for a tailored approach [36] ultimately making NSA 'equity sensitive'.

The IAHBI project interventions and their implementation process facilitated the initial adoption through several factors such as adaptability of interventions, integration of nutrition and agriculture through multisectoral coordination, quality of design, and motivation of actors. Some of these have previously been suggested, such as fit-to-context reported from Bangladesh [42], and quality of inputs reported from Cambodia [43], Ethiopia [39] and Burkina Faso [44], or incentives for participation of the extreme poor [40]. Some of the attributes that contributed to the sustainability of the project were design quality and better motivation through practice-oriented information and skills. However, the sustainability of some of the mechanisms created for long-term adoptions, especially FFS meetings and multisectoral collaboration, were rarely evident. Although some members of FFS were also part of groups created by other projects following the IAHBI project cycle, the continuation of the FFS meetings facilitated by the project was rarely evident. Collaboration within agricultural departments and nutrition incorporation in agriculture was evident through another project implemented after the IAHBI project cycle. However, sustained collaboration with the health sector could not be established from our research. There seems to be a trade-off between some measures to facilitate the initial adoption of mechanisms and contribution to sustained adoption. This study found that, while some resource-intensive measures, such as incentives for participation, or feed for poultry, facilitated adoption in the short term, a lack of these affected sustainability in the post-funding cycle. The reason could be linked to a past study that reported the trade-offs between the requirement to bring short-term effects versus sustained impacts [36], which needs further exploration. To scale up the interventions within the existing public institutions and bring about change, this study stresses the need to strengthen local institutions [6]. The challenge lies in determining which of the practices should be taken up by the government. There is, therefore, a need to revisit existing institutional arrangements and line ministry functions to understand which of the mechanisms should be sustained and how they can be made viable beyond the project phase. Some viable options could be the integration of nutrition in the training curriculum and/or job description of agricultural staff [25], strengthening cross-sectoral collaboration, such as mobilizing community clinics, and an integrated monitoring system [45]. As mentioned earlier, this study also recommends increased alignment between NGOs and (local) public institutions and coherence across different projects to sustain interventions. Future funding on NSA should focus on strengthening local institutions to scale up evidence-based good practices, enhance alignment with public service delivery institutions, and enhance coherence across different co-located projects.

The main strength of this research is that it investigates the factors that affected both the implementation and sustainability of the interventions through an exploration of the participants' perceptions three years after the end of the project funding cycle. Two limitations might have affected the results that have been presented. The first is the lack of generalizability evident in other qualitative studies. Restriction of the data collection to one sub-district might have led to an inadequate representation of the entire implementation area. Further, several factors within the outer and inner settings on national institutional arrangements are largely contextual and may not be fully applicable to other countries. The second limitation is the possibility of information bias. As data was collected three years after the project ended, the possibility of recall bias and difficulties in finding respondents due to their transfer could have led to some information being biased or overlooked. The

study, however, took precautions specifically to address recall bias, by capturing all possible data through focus group discussions.

5. Conclusions

Effective implementation of NSA interventions and their sustainability within a traditional agri-food system requires consideration of complex factors that span across multiple domains—outer setting, inner setting, characteristics of actors, intervention characteristics, and implementation process. Achieving sustainable impact will require considering local capacity and household capacity to absorb the interventions and sustain the adoption. Further, there is a need to study which mechanisms established to facilitate adoption can be continued, and how to enhance sustainability. This should mainly address how to scale-up small-scale initiatives, and make the interventions more inclusive for the ultra-poor. Consideration of the factors can contribute to enhancing the effectiveness and sustainability of practices that contribute towards achieving food security and address malnutrition in Bangladesh.

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Acronyms and Abbreviations

Agri-food	Agriculture and food
FGD	Focus group discussion
IAHBI	Integrated agriculture and health-based interventions
NSA	Nutrition-sensitive agriculture
WASH	Water sanitation and hygiene

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