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Cost-Effectiveness Analysis of USAID/Nigeria's Livelihoods Project

Final Report

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Cost-Effectiveness Analysis of USAID/Nigeria's Livelihood Project – WASH and Nutrition Component (IR3)

Final Report

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LIST OF ACRONYMS

CBA	Cost Benefit Analysis
CDC	Centers for Disease Control and Prevention
CEA	Cost Effectiveness Analysis
CRS	Catholic Relief Services
CSOs	Civil Society Organizations
DALYs	Disability Adjusted Life Years
EBF	Exclusive Breastfeeding
FCT	Federal Capital Territory
FtF	Feed the Future
GDP	Gross Domestic Product
HHs	Households
ICER	Incremental Cost Effectiveness Ratio
IRC	International Water and Sanitation Centre
IR	Intermediate Result
IYCF	Infant and Young Child Feeding
LGAs	Local Government Authorities
NDHS	Nigeria Demographic Healthy Survey
NGN	Nigerian Naira
NNHS	National Nutrition and Health Survey
ORS	Oral Rehydration Solution
POU	Point of Use
SanPlats	Sanitation Platforms
SBCC	Social and Behavioral Change Communications
USAID	United States Agency for International Development
US$	United States Dollar
WASH	Water, Sanitation, and Hygiene
WASHCOMs	Water, Sanitation and Hygiene Committees

WHO	World Health Organisation
WHO-CHOICE	World Health Organisation's Choosing Interventions that are Cost-
WHO/UNICEF JMP	World Health Organisation and United Nations Children's Fund Joint
YLD	Years Lived with Disability
YLL	Years of Life Lost

1. EXECUTIVE SUMMARY

PROJECT DESCRIPTION

The Feed the Future (FtF), Nigeria Livelihoods Project, supports 42,000 impoverished households growing their agriculture production and incomes, and improve nutrition, ensuring their move along the Pathway to Prosperity. It targets a total of seven Local Government Areas (LGAs) in the three selected states; four LGAs in Sokoto, two in Kebbi and one in Federal Capital Territory (FCT). The Livelihoods Project has an implementation period of five years, with support from the USAID and cost share from CRS and partners. It involves four main components of cross-sectoral community-based interventions, also known as sub-Intermediate Result (IR), namely; agriculture production and productivity (IR1), income generation and education (IR2), nutrition and WASH (IR3), and governance and social safety net (IR4). This cost-effective analysis (CEA) focuses on the WASH and nutrition component.

The objective of the WASH and nutrition component (IR3) is to promote optimal nutrition, provide water and sanitation access, and improve hygiene practices through interventions in WASH and nutrition areas. The total investment costs for IR 3 component is $3,170,587 as provided by CRS. This amount covers the costs of all interventions under IR3 namely; i) improved water supply, treatment & safe storage; ii) improved sanitation; iii) improved hygiene practices with focus on handwashing; and iv) improved nutrition practices including promotion of exclusive breastfeeding. This CEA covers all interventions mentioned above, however, on nutrition intervention; only promotion of exclusive breastfeeding has been included in the CEA. Other nutrition interventions such as complimentary feeding for children over 6 months, promotion of balanced diet, etc. are not covered by the CEA as further explained in section 2.4. Therefore, the total investment costs considered in the CEA are thus reduced to US$ 2,681,739.

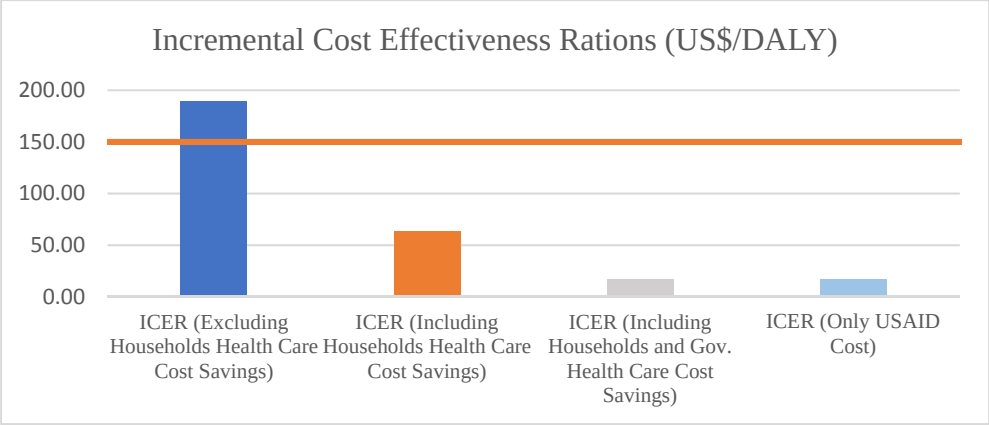
RESULTS

In the Livelihoods Project is expected to make a significant contribution in improving health and livelihoods of the beneficiary communities. The project is expected to prevent 2.1 million diarrhea cases among children under-5 years as well as to prevent 3,800 deaths due to diarrhea. For older ages (over six years), promoting WASH interventions would potentially prevent 3.5 million cases of diarrhea and 102 deaths.

i) All-Interventions Combined Incremental Cost-Effectiveness Ratios (ICER):

The analysis adopts WHO-CHOICE approach to estimate ICERs. Under the current base case assumptions, the WASH and EBF interventions of the Livelihoods Project have demonstrated to be cost-effective, with an estimated ICER of all-interventions combined of US$ 63.8 per disability adjusted life year (DALY) averted. This ratio is well within the commonly used thresholds established by the World Bank (US$ 150/DALY averted) and WHO's Commission on Macroeconomics and Health (measured by Nigeria's GDP per capita of US$ 2,092 in 2017). Table 1 below provides a highlight of USAID investment under each intervention, total benefits and ICERs.

Figure 1. Incremental Cost Effectiveness Ratios



The cost of an outpatient visit to the primary health center in Nigeria is NGN 507, while the cost per bed per day is NGN 2,211. Reduction in the incidents of diarrhea will also imply US$ 6.9 million of health sector savings. When these cost savings are included in the calculation of ICER, the ratio falls to US$16.6 per DALY averted.

ii) ICER for Individual Interventions:

Improved sanitation is the most cost-effective intervention among all the interventions at an ICER of US$ 18.5 per DALY averted, after taking into account both USAID investments and household costs. The ICER is primarily driven by the low cost at the household level, given a requirement to replace sanitation platform (SanPlats) once in several years. However, at any given point in time, a cash expenditure required to construct SanPlat may impose a challenge to the households given common cash constraint situation. The next two most cost-effective interventions are the promotion of good hygiene practices, and EBF, at ICERs of US$ 98.7 and US$ 168 per DALY averted, respectively. The least cost-effective intervention is improved water supply, water treatment at POU and safe storage with an ICER of US$ 507.6 per DALY averted. Cost of obtaining water mainly drives the higher cost of this intervention. The livelihood project involves rehabilitation of the existing water points, most of which are located at longer distances from people's houses (particularly in Sokoto). Households are currently walking an average length of 2-6 km to reach the water points. Moreover, during the dry seasons, the demand is very high that people have to queue up for an additional 30-40 minutes before they can obtain water. Although the project addresses the quality issue, where people are now able to get clean water from water points, the challenge of longer distances to water facilities still exists in the beneficiary states, which is reflected in the cost of effort and time taken to obtain water. This important observation highlights the need to facilitate improved access to clean water throughout the beneficiary states.

iii) Health Care Cost Savings:

Adoption of the project interventions also results in savings in costs related to health care services, patient treatment, and transport. The total health care cost savings have been estimated at US$ 25.4 million in present value terms, comprising US$ 18.5 million savings in households' direct costs and US$ 6.9 million from direct expenditures averted by the healthcare facilities. These cost savings will free up resources that can be channeled to other productive activities. When these cost savings are used to offset the costs of the interventions, the net ICER significantly improves to US$ 16.6 per DALY averted. In other words, these savings alone more than outweigh US$25.2 million of direct costs at the household level.

iv) Sensitivity Analysis Results

The sensitivity analysis conducted on the base case model highlights two key variables that have a significant impact on project results. These include the discount rate and interventions adoption rates. A social discount rate of 3% has been used to discount costs and benefits in the base case as recommended by WHO-CHOICE. In the sensitivity analysis, a) 6% discount rate results in an improvement in the all-interventions ICER, estimated at US$ 68.7 per DALY averted, and b) 12% discount rate, this is taken as a proxy for USAID rate of return on this project. At this discount rate, the ICER deteriorates to US$ 73.9 per DALY averted. Even at 12% discount rate the results are still way below WB benchmark of US$ 150/DALY averted.

A 10% increase in adoption rates for all individual interventions will increase the average adoption rate from 43% in the base case to 52.4% from 2018 onwards. Such an increase will drastically improve ICER to US$ 34.0/DALY averted. This implies that the HHS would enjoy more health benefits than the incremental costs they would incur from an increase in intervention activities. On the downside, a 5% decrease in adoption rates for all interventions from 2018 onwards would result in a small increase in ICER from US$ 63.75 per DALY averted to US$ 65.74. Even under these stress scenarios, the results of cost-effectives analysis are still robust.

CONCLUSIONS & RECOMMENDATIONS

This cost effectiveness analysis has demonstrated that there is a substantial financial and economic case for investing in integrated interventions in improved WASH services as well as promoting child health and nutrition through exclusive breastfeeding for infants under six months. The expected incremental health benefits far outweigh the incremental costs of investing in these interventions.

The impact of the livelihood project in improving the WASH infrastructure and livelihoods in the target states in undoubtedly huge as demonstrated by the CEA. Despite this progress, the challenge of inadequate WASH infrastructure persists in these states, especially the availability of clean water, and sanitation and hygiene facilities.

The following recommendations could further improve WASH services and reduce the prevalence of diarrhea disease in the target states:

1. ***A program on rural water supply.*** This may result in significant economic returns and may address the prevailing shortage of clean water supply in the beneficiary states. While additional analysis is required to justify the rural water supply program, this study indicates potential high economic returns of such a program. For instance, the 42,000 benefiting households from the project will incur a cost of obtaining clean water of PV USD 273 mill over next ten years. This figure is only for 42000 families compared to about 2.1 million households living in these three states. It is also excluding any potential cost savings during the wet season, that is when people are using their wells. The cost of rural water supply program, on the other hand, is unknown to the authors, preventing a precise conclusion.

2. ***Direct engagement of community leaders and/or local government authorities to support the WASH committees is strongly encouraged.*** This would help to ensure sustainability of the current business model of maintaining the rehabilitated water points. The communities have taken ownership of the rehabilitated water points and are making regular contributions to cover operating and maintenance costs. Actively involving communities' leaders would ensure WASHCOM continues its efforts even beyond the period of USAID/CRS' involvement.

3. ***Sensitization efforts in use of tippy taps should be encouraged and extended to household level and also included in the school WASH agendas.*** This would contribute to further improvement in handwashing and hygiene practices, particularly in schools. Currently, tippy taps are only implemented in public places like mosques, churches, and compounds of village chiefs. Tippy taps offer several

benefits including: improving handwashing rates, using less water, and also help build good hygiene behaviors in children from the early age.

4. ***Adoption of Rotavirus Vaccine:*** We highly recommend that the government of Nigeria intensify and expand its current efforts in the adoption of the vaccine to alleviate diarrhea disease burden in both rural and urban communities. This is in addition to the preventive measures such as WASH and nutrition interventions, and treatment measures such as Oral Rehydration Therapies that are currently being implemented. Recent studies reveal that rotavirus is the major cause of infant and childhood diarrhea in Africa [29]. The danger of rotavirus is that providing clean water and improving sanitation and hygiene do not significantly reduce the spread of the virus. Therefore, vaccination is considered the first strategy in the prevention of rotavirus infection. The health benefits of Rotavirus vaccine are well established, such that some countries adopting the vaccine have reported a substantial decrease in diarrhea mortality, by 22% - 50% among the children in under five years of age following vaccine introduction [30]. Examples of such countries include Ghana, South Africa, Malawi, Kenya, and Mali [16].

1. INTRODUCTION

1.1 PROJECT DESCRIPTION

The Feed the Future (FtF), Nigeria Livelihoods Project, is based in rural communities in Northern Nigeria's Sokoto and Kebbi states, and the Federal Capital Territory (FCT). The project uses a multi-sectoral approach that will help 42,000 impoverished households grow their agriculture production and incomes, and improve nutrition, ensuring their move along the Pathway to Prosperity.

The Livelihoods Project has an implementation period of five years, with support from the United States Agency for International Development (USAID) and cost share from Catholic Relief Services (CRS) and partners. The project targets a total of seven Local Government Authorities (LGAs) in the three selected states; four LGAs in Sokoto, two in Kebbi, and one in FCT.

It involves four main components of cross-sectoral community-based interventions, also known as sub-Intermediate Result (IR), namely; agriculture production and productivity (IR1), income generation and education (IR2), nutrition and WASH (IR3), and governance and social safety net (IR4).

Cost Benefit Analysis (CBA) of USAID Nigeria Livelihoods Project was designed as a CBA of the agricultural project. During the field visits and discussions with the implementing partner, the team determined that Water, Sanitation, and Hygiene (WASH) and nutrition component of the project should also be included in the analysis due to the cost share of this component in the total cost as well as the importance of its outcomes. The WASH component, in turn, includes several interventions: (a) improved water access, water treatment, and safe storage, (c) improved sanitation, and (d) promoting good hygiene practices, while on nutrition side (d) exclusive breastfeeding (EBF) has been included in the analysis. Cost Effectiveness Analysis (CEA) is more applicable to these interventions.

The objective of the WASH and nutrition component (IR3) is to promote optimal nutrition and water, sanitation and hygiene practices through comprehensive behavior change communication packages of interventions, with an emphasis on the first 1000-day approach [1]. These interventions aim to help break the inter-generational cycle of malnutrition and significantly reduce infant and child mortality, improve physical and mental growth and development, as well as improve the productivity of the communities in the target states.

The total budget of the IR3 (nutrition and health component) is US$ 3,170,587 as provided by CRS. This amount covers the costs of all interventions under IR3 namely:

- improved water supply, treatment & safe storage; (Included in CEA)
- improved sanitation; (Included in CEA)
- improved hygiene practices; and (Included in CEA with focus on handwashing)
- all nutrition categories of interventions, including promotion of exclusive breastfeeding. (Only exclusive breastfeeding is included in CEA; all others are excluded).

As can be seen from the above, other than exclusive breastfeeding, nutrition interventions such as complimentary feeding for children over 6 months, promotion of balanced diet, etc. are not covered by the CEA. Therefore, the total investment costs are reduced to US$ 2,681,739. This cost figure was derived through a detailed review of the CRS cost break down, however, it may not be 100% accurate as it was challenging to allocate overheads and other general expenses to a particular intervention.

The following sections explain in detail the project's primary interventions under the IR 3 component.

1.2 DESCRIPTION OF INTERVENTIONS

Feed the Future Nigeria Livelihoods Project's primary activities under the nutrition and WASH (IR 3) component are further divided into two categories as explained in the following sections:

Promote adoption of Improved Hygiene Behaviors

The project supports the Water, Sanitation and Hygiene Committees (WASHCOMs) to influence the community practices related to WASH through advocacy and community engagement. The key areas of project interventions under this component include:

- Rehabilitation of water points to increase access to safe water by the households.
- Establishing and encouraging use of sanitation platform (SanPlat) latrines to improve sanitation facilities.
- Promoting treatment of drinking water and safe water storage practices, such as introduction of Becky pot.
- Promoting good hygiene practices such as hand washing with soap in critical moments, among others.

Rehabilitated water point in Tangaza LGA

Highlights of Intervention Achievements By 2017 Q3:

- 150 water points were rehabilitated
- 2,445 households constructed SanPlat latrines
- 28 local potters were trained on Beck pot construction and 300 Becky pots produced and supplied in 2017 Q3.
- Households treating water increased from a baseline of 6.1% to 14.6% in 2016.
- Households washing hands during critical moments increased from baseline of 6.6% to 36% in 2016.

Distribution of a Becky Pot in Bwari,

Promote adequate nutritious diet for all households

The project supports Civil Society Organizations (CSOs) to train, engage and mentor caseworkers, community health workers, liaisons, and liaison supervisors on improved knowledge, better attitude and best practices on nutrition, child health, and hygiene. This knowledge and best practice gets passed down to caregivers and households during home visits or monthly group sessions through what is referred to as nutrition and hygiene key messages. Some of the key messages on nutrition include: early initiation of breastfeeding and exclusive breastfeeding for children under six months, and appropriate complementary feeding for children above six months.

Highlights of Intervention Achievements By 2017 Q3:

- 120 Community Health Workers were trained on Infant and Young Child Feeding (IYCF).

Training for community health workers in Sokoto

- 541,339 beneficiaries trained on nutrition and hygiene.
- 114,979 children under-5 were reached with nutrition and health services, including malnutrition screening and referrals.
- 1,423 caregiver groups and 1,030 liaisons/liaison supervisors were involved in nutrition and hygiene counselling.

2. CEA COVERAGE AND RATIONALE

The CEA is a tool that is generally adopted for evaluation of interventions in health as recommended by the World Health Organization (WHO). The following sections explain the four main areas this CEA focuses on and the underlying rationale.

2.1 IMPROVED WATER SUPPLY, WATER TREATMENT AT POINT OF USE (POU) AND SAFE STORAGE

The CEA under this intervention evaluates the combined effects of improved water supply through the rehabilitation of existing water points and further improvement in water quality through household-based treatment and safe storage. WHO/UNICEF Joint Monitoring Program for Water Supply, Sanitation and Hygiene (JMP) reports that up to 46% of Nigeria's rural population of 95 million lacked access to safe drinking water in 2015 [2], and the situation is even worse in Northern states. Lack of safe water, basic sanitation, and hygiene may account for as much as 88% of the disease burden due to diarrhea [3]. According to UNICEF, an estimated 124,000 children under the age of five die every year because of diarrhea, mainly due to unsafe water, sanitation, and hygiene [4]. However, an IRC study shows that this type of intervention would reduce diarrhea morbidity by over 29% [5], and mortality by 13.4% [6], thereby justifying the significance of improved water supply to public health.

2.2 IMPROVED SANITATION

Improving the quality of water for consumption affects the transmission of diseases through the waterborne route. The diarrhea infections can also be transmitted fecal-orally through other ways such as by contamination of fingers, food, crops, and flies, which are all referred to "water-washed" routes. Improved sanitation and hygiene can contain the spread of water-washed diseases. WHO/UNICEF JMP reports that over 70% of Nigeria's rural population lack access to improved sanitation, and open defecation rates in rural areas stand at 36%. The IRC study echoes on the need to improve sanitation and reveals that this intervention can reduce diarrhea morbidity by up to 34%.

2.3 PROMOTION OF GOOD HYGIENE PRACTICES WITH FOCUS ON HANDWASHING WITH SOAP

Promotion of good hygiene practices is very critical in controlling the spread of infectious diseases. The CEA under this intervention focuses on handwashing with soap during critical times. Good hygiene practices in Nigeria are one of the lowest in the world with only 13% of the country's population (7% in rural areas) having handwashing facilities with soap and water. Studies indicate that hand-washing with

soap at critical times can reduce the number of diarrhea cases by almost 37% and diarrhea deaths by up to 50% [7]. However, the less readily available water is, the less likely that good hygiene will be practiced in households [8], emphasizing the need for the integrated approach in implementation and management of the WASH interventions.

2.4 EXCLUSIVE BREASTFEEDING (EBF) FROM BIRTH FOR CHILDREN UNDER 6 MONTHS

EBF intervention directly involves children under 6 months of age. Due to this, the assessment of health impacts on this population has been done separately from all the other age groups of the target population. The other categories of nutrition interventions have not been included in this analysis. This is mainly because this would have required its own comprehensive assessment as it targets children from six months to school age (i.e. 14 years). However, due to limited resources, it has not been covered under this analysis. Also, among all the interventions undernutrition, EBF has had a higher adoption rate by the beneficiaries, particularly in Sokoto and Kebbi. The Lancet report explains that EBF has a potential to reduce child mortality by 13% and child morbidity by up to 40%, particularly in countries with high diarrhea mortality like in sub-Saharan African [9] [10] [11].

3. METHODOLOGY

The analysis adopts cost-effectiveness approach followed by WHO-CHOICE. [12] The costs and health impacts of WASH and EBF interventions of the Livelihoods Project (or “with” project scenario) are compared with the costs and health impacts of the existing WASH and EBF practices by the households (or “without” project scenario). The difference then measures how much better off the project beneficiaries are compared to what their alternative likely would have been in the absence of the project.

The costs include the incremental direct and indirect costs of providing the household's access to WASH and exclusive EBF practices, while the main benefits are averted morbidity and mortality cases of diarrhea, additional benefits include the incremental benefits associated with savings in health care costs of medical treatment, hospitalization, and transportation.

CEA of these interventions requires the availability of the baseline assessment and final impact assessment studies to derive “without” and “with” project scenarios, respectively. However, these two studies were not available when the assignment was undertaken. In view of this, “without” and “with” project scenarios have been estimated by using data from intensive literature review, project’s survey and progress reports as well as data collected by CBA team during the field visits in September-October 2017.

In constructing the baseline or "without" project scenario, the estimates of direct costs incurred by the households (HHs) for the interventions and health care services have been sourced from literature, particularly, WHO-CHOICE unit cost database [12] and data collected from interviews with the HHs during the field visits. In estimating health benefits, the baseline prevalence rates of diarrhea morbidity and mortality in the target states have been derived from literature and national statistics. The sources included (NNHS 2015), Nigeria Demographic Health Survey (NDHS 2008 & 2013), UNICEF, WHO, IRC and reputable journals in public health, water, and sanitation such as The Lancet. To develop "with" project scenario, we used data from project survey, CRS/USAID progress reports, field visits, and literature to estimate the contribution of the WASH and EBF interventions to the reduction of the baseline diarrhea morbidity and mortality rates. The incremental costs and benefits are then used to compute the incremental cost-effectiveness ratios. Sections 5 and 6 below provide the details of how the costs and benefits in "without" and "with" project cases have been derived.

The analysis has been restricted to infectious diarrheal as the principal health outcome measure because it accounts for the main disease burden associated with poor water, sanitation and hygiene.[1] A WHO study shows that 94% of this disease burden is attributable to the environment, including risks associated with unsafe water, lack of sanitation for safe disposal of excreta, poor feeding practices among children, and unhygienic practices, particularly lack of handwashing with soap following critical moments [13]. The analysis has been carried out over a period of 10 years, starting in 2015 and ending in 2024, including an actual investment period of four years. The benefits from each intervention are expected to accrue in the year following the investments. The total investment costs incurred by the WASH and EBF interventions (excluding other areas of nutrition category) is US$ 2,681,739.

The results of the project are expressed in terms of number of diarrhea cases averted (i.e. reduction in the number of diarrhea episodes), number of death averted (i.e. reduction in death due to diarrhea), and disability adjusted life years (DALYs) averted.[2] The incremental cost effectiveness ratios (ICER) are expressed in terms of US$ cost per DALY averted. The ICER are estimated as present value of incremental streams of all intervention costs divided by present value of additional DALYs averted due to fewer diarrhea. The discount rate used in estimation of ICER is taken as 3% as recommended by WHO CEA guideline. The following sections explain in detail the scope and estimation of costs and the associated health benefits of the interventions.

4. LIMITATIONS OF THE MODEL AND ANALYSIS

Although CEA is a powerful tool and can play a vital role in setting development priorities and comparing the effectiveness of a set of interventions, it is also important to understand the limitations to the precision of the results of the analysis. This section highlights the five main sources of weaknesses of the model that could potentially have an impact on the results:

1. The lack of baseline and final impact assessment studies to derive the data required for the CEA. For instance, the data on prevalence rates of diarrhea had to be taken from the intensive literature review and national statistics.
2. Estimating actual USAID total costs by individual intervention was a challenge because the IR3 component is implemented as a package (through SBCC) and spans several interventions under the IR3 component. Therefore, the amount of USAID investment cost by intervention included in the CEA was derived through a detailed review of the CRS cost breakdown. However, it may not be 100% accurate as it was challenging to allocate overhead costs and other general expenses to a particular intervention.
3. The analysis assumes that the total beneficiary population of the project 42,000 households. However, households expressed that people from other communities surrounding the project communities were also benefitting from the project, especially from the use of water points and exclusive breastfeeding. Due to lack of precise data on the number of these additional people, 42,000 is used.
4. There is a general dearth of data on diarrhea in populations older than five years. Therefore, the baseline data on diarrhea morbidity is assumed to be at levels lower than the under-five year's rates as supported by literature, and the national mortality rates for this age group are assumed to be representative of the target states.

[1] Diarrheal diseases include typhoid and cholera. Prevalence of malaria was also observed during the interviews with beneficiaries; however, it has not been included in the analysis because the reported reduction in malaria cases due to the USAID project interventions was not very significant.

[2] DALY is a combined morbidity and mortality measure of public health widely used to quantify burden of disease. It measures the potential years of life lost due to premature death and years of ‘healthy’ life lost by virtue of being in states of poor health or disability.

5. The adoption rates for all individual interventions, except the use of SanPlat latrines, from 2018 onwards have been assumed to maintained at the level of 2017 adoption rates. During the interviews with households, they expressed some reluctance (especially in FCT) in adopting the use of SanPlats due to cultural beliefs. Therefore, in the base case, we assumed that there will be no new annual adoption of SanPlats latrines from 2018 until end of the projected period.

These limitations could potentially underestimate and overestimate the costs and benefits of the project. Because these limitations are equally likely to affect both the "without" and "with" project scenarios, the impact on the incremental cost effectiveness ratios is likely to average out. Furthermore, sensitivity analysis has been used to quantify some of these limitations to provide a range of possible incremental cost-effectiveness ratios of the interventions.

5. BASE CASE PROJECT RESULTS

5.1 HEALTH IMPACTS

In the base case scenario, the Livelihood project is expected to make a significant contribution in improving health and livelihoods of the beneficiary communities. By promoting the WASH services through the livelihood project in the beneficiary states, 2.1 million diarrhea cases among children of under-5 years would be avoided, 3,800 deaths due to diarrhea will be prevented and 134,000 DALYs would be gained - all in present value terms over the projected period. For older ages (over 6 years), promoting WASH interventions would potentially prevent 3.5 million cases of diarrhea and 102 deaths and 13,000 years of DALY averted. The higher number of diarrhea cases in the over 6 years age group compared to the under-five is primarily driven by the population size, where over 75% of the population in the beneficiary states is within the 6-64 years age group, while under 5 make up 17% of the population. The number of deaths for the population over 6 years is lower than that of the under-5 years supporting the literature that diarrhea is unlikely to be life-threatening at the ages above 6 years [13].

By promoting exclusive breastfeeding rate from the 45% in “without the project” scenario to an average of 68% over the 10-year period in the “with project scenario”, the number of exclusive breastfed children increased by about 52%. This increase in exclusive breastfed children is expected to prevent 41,000 diarrhea cases (in present value terms) in infants over the 10-year projected period. The number of infant DALY's averted is expected to increase by 2,444 years over the 10-year period.

The ICER has also been estimated to determine the interventions that offer substantial health benefits at relatively lower costs. The incremental ratios have been computed from three different perspectives:

1. **Combined point of view:** Considers all of the costs of the project interventions, both the investment (by USAID) and direct costs incurred by the households from adopting the interventions. ICER of this scenario is US$ 63.8 per DALY averted.
2. **USAID point of view:** This takes into account only USAID investment costs of the project interventions. ICER of this scenario is US$ 16.4 per DALY averted.
3. **Economy point of view:** This scenario includes both USAID costs and households’ costs. Also, it incorporates cost savings accruing to the health sector of Nigeria due to the reduction in outpatients and inpatients visits. ICER of this scenario is also equal to US$ 16.4 per DALY averted.

Table 1: Incremental Cost Effectiveness Ratios from Different Points of View – Base Case

Project Intervention	Present Value USAID Investment Costs (USD mill)	Present Value Beneficiaries Costs (USD mill)	DALYs Averted (000')	ICER (USAID Cost/DALY) US$	ICER (Total Cost/DALY) US$
1. Improved water supply, water treatment at POU & safe storage	0.7	20.5	41.8	17.2	507.6
2. Improved sanitation	0.7	0.2	49.0	14.14	18.5
3. Good hygiene practices, focus on handwashing with soap	0.7	4.5	53.3	12.2	86.4
4. Exclusive breastfeeding	0.4	-	2.4	168.0	168.0
5. Health care and medical cost savings by households		(18.5)			
All Interventions Combined	**2.6**	**6.8**	**146.6**	**16.64**	**63.8**

The estimated ICERs are well within the different cost-effectiveness thresholds recommended in the industry, proving that the Livelihoods Project's interventions are cost-effective. For instance, the World Bank considers interventions that cost lower than US$ 150 per DALY averted as cost-effective.

5.2 EFFECTIVENESS OF INDIVIDUAL INTERVENTIONS

This section discusses the results of the individual interventions. These ICERs are estimated excluding the households cost savings from the reduction in transportation costs and costs of drugs that the households would incur if they get sick. These avoided costs are "indirect" benefits to the households and are discussed in more details in the following section.

Improved sanitation is the most cost-effective intervention among all the interventions at a cost/Daly averted ratio of US$ 18.5, after taking into account both USAID investments and household costs. The lower costs of sanitation are driven by, the lower frequency at which SanPlats latrines are required to be replaced over the projected period. Unlike all other interventions, the construction of SanPlat latrines occurs once every three years (at the minimum depending on the depth of latrine), while at the same time the health benefits accruing to the entire population due to promoting the use of SanPlat latrines as opposed to open defecation are enormous. Also, production of SanPlats provides the additional source of income to the local masons, who produces and sells it at a net profit of around NGN 350 for each SanPlat. This additional income is not included in this analysis.

The next most cost-effective intervention is promotion of good hygiene practices with focus on handwashing with soap promotion at a cost/Daly averted ratio of US$ 86.4. The handwashing soap is the most expensive item in this intervention, making up over 50% of the total costs incurred by households for handwashing and hygiene promotion. Construction of tippy tap is the least cost making up only 0.4% of the total cost of this intervention, followed by hygiene promotion making up only 11% of the total household costs for this intervention.

Exclusive breastfeeding is the third cost-effective intervention, with a cost/Daly averted ratio of US$ 168. Although the households would incur very minimal to no direct cost for this intervention, the USAID investment costs that have been currently assumed to go to this intervention are quite high compared to the

benefits that would be obtained, which only come from the infant population of 0 to 6 months. This age group make up just 3.5% of the entire population in the beneficiary states.

The least cost-effective intervention is improved water supply, water treatment at point of use, and safe storage with a cost/Daly averted ratio of US$ 507.6. The higher cost of this intervention is largely driven by high cost of obtaining and treating water at the point of use. The Livelihoods Project involves rehabilitation of the existing water points, most of which are located at longer distances from people's houses (particularly in Sokoto where most of the project beneficiaries are). Households are currently walking an average distance of 2-6 km to reach the water points. Moreover, during the dry seasons, the demand is very high that people have to queue up for an additional 30-40 minutes before they can obtain water. Although the project addresses the quality issue, where people are now able to get clean water from water points, the challenge of longer distances to water facilities still exists in the beneficiary states, which is reflected in the cost of effort and time taken to obtain water. This time cost accounts for PV of USD 17.4 million. The households, particularly in Sokoto, do not collect water from the standpipes in the wet season. The water treatment cost is PV of USD 10.6 million, which households spend to treat the water they obtain from wells during wet season.

Safe water storage through use of Becky pots is the least cost component in this intervention. Although Becky pots require higher initial cash outlay, they do result on significant water storage cost savings given the prolonged life of the pots when compared to the average life of the plastic jerry cans traditionally used by the households. The use of Becky pots generates a cost savings of USD 7.5 million (in PV terms) to the households. Therefore, the total incremental cost of this intervention is USD 20.5 million. Furthermore; the production of Becky pots also provides an additional source of income to the potters, including women who have been trained to produce these pots. The Livelihood 2017 Q3 report stated that 28 local potters were trained and they produced 300 Becky pots. Becky pots are sold on an average unit price of 817 Naira. Therefore, assuming approximately 35 potters are trained every year by the project, and each potter produces about 10 Becky pots per year, and the profit margin is 15 %, the Present value of potters' income over ten years period amounts to USD 7,000.

5.3 HEALTH CARE COST SAVINGS

The potential health care and medical treatment cost savings by households amount to US$ 18.5 million in present value terms over the projected period, averaging US$ 2 million per year (in real terms). This translates to a patient cost saved per capita of US$ 3.5. This is money saved from payment for health services, patient treatment, and transport. These benefits are very important for households, especially in this case where they have to buy drugs out of pocket to get the treatment required and have to travel relatively long distances to access community clinics and/or district hospitals in case of referral cases. It should be noted that the majority of rural households in Nigeria are cash constraint, and in the case of sickness, frequently borrow from communal savings groups at a very high-interest rate of 10 percent per month. In areas where the communal savings groups are not available, households may not be able to visit hospitals even when the illness is severe.

In addition to the direct costs saved by households, the investment in EBF and WASH interventions would save the direct costs incurred by health care facilities, amounting to US$ 7 million in present value terms over the projected period, averaging US$ 785,000 per year (in real terms). These are direct expenditures averted by the health sector (through the LGAs managing the community and district health clinics) due to reduced levels of diarrhea disease.

These cost savings would free up resources that can be channeled to other productive activities. Moreover, in assessing the overall incremental cost effectiveness of WASH and EBF interventions of the project, the total gross incremental costs (household + USAID investment) for all interventions estimated at US$ 27.8

million would be significantly offset by the total health care cost savings of US$ 25.4 million, resulting to a net incremental cost of the interventions of only US$ 2.4 million as presented in the table below.

Table 2: Health Care Cost Savings Offsets

Health Care Cost Savings from All Interventions	
	NPV (Million USD)
Health Care Cost Savings	-
From Health Care & Medical Costs by Households	
Health care & medical treatment costs - without project	64.7
Health care & medical treatment costs - with project	46.2
Health care & medical treatment costs savings for households	(18.5)
From Health Care Facilities Costs	
Unsubsidized health care facilities costs - without project	10.9
Unsubsidized health care facilities costs - with project	4.0
Unsubsidized health care facilities costs savings	(6.9)
Total health care & medical cost savings	**(25.4)**
Total Gross Incremental Costs of Project Interventions	
Total Households incremental costs (Gross)	25.2
Total USAID incremental costs (Gross)	2.6
Total Gross Incremental costs of all interventions	**27.8**
Total Net Incremental costs of all interventions	**2.4**

6. ESTIMATION OF INTERVENTIONS COSTS

The following sections provide the detailed assumptions in the estimation of costs for each intervention under both "without" and "with" project scenarios to derive incremental costs used for the CEA.

6.1 IMPROVED WATER SUPPLY, WATER TREATMENT AT POU AND SAFE STORAGE

Without the Project:

In the absence of the project, the HHs' access to improved water supply was limited due to lack of clean water facilities, such as available functioning water points and protected wells. During the dry season, the HHs consumed water from streams (making about 52% of total consumption) and during wet season the HHs met their water needs from open wells (48% of total consumption). Prior to the rehabilitation of existing water points, there were no available functioning water points in the target states, thus, we have conservatively assumed that before the project there was no consumption from water points. A total required consumption is estimated at 40 liters per person per day as per WHO requirements and this amount was verified during the field visits. On average, the HHs spent NGN 4.0 (US$ 0.021) per liter to obtain water from a streams and NGN 1.0 (US$ 0.01) per liter to obtain water from open wells. This cost is mainly

associated with effort and productive time spent by households to fetch water from these sources.[3] Furthermore, only 6.1% of households treated their drinking water and stored water in safe storage containers prior to the Livelihoods Project. The average cost of treating water is estimated at NGN 5.8 (US$ 0.03) per liter.[4] The cost of water storage, using traditional utensils is estimated at NGN 20 (US$ 0.10) per liter and lasts for about three years before requiring a replacement. In the absence of the project, it is estimated that households would on average spend 13% of their income to obtain water for consumption.

With the Project:

The project fully rehabilitated up to 150 water points by Q3 of 2017, comprising manual handpumps, motorized standpipes, and solar-powered standpipes. With the availability of functional water points and hygiene promotion initiatives by the project, the HHs' consumption pattern has changed as their demand for quality water increased. After a two-year ramp-up period for adopting water points, the HHs now consume about 52% of total water consumption from water points during the dry season, and 48% from protected wells during the wet season. Very few to none of the HHs consumed water from streams in dry season since the existence of water points in 2016. This is partly because the HHs now understand the benefits of using clean water and prefer to use water from water points than streams. Also, water from streams becomes very scarce during the dry season due to the prevailing hot temperatures that dry up the streams. Therefore, in with project scenario, we have conservatively assumed that there is no consumption from streams from 2017 onwards. On average, HHs are currently spending NGN 4.4 (US$ 0.023) per liter to obtain water from the water points. The cost of obtaining water from water points is slightly higher than the other sources due to an additional contribution of NGN 10 per jerrycan or (NGN 0.4 per liter) that the HHs have to make to cater for future maintenance and repair costs of the water points.

The households have also been trained and educated to cover their private wells, treat water and also to store water in recommended safe containers. About 14.6% of households were treating water and storing it in safe containers by end of 2016, up from only 6.1% in "without" project case. By 2017, it was projected that 60% of households will be treating and storing treated water in safe storage utensils such as a Becky pot. The Becky pot utilization rate is estimated at 40%. The cost for treating water remains at NGN 5.8 (US$ 0.03) per liter, while the costs for storing water slightly increases to NGN 53 (US$ 0.27) per liter, including the cost of the Becky pot at an average unit cost of NGN 817 (US$ 4.3) for each. Becky pot capacity is 25 liters. The benefit with the Becky pot is that it takes about five years, in some cases longer, to require a replacement. The investments cost by USAID allocated to this intervention is about US$ 0.8 million. This is to cover the costs of fully rehabilitating existing water points and project personnel.

6.2 IMPROVED SANITATION

Without the Project:

Before the livelihood project, there were no SanPlat latrines, and the HHs in the beneficiary states were practicing open defecation. This was largely due to social and cultural beliefs as well as lack of education and knowledge on the benefits of improved sanitation. The direct costs incurred by the households for practicing open defecation is zero. The indirect costs spent by households on health effects such illnesses from oral-fecal pathogens is explained in section 6.

With the Project:

[3] The cost of effort and opportunity cost of time to fetch water has been derived from an average rural wage rate of NGN 800 per person and an assumption that 50% of the households' productive time is lost in fetching water.
[4] Water is commonly treated using water guard, filtering and boiling in the beneficiary states.

Through the Livelihoods Project, households have been educated and trained on the benefits of using improved sanitation facilities and on how to construct the SanPlat latrines. By 2017, about 2,445 households (i.e. 6% of total households in beneficiary states) had established SanPlat latrines. It has been conservatively assumed in the analysis that the number of households establishing SanPlat latrines will be maintained at this level from 2017 until end of projections in 2024. On average, the households are currently spending a total cost of NGN 7,700 (US$ 31) in labor and materials required to construct one SanPlat latrine. The estimated useful life of a SanPlat latrine is three years. Thus, HHs will only have to incur additional costs of replacement after every three years. Replacement costs have been estimated at the same level as initial costs but adjusted for the domestic inflation. The investments costs by USAID allocated to this intervention is about US$ 0.7 million.

6.3 HANDWASHING WITH SOAP AND HYGIENE PROMOTION

Without the Project:

In the “without-project” situation, only about 6.6% of households in beneficiary states were practicing good hygiene behaviors, particularly handwashing with soap during the critical moments. These HHs spent an average cost of NGN 632 (US$ 3.3) per capita per year in water, soap, handwashing facility (e.g., bucket or cup) and time required to wash the hands.

With the Project:

With the introduction of the Livelihoods Project, the number of households washing hands with soap and practicing good hygiene activities increased from 6.6% to 36% in 2016. The project forecasted this rate to increase to 37% in 2017. The HHs spent an average of NGN 836 (US$ 4.4) per capita per year in water, soap, handwashing facility (including tippy tap) and time required to wash the hands. The project has introduced a handwashing facility called "tippy tap" which at present is mostly practiced in public places such as churches, mosques, and village heads compound. It is assumed that about 10% of households have access to tippy taps and the cost of constructing one tippy tap is estimated at NGN 211 or US$ 1.1 per capita per year. The investments cost by USAID allocated to this intervention is about US$ 0.8 million to train project personnel who would pass down the knowledge to the households.

6.4 PROMOTING EXCLUSIVE BREASTFEEDING

Without the Project:

The baseline breastfeeding rate in the beneficiary states was 45% in 2014 as provided in the Project's annual survey. This is the EBF rate that has been used in the “without project case” situation. At the household level, it is conservatively assumed that households incurred no direct costs from practicing EBF. This is because the breast milk is sourced naturally from the lactating mothers. There are some costs that households may incur from practicing EBF such as the costs of additional food for a lactating mother and value of a mother's time for breastfeeding. A WHO study conducted in Cote d'Ivoire estimated an average annual cost of the mother’s diet at US$139 in 2015 prices (US$77 in 1990). Despite this cost, the study confirms that there are tremendous household cost savings, estimated at the average of US$492 in 2015 prices (US$271 in 1990) per year associated with EBF (after deducting the increased dietary cost of mothers) compared to the alternative of feeding the child with breast-milk substitutes [15].

Although the estimated cost of mother’s time for breastfeeding a child has not been explicitly included in this study, the time that a mother would spend breastfeeding a child would equate to the time the mother would spend to prepare the breast-milk substitute and feed the child, therefore, the incremental impact

would most likely be close to zero. As we note from literature review, the household cost savings generated from breastfeeding far outweigh the indirect costs that households may incur from practicing EBF.

For the Livelihoods Project, the household costs of time and mothers diet as well as the household cost savings from exclusive breastfeeding have not been included in the CEA because team did not have sufficient information to develop estimates. However, the health benefits associated with the promotion of exclusive breastfeeding for infants have been incorporated in the CEA, as reflected in the reduction of diarrhea cases, death, DALYs averted as well as health care cost savings.

With the Project:

With the introduction of the project, EBF rate in the beneficiary states increased to 70% in 2016. We have assumed that EBF rate in target states will remain at 70% from 2018 until the end of the projected period. Among all the interventions under the IR3, EBF has been identified to have the highest adoption rate by households, particularly in Sokoto (Kebbe LGA), where EBF was reported to be as high as 93.6%. USAID investments towards EBF intervention is estimated at US$ 0.4 million. Just like in the "without" the project scenario, the direct and indirect costs at the household level are not included in the analysis.

7. ESTIMATION OF INTERVENTIONS BENEFITS

There are several health benefits resulting from improved WASH services and promotion of EBF. The two main benefits covered in this analysis include the following:

1. **The indirect benefits related to health improvement.** These measures productivity effects of improved health as captured by the reduction in diarrhea morbidity and mortality cases, as well as DALYs averted.
2. **Direct benefits of avoiding diarrhea disease.**[5] This consists of costs averted due to prevention or early treatment of the disease. These include averted health care costs of medical treatment, hospitalization and transportation.

Because the EBF interventions impact children of under 6 months of age only while all other interventions affect the entire population, the analysis separates the estimation of health impacts associated with EBF for this age group (under 6 months) from the rest of the population to avoid double counting and at the same time to correctly capture the health impact of EBF on the under 6 months children.

To this effect, the population has been separated into three groups, namely: infants (0 - 5 months), non-school age children (6 months - 5 years), and older children and adults (over 6 years). To estimate the health impacts for infants (i.e., EBF), we note from the interviews with the beneficiaries that if the children are not exclusively breastfed, the parents use water, herbs, and local food as complimentary food to breastfeeding. It is through this route and practice that the infants get infected with the diarrheal disease. For the rest of the age groups (over 6 months), the interventions that directly impact them are water, sanitation, and hygiene. The total number of households targeted by the project is 42,000. With an average household size of 5.4, the total target population in the beneficiary states is 226,827. This is the minimum number of people that would benefit from the project interventions throughout the projected period.[6]

[5] "Direct" includes the value of all goods, services, and other resources that are consumed in the provision of an intervention or in dealing with the side effects or other current and future consequences linked to it (WHO).
[6] The actual number of people that would benefit from the project may be higher than this. During the field trip, CBA team observed that other communities surrounding those where the project is taking place are learning from the project communities and benefitting from the project interventions, particularly EBF and water supply.

7.1 INDIRECT BENEFITS OF IMPROVED HEALTH

a. Reduction in Diarrhea Morbidity

Morbidity refers to the state of being diseased or unhealthy within a population. To estimate the reduction in diarrhea morbidity, the number of diarrhea cases for the population in the beneficiary states in both “without” and “with” the project situations are estimated. The difference in diarrhea cases between these two situations captures the reduction in diarrhea cases or morbidity.

In "without" project scenario, diarrhea morbidity rates for the children under five years have been sourced from NNHS 2015. The morbidity rates in the states of intervention are estimated at an average of 7% for infants (i.e., under six months) and 31% for non-school age children (i.e., aged six months - 5 years) [16]. Due to a general shortage of data on diarrhea rates in populations older than five years, the baseline data on diarrhea morbidity for the population over six years has been assumed at 5%, as guided by literature. These rates are applied to the associated population age groups to estimated diarrhea cases in the target states before the livelihood project. To construct "with" project morbidity rates, we have used the WHO's IRC data on the effectiveness of WASH and EBF interventions to reducing diarrhea morbidity and multiplied this data with the incremental adoption rates of each intervention to derive the effective contribution rates of each intervention to diarrhea morbidity reduction. These effective reduction rates are then multiplied with baseline diarrhea morbidity to estimate "with" project diarrhea morbidity rates and consequently derive the diarrhea cases “with the project” interventions.

b. Reduction in Diarrhea Mortality

Mortality is the number of deaths per population in a given time or place. To estimate the reduction in diarrhea mortality, the number of deaths due to diarrhea for the population in the beneficiary states in both “without” and “with” the project situations are estimated. The difference in diarrhea deaths between these two situations captures the reduction in diarrhea mortality. The baseline diarrhea mortality rates have been sourced from UNICEF and other research institutions, at an estimated 1.4% and 2.3% for infants and non-school age children, respectively [18] [4]. The mortality rates for the population over six years have been represented by the national-wide diarrhea mortality rates, averaging 0.067% for this age group [19]. These rates are then multiplied by population age groups to estimate the number of deaths due to diarrhea in the target states before the livelihood project. Diarrhea mortality rates “with” the project have been estimated using the effectiveness ratios of WASH and EBF interventions to reducing diarrhea mortality as well as the incremental adoption rates of each intervention to derive the effective contribution rates of each intervention to diarrheas mortality reduction. These effective reduction rates are then multiplied with baseline diarrhea mortality to estimate "with" project diarrhea mortality rates and consequently derive the number of death due to diarrhea “with” the project interventions.

It is worth noting that diarrhea morbidity and mortality rates decline as the child ages and remain relatively constant during adulthood. The prevalence of diarrhea morbidity and mortality are particularly highest among the children aged between 6 months to 2 years because this is a delicate transition period when children are introduced to complementary feeding. Table 5 in the Annex provides a summary of key parameters used in estimating reduction in diarrhea morbidity and mortality rates.

c. Number of DALY’s Averted

People may lose healthy life years through living with illness and through dying before a reference life expectancy. These losses in healthy life years are measured by a population health metric known as DALY, which combines the health effects of both diarrhea mortality and disability (morbidity). It is calculated as the sum of Years Lived with Disability (YLDs) and Years of Life Lost due to premature mortality (YLLs).

The estimation of YLD (also known as morbidity DALY) takes into account the disability weight and age weights to capture the severity of the illness and relative value of life. To derive the incremental morbidity DALYs (or YLD), the estimated incremental number of diarrhea cases are multiplied by the duration of the illness (taken as ten days for the under-5 years and seven days for those over five years), disability weight and age weight. Diarrhea disability weights are taken from The Lancet study at 0.35 for severe cases and 0.184 for mild cases [20], while age weights are sourced from the WHO at 0.05 for infants and 1 for those above six months [21]. To derive incremental mortality DALYs (or YLL), the incremental number of diarrhea deaths are multiplied by mortality DALYs lost at the age of death. The mortality DALYs lost per age group are sourced from the World Bank study, estimated at 32.5 years for the under-5, 29 years for school-age children (aged 6-14 years) and 12 years for adults (over 15 years) [22].

7.2 DIRECT BENEFITS – HEALTH CARE COST SAVINGS

These are cost savings related to seeking less health care due to fewer cases of diarrhea occurrences among the households. Health care cost savings are estimated as a function of treatment seeking rates, medical practices and unit costs of medical services. The direct costs of health care service comprise the costs of drugs for treating the illnesses (in this case its mostly Oral Rehydration Solutions - ORS, Zinc treatment and prescribed antibiotics for adults), consultation, transportation, and cost of hospitalization (covering feeding and bed days).

Drug costs are estimated at NGN 411 (US$ 2.1) per treatment course, the average cost of consultation (i.e. purchase of card required before consultation) in beneficiary states in NGN 35 (US$ 0.2) per new visit and cost of hospitalization is estimated at NGN 785 (US$ 4.1) per bed day. Regarding transportation, we have assumed that 30% of the diarrhea cases for the under-5 years children and 5% of cases for those over six years would visit the hospital for treatment [14]. Out of the total cases that visit the hospital, the severe cases that would require hospitalization are estimated at 10% for the under-5 years and 50% for those over six years. The higher rate of hospitalization for older children and adults is based on the assumption that this age group would only visit the clinic if the case is so severe that the probability of being hospitalized in this situation would be very high. Due to lack of adequate hospitalization facilities at the community clinics, we have assumed that all the hospitalized cases will be referred to the district clinic, which is located on average 20-30 km away from the communities. The average transport costs to community clinic and district clinic are estimated at NGN 1,000 (US$ 5.2) and NGN 5,750 (US$ 30) per return visit, respectively.

Besides the household costs, there are also costs that are incurred by the healthcare facilities such as personnel, capital, and food costs. Using the unit cost data from WHO-CHOICE database, we have estimated unsubsidized outpatient costs per visit of NGN 507 (US$ 2.6) and inpatient cost per bed day of NGN 2,211 (US$ 11.5). Regarding financial obligation, these costs are assumed to be fully subsidized by the government. However, there is an economic impact that these costs have on the government budget. Due to the project and fewer cases of diarrhea incidences, these costs are expected to be significantly reduced, thereby freeing up resources that can be utilized in other productive sectors within the economy of Nigeria.

8. SENSITIVITY ANALYSIS RESULTS

A sensitivity analysis has been conducted on the base case model, using combined point view, to show the impact on the gross ICER of varying different parameters. Several project parameters have been tested including macroeconomic variables such as Nigeria's inflation rate, US' inflation rate, and fluctuations in real exchange rate; interventions adoption rates; age and disability weights; population growth rate; and the discount rate. The macro-economic variables such as fluctuations in the real exchange rate do not have big impacts on CERs because after 2018 there is assumed to be no further US dollar denominated investment

from USAID, and the only costs that will be spent are those from households which are denominated in Naira. Also, changes in disability weights and age weights in the calculation of morbidity DALYs (YLD) have minimal impacts on the project's ICERs.

Therefore, the key project variables that have been identified to have the significant impact on project results include the discount rate and interventions adoption rates. These key risk variables are discussed in detail below, while Table 4 presents the summary results of the sensitivity analysis.

Discount Rate

1. Discounting is the process of converting the future stream of costs and benefits to their present values. It reflects the belief that, in general, society prefers to receive benefits sooner rather than later, and pay costs later rather than sooner. A social discount rate of 3% has been used to discount costs and benefits in the base case as recommended by WHO-CHOICE. In the sensitivity analysis, a) 6% discount rate results in an improvement in the all-interventions ICER, estimated at US$ 68.7 per DALY averted, and b) 12% discount rate, this is taken as a proxy for USAID rate of return on this project. At this discount rate, the ICER deteriorates to US$ 73.9 per DALY averted. Even at 12% discount rate the results are still way below WB benchmark of US$ 150/DALY averted.

Interventions Adoption Rates

2. As with interventions of this nature (involving social, behavioural and cultural changes), there is always a concern whether or not the households will continue to practice the adoption of the interventions beyond the time that the program sponsors are actively involved. The investment program for the Livelihoods Project by USAID is expected to end in 2018. We have stress-tested the model outputs under various adoption rates from 2018 until end of projection for each of the interventions to assess their impact on project results. Overall, the sensitivity analysis shows that 10% increase in adoption rates for all interventions from 2018 onwards would result to a significant improvement in ICER, from an estimated base case ratio of US$63.75/DALY averted to US$ 34.0/DALY averted. This implies that the HHs would enjoy more health benefits than the incremental costs they would incur from an increase in intervention activities. On the downside, a 5% decrease in adoption rates for all interventions from 2018 onwards would slightly increase ICER to US$ 65.74 per DALY averted.

Table 3: Summary of Sensitivity Analysis of Key Project Variables

	Base Case Factor	Sensitivity Factor	ALL INTERVENTIONS (US$ Cost/DALY Averted)			INDIVIDUAL INTERVENTION (US$ Cost/DALY Averted)			
			All Interventions CER	CER (US$ /Case Averted)	CER (US$ /Death Averted)	Improved Water Supply & Treatment CER	Improved Sanitation CER	Handwashing & Hygiene CER	Exclusive Breastfeeding CER
Base Case Scenario			63.75	4.96	7,135.61	507.63	18.53	98.72	168.02
Social discount rate	**Base Case**	0.0%	56.79	4.75	6,883.15	495.03	14.98	94.57	132.25
		3.0%	**63.75**	**4.96**	**7,135.61**	**507.63**	**18.53**	**98.72**	**168.02**
		6.0%	68.68	5.11	7,309.91	512.14	22.32	103.22	207.58
		12.0%	73.87	5.31	7,480.88	503.48	30.15	112.79	294.85
EBF adoption rate - from 2018 onwards		50.0%	65.04	4.98	7,216.30	507.63	18.53	98.72	401.88
	Base Case	**70.0%**	**63.75**	**4.96**	**7,135.61**	**507.63**	**18.53**	**98.72**	**168.02**
		80.0%	63.12	4.95	7,095.93	507.63	18.53	98.72	130.15
Improved water supply, treatment & safe storage adoption rate - from 2018 onwards	**Base Case**	**50.6%**	**63.75**	**4.96**	**7,135.61**	**507.63**	**18.53**	**98.72**	**168.02**
		60.6%	44.44	4.43	6,514.83	453.30	17.75	94.94	168.02
New households adopting use of SanPlat per year - from 2018 onwards	**Base Case**	**0**	**63.75**	**4.96**	**7,135.61**	**507.63**	**18.53**	**98.72**	**168.02**
		100	63.01	4.93	7,122.39	505.55	19.41	98.31	168.02
		300	61.53	4.89	7,096.23	501.45	21.15	97.51	168.02
Handwashing with soap & hygiene adoption rate - from 2018 onwards		20.0%	95.65	5.47	9,267.64	683.83	24.97	93.66	168.02
	Base Case	**38.5%**	**63.75**	**4.96**	**7,135.61**	**507.63**	**18.53**	**98.72**	**168.02**
		50.0%	50.97	4.71	6,312.15	437.54	15.98	100.73	168.02
All interventions (combined) adoption rate - from 2018 onwards		39.0%	65.74	4.97	7,332.88	519.33	19.22	100.09	196.62
	Base Case	**43.5%**	**63.75**	**4.96**	**7,135.61**	**507.63**	**18.53**	**98.72**	**168.02**
		52.4%	34.07	4.22	5,841.94	396.58	17.49	96.34	130.15

Although an integrated approach to the implementation of the WASH and EBF interventions is highly recommended, it is also important to test the effectiveness of each intervention under various scenarios. Three individual interventions we would like to highlight in this analysis that appear to be most sensitive to changes in adoption rates are: 1) the promotion of EBF, 2) improved water supply, treatment at POU and safe storage, and 3) promotion of good hygiene practices with the focus on handwashing with soap. If EBF rate reduces from the base case value of 70% from 2018 onwards to 50% during the same period, the ICER for this intervention and infants age group deteriorates from the base case ratio of US$ 168/DALY averted to US$ 401.9/DALY averted. If the adoption rate for good hygiene practices reduces from base case of 38.5% to 20%, overall costs incurred by the households on this project would also be reduced, but the health benefits that would accrue to the households due to this intervention would be reduced at a higher rate, resulting in a worse off all-intervention CER of US$ 239.8/DALY averted.

In case of improved water supply, treatment & safe storage intervention; an average adoption rate of 75% (from a base case value of 51%) for this intervention would result to a significant improvement in ICER, estimated at US$ 122.4/DALY averted for this intervention and US$75.6 per DALY averted for all-interventions combined. This improvement is largely attributed to the reduction in costs of obtaining and treating water as the HHs access to clean water from water points increases.

9. CONCLUSION AND RECOMMENDATIONS

9.1 CONCLUSION

This CEA has demonstrated that there is a solid financial and economic case for investing in integrated interventions in improved WASH services as well promoting child health and nutrition through exclusive breastfeeding for infants under six months. The expected incremental health benefits far outweigh the incremental costs of investing in these interventions.

Under base case assumptions, the estimated ICERs of all interventions combined at US$ 63.8 is well within the commonly used thresholds established by the World Bank and WHO's Commission on Macroeconomics and Health. The World Bank established a threshold ICER of US$ 150/DALY averted as a measure of cost effectiveness (World Bank 1993). While, the WHO recommends using a national GDP as a more useful benchmark in guiding national decisions, despite the current debate and criticism surrounding this notion [23]. The 2017 Nigeria GDP per capita is US$ 2,092. Under both of these benchmark levels, the analyzed WASH and EBF interventions of the Livelihoods Project are very cost effective. Even under the downside scenarios described under sensitivity analysis section 7, the combined WASH and EBF interventions of the project still appear to be cost-effective if adopted consistently.

Furthermore, when potential direct benefits from savings in health care and medical costs are included in the analysis, the financial and economic case for investment in the WASH and EBF interventions become stronger. The total savings in healthcare and medical costs of US$ 25.4 million largely offset the total costs of the in interventions of US$ 27.8 million - in real present value terms.

Overall, the results of the cost effectiveness analysis have shown that targeting, combining, scaling up, and financing interventions in WASH and EBF in rural communities of Sokoto, Kebbi, and FCT is worthwhile. The analysis has also demonstrated that the integrated approach of implementing WASH and EBF services, such as one adopted by the FtF Livelihoods Project, could be one of the most cost-effective approaches to prevention and management of the disease in the target states. Also, this analysis serves as a guide to ensuring that development priorities in this sector are undertaken in a cost-effective way, and financial resources by the potential donors and government are allocated in an efficient manner.

9.2 RECOMMENDATIONS

The Livelihoods Project has been instrumental in improving the WASH infrastructure and livelihoods in the target states and there has been an overwhelming acceptance of the project by the households in the beneficiary states. Despite this huge progress, the challenge of inadequate WASH infrastructure persists in these states, especially the availability of clean water, and sanitation and hygiene facilities.

The following recommendations could further improve WASH services and reduce the prevalence of diarrhea disease in the target states:

1. ***A program on rural water supply.***

   The rehabilitation of the standpipes is a necessary but not sufficient intervention to address the significant water shortage that prevails in the rural communities. The households' use of the standpipes during the dry season despite considerable time required, indicates that the total cost of obtaining water from the standpipes is cheaper than the cost of obtaining water from the streams. The hot temperatures that exist in dry season dry up the wells and most of the streams, thus significantly reducing the streams' water flow. Therefore, the households spent a considerable effort to dig inside the "dried/or almost dried" streams to find water, which is also a means of survival for the households' livestock. The high

cost of water from the dried/or almost dried streams is primarily driven not by the time one spends on collecting the water, but by the unfortunate quality, hence health impacts from the water.

A USAID program on rural water supply may result in significant economic returns and may address the challenge of limited clean water supply in the beneficiary states. There is currently a limited number of functioning water points in the target states, and demand for clean water in all states (particularly Sokoto) exceeds available supply. The higher cost-effectiveness ratio of US$ 507.6 per DALY averted for the improved water supply intervention is largely attributed to the higher cost of effort and time taken to obtain water by the households as discussed in section 5.1. While additional analysis is required to justify the rural water supply program, this study indicates potential high economic returns of such a program. For instance, the 42,000 benefiting households from the project will incur a cost of obtaining clean water of PV USD 273 mill over next ten years. This figure is only for 42000 families compared to about 2.1 million households living in these three states. It is also excluding any potential cost savings during the wet season, that is when people are using their wells. The cost of rural water supply program, on the other hand, is unknown to the authors, preventing a precise conclusion.

2. ***Direct engagement of community leaders and/or local government authorities to support the WASH committees is strongly encouraged.*** This would help to ensure sustainability of the current business model of maintaining the rehabilitated water points. The communities have taken ownership of the rehabilitated water points and are making regular contributions to cover operating and maintenance costs. However, the running cost of fuel-based water pumps (averaging NGN13,000 or US$36 per week) is too high for some communities to sustain in the long run. At present, the WASHCOM are collecting sufficient funds to cater for this, but actively involving communities' leaders would ensure WASHCOM continues its efforts even beyond the period of USAID/CRS' involvement.
3. ***Providing technical training on how to operate and repair solar-based water pumps.*** The recent construction of solar-based water point in FCT is observed to have reduced the use of manual boreholes. Although this is the most preferred way for households to obtain water due to its convenience with no pumping effort required, the maintenance of this type of water points could be challenging as the communities currently have no knowledge on how to repair solar based water pumps. Providing technical training on how to operate and repair solar-based water pumps could help address this technical/skill challenge.
4. ***Sensitization efforts in use of tippy taps should be encouraged and extended to household level and also included in the school WASH agendas.*** This would contribute to further improvement in handwashing and hygiene practices, particularly in schools. Currently, tippy taps are only implemented in public places like mosques, churches, and compounds of village chiefs. Tippy taps offer several benefits including, improving handwashing rates, using less water (about 40-50ml of water as compared with 600ml when water is accessed by other means, which becomes very practical in areas where water is scarce), and also helps build good hygiene behaviors in children from the early age. The discussion on Sustainable Sanitation Alliance website provides some useful lessons learned from the adoption of tippy taps in schools [15].
5. ***Becky Pots:*** Becky pots, although, require higher initial cash outlay, do result on significant water storage cost savings given the prolonged life of the pots when compared to the average life of the plastic jerry cans traditionally used by the households. In addition, Becky pots are more environmentally friendly and hygiene way of storing water. They also provide income to the potters. It is consider including this element into upcoming USAID projects, when appropriate.
    - ***Adoption of Rotavirus Vaccine:*** This vaccine was recently introduced in Nigeria, with a pilot scheme expected to commence in 2018 in Lagos state. We, therefore, highly recommend that the government of Nigeria intensify and expand its current efforts in the adoption of the vaccine to alleviate diarrhea disease burden in both rural and urban communities. This is in addition to

the preventive measures such as WASH and nutrition interventions, and treatment measures such as Oral Rehydration Therapies that are currently being implemented. Recent studies reveal that rotavirus is the major cause of infant and childhood diarrhea in Africa. In Nigeria, about 30,800 deaths of children under five years old were attributed to rotaviruses, which accounted for 14% of all deaths attributed to rotavirus in 2013 [25]. The danger of rotavirus is that providing clean water and improving sanitation and hygiene do not significantly reduce the spread of the virus. Therefore, vaccination is considered the first strategy in the prevention of rotavirus infection. The health benefits of rotavirus vaccine are well established. Some countries adopting the vaccine have reported a substantial decrease in diarrhea mortality, by 22% - 50% among the children in under five years of age following vaccine introduction [26]. Examples of such countries in Africa include Ghana, Malawi, South Africa, Kenya, and Mali. Among the first African nations to introduce rotavirus vaccine in 2012 were South Africa, Malawi, and Ghana and they observed a significant decline in diarrhoeal disease. In the first three years following the vaccine, the hospital admissions positive for rotavirus fell from 48% in the pre-vaccine period to 28% for children under 5 years of age in Ghana. Studies conducted in South Africa and Malawi demonstrated a rotavirus vaccine effectiveness of 61% in preventing hospital admissions against severe rotavirus [16]. Recent CEA studies have shown this intervention to be cost-effective, particularly with the support of GAVI [17].

10. ANNEX

Table 2: Key Assumptions for Estimating Reduction in Diarrhea Morbidity and Mortality Rates

Key Assumptions for Estimating Reduction in Diarrhea Morbidity and Mortality Rates			
Parameter	**Without Project**	**With Project**	**Data Source**
Morbidity Rates:			
Diarrhoe morbidity rate for infants (0-5 months)	7%	6.4%	NNHS 2015
Diarrhoe morbidity rate for non-school age (6M -5 years)	31%	23%	NNHS 2015
Diarrhoe morbidity rate for population over 6 years	5%	4%	Assumed based on Literature
Mortality Rates:			
Diarrhoe mortality rate for infants (0-5 months)	1.42%	1.38%	UNICEF and sas.upenn.edu
Diarrhoe mortality rate for non-school age (6M -5 years)	2.3%	1.8%	global-health.healthgrove.com
Diarrhoe mortality rate for population over 6 years	0.067%	0.05%	global-health.healthgrove.com
Intervention Adoption Rates:			
Average adoption rate for improved water supply, water treatment at POU & safe storage	6.1%	45%	CRS/USAID Annual Survey Report and Quarterly Progress Reports for 2016 & 2017
Average adoption rate for improved sanitation	0%	6%	
Adoption rate for good hygiene practices, focus on Handwashing with soap	6.6%	37%	
Adoption rate for EBF	45%	68%	
Intervention Effectiveness Weight to Morbidity Reduction:			
Reduction in morbidity due to improved water supply, water treatment at POU & safe storage	n/a	29%	ircwash.org
Reduction in morbidity due to improved sanitation	n/a	34%	ircwash.org
Reduction in morbidity due to handwashing with soap & hygiene promotion	n/a	37%	ircwash.org
Reduction in infant diarrhoea morbidity due to exclusive breastfeeding	n/a	40%	ncbi.nlm.nih.gov
Intervention Effectiveness Weight to Mortality Reduction:			
Reduction in mortality due to improved water supply and water treatment (Point of Use)	n/a	13.4%	The Lancet.com
Reduction in mortality due to improved sanitation	n/a	13.4%	The Lancet.com
Reduction in mortality due to handwashing with soap & hygiene promotion	n/a	50%	CDC.gov
Reduction in child mortality due to exclusive breastfeeding	n/a	13%	sas.upenn.edu
Effective Contribution of Interventions to Morbidity Reduction:			
Effective contribution of all interventions except EBF to Morbidity reduction	n/a	26.1%	Estimated
Effective contribution of EBF to Morbidity reduction	n/a	9%	Estimated
Effective Contribution of Interventions to Mortality Reduction:			
Effective contribution of all interventions except EBF to Mortality reduction	n/a	22%	Estimated
Effective contribution of EBF to Mortality reduction	n/a	3%	Estimated

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