Estimated number of deaths averted by
the Micronutrient Initiative (MI) Public Sector ORS & Zinc Diarrhoea Treatment Program in Bihar, India

An Internal Report of Results from *LiST* Modelling

Funded by
the Children's Investment Fund Foundation (CIFF)

Submitted by: **Jayachandran A A, *Ph D***
Independent Consultant
Flat No 32, Suruchi Apartments
Plot No 31, Sector -10, Dwarka
New Delhi – 110 075. INDIA.

e-mail: preejayan@gmail.com
Cell Phone: +91 98 187 59368

November 2015

Acknowledgment

This modelling activity was fully supported by Children's Investment Fund Foundation (CIFF), London and I thank CIFF for providing me with this opportunity and work with wonderful colleagues from CIFF and MI. I would like to whole-heartedly thank Dr Catherine Harbour of CIFF who provided insight and expertise that greatly assisted to complete this important activity. I would also like to thank Mr Sanjeev Kumar of Micronutrient Initiative for his incisive comments and inputs on different phases of the program implementation which helped to successfully complete this activity. Both were part of whole of this activity from start to end. Ms Manjula Singh of CIFF was supporting generously with her comments and suggestions despite her busy travel schedules. Meeting with Dr Saul Morris of CIFF was the turning point of analysis and I wish to thank him for his support.

Finally, I thank my former colleague Dr Ingrid Friberg (formerly with JHU) for introducing me to CIFF team and her useful suggestions at the initial stage of modelling activity, Dr Christa Walker of JHU and Dr Neff Walker of JHU for their support at different stages of this modelling activity.

Introduction

The Children's Investment Fund Foundation (CIFF) supported the Micronutrient Initiative (MI) to conduct an intervention program titled "Reducing Deaths from Diarrhoea in the Indian State of Bihar," in collaboration with the Government of Bihar. The goal of the program was to reduce child morbidity and mortality related to diarrhoeal disease among children under five through deployment of enhanced public sector delivery of ORS and Zinc for the treatment of diarrhoea in the state. The program was successfully implemented in 15 districts of Bihar between August 2011 and August 2015.

During the implementation phase, CIFF commissioned an independent evaluation. A team led by Christa Fischer Walker at the Institute for International Programs of the Department of International Health, Johns Hopkins Bloomberg School of Public Health (JHSPH) in association with Society for Applied Studies (SAS), New Delhi conducted a baseline survey in 15 districts in April – May 2011 and a midline survey in all 15 districts September – December 2013. Additionally, the midline assessment estimated the number of lives saved (or deaths averted) of children below five years of age by conducting the Lives Saved Tool (*LiST*[1]) modelling to measure the (partial[2]) impact of MI's ORS & Zinc program. Ingrid Friberg, formerly of the Institute for International Programs, led this modelling.

MI has successfully completed the implementation of the program in the selected 15 districts of the state as per the implementation plan for five years. This provides an opportunity for CIFF to measure the program achievements by estimating the number of children saved by the targeted intervention efforts to increase the coverage of ORS & Zinc for diarrhoea treatment.

Purpose of this specific modelling activity

As this program comes to a close, CIFF and MI wanted to estimate the number of child deaths averted by the Micronutrient Initiative (MI) ORS & Zinc Bihar program, using MI monitoring data, from August 2011 through April 2015,[3] based on *LiST* modelling. The current modelling exercise updates the modelling and projections that Johns Hopkins University (JHSPH) conducted based on the ORS & Zinc coverage estimates from 2011 baseline and 2013 midline household surveys. CIFF and MI will use these estimates of deaths averted by the intervention in a program review meeting scheduled for late 2015. The 2013 *LiST* modelling results were:

[1] For more details about *LiST* can be accessed from: *http://www.jhsph.edu/research/centers-and-institutes/institute-for-international-programs/current-projects/lives-saved-tool/*

[2] Partial because this assessment was conducted just two years after the program started.

[3] At the time the modelling work started, in July 2015, the latest available monitoring data was from April 2015.

Estimated Lives Saved With Scale up of Diarrhea Treatment in Bihar

	Baseline Year	Intervention Period			Future Potential	
	2010	2011	2012	2013	2014	2015
Coverage Rates Achieved						
ORS coverage rate	19.7	21.8	23.8	25.9	25.9	25.9
Zinc coverage rate	3	6.7	10.4	14.1	14.1	14.1
Diarrhea Deaths Averted (if all districts covered)	0	607	1,176	1,711	1,669	1,634
Diarrhea Deaths Averted by Program	0	67	270	625	1,031	1,422
Districts / Proportion of Children in the State		5 districts/11%	10 districts/23%	15 districts/36.5%	61.80%	87%

(JHSPH, 2014, p. 17)

Approach

The consultant used a computer-based software tool called the Lives Saved Tool (*LiST*) version 5.31 to estimate the number of lives saved (or deaths averted) due to the specific levels of ORS & Zinc coverage that the program achieved, based on MI's monitoring data. *LiST* helps estimate the mortality impact of scaling-up of maternal, newborn, and child health interventions. The tool requires three sets of inputs to project the impact of interventions on mortality: (1) measures of population-level health status including mortality (accessed from Annual Health Surveys) and causes of death (available by default in *LiST*); (2) effect sizes[4] of interventions and affected fractions, based on estimates provided by Child Health Epidemiology Reference Group (CHERG[5]) through a series of review processes and peer reviewed publications and (3) intervention coverage which are scaled up measured through a baseline, midline/endline or other population based surveys.

***LiST* Input**	**Data Source**	**Date**
Health status	Annual Health Survey (AHS)[6]	2010/11 (compiled for 15 program intervention districts
Effect sizes and affected fraction	International Journal of Epidemiology, 2010 and Research conducted worldwide provided by Child Health Epidemiology Reference Group (CHERG)	*LiST* version 5.31, updated on June 5, 2015
Intervention Coverage	Micronutrient Initiative (MI)'s MIS and JHSPH survey data *(details below)*	MI's MIS for 2013/14 and 2014/15; JHSPH, 2014

[4] Munos M, Fischer Walker CL, Black RE. The effect of oral rehydration solution and recommended home fluids on diarrhea mortality. *International Journal of Epidemiology* 2010; 39(Suppl. 1): i75-i87. http://www.ncbi.nlm.nih.gov/pubmed/20348131 & Fischer Walker CL, Black RE. Zinc for the treatment of diarrhea: Effect on diarrhea morbidity, mortality and incidence of future episodes. *International Journal of Epidemiology* 2010; 39(Suppl 1): i63-i69. http://www.ncbi.nlm.nih.gov/pubmed/20348128.

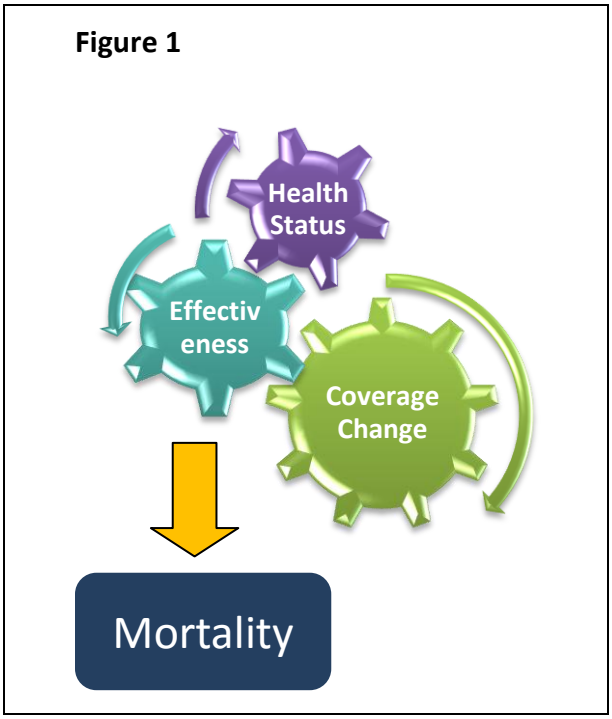
[5] More details about CHERG will be available on http://www.cherg.org/

[6] Annual Health Survey reports can be accessed from: http://www.censusindia.gov.in/2011-Common/AHSurvey.html

There is an India-specific version of *LiST*, developed during the Child Survival Call to Action (CSC2A) in 2013. The India-specific version uses only effect sizes from review processes on specific research studies conducted in India, rather than the default values which are based on research conducted anywhere in the world. However, the modelling work described here used the default values, not India-specific values since the results are not widely discussed or published.

Figure 1 is a schematic of how these interact. Note that program coverage is highly influential on estimated mortality.

Figure 1



Input data

(Target population of the intervention and the modelling is children in the 2-59 months age group)

1. Large part of inputs to the *LiST* module is accessed from *DemProj*[7] module of Spectrum Suite. The *DemProj* module projects the population for an entire country or region by age and sex, based on certain assumptions about fertility, mortality, and migration. *DemProj* requires a wide range of data on base-year age-sex population by five-year age group, fertility indicators, mortality indicators and migration level data (which is optional and normally neglected) to be inputted.
2. Additionally, *LiST* requires inputs on coverage information from different program interventions besides a major list of default values for intervention efficacies and population affected

[7] For more details: *http://www.avenirhealth.org/software-spectrummodels.php#demproj*

fractions. In our case the program intervention is exclusively covered ORS & Zinc supplementation in the management of diarrhoea treatment among children. The coverage values for ORS & Zinc have been generally accessed from population based cross-sectional surveys. In the previous modelling exercise, JHSPH conducted two cross-sectional studies – baseline (2011) and a midline (2013) survey – and used coverage information from these two surveys to estimate the number of lives saved (or deaths averted) due to program impact.

3. However, in the current exercise, we are depending on two sets of information to calculate the latest coverage estimates, viz., i) JHSPH's (baseline and midline) coverage information for ORS & Zinc and ii) MI's monitoring information system (MIS) which gathers time-series data on how many children affected with diarrhoea have been treated in the public sector with ORS & Zinc from the targeted intervention districts. MI's intervention was worked solely through public health functionaries in the intervention districts (Accredited Social Health Activists - ASHAs, *Anganwadi* workers, Auxiliary Nurse Midwives, Primary Health Centers and government hospitals). Thus, the impact of MI's program is to be computed accordingly. *Eventually*, *coverage rates for ORS & Zinc are calculated exclusively for the public health sector for the current LiST modelling to evaluate the impact of MI's targeted intervention program in Bihar.*
4. ORS & Zinc coverage rates are calculated from ii. MI's Management Information System (MIS) data by finding out numerator and denominator. Denominator is the number of children (2-59 months) who are affected with diarrhoea in the intervention areas and was calculated by multiplying factors 1.81 (diarrhoea incidence of 1.81 episodes/child/year – on lower side) and 2.2 (on higher side) with total number of children in that age group[8].
5. Numerators are directly taken from the MIS data and coverage rates for ORS & Zinc were computed accordingly from MI's MIS data.

Notes on data sources

The LiST data source inputs have some acknowledged limitations.

The JHSPH data does not clearly and consistently distinguish the percentage of caregivers who received ORS and/or zinc from public sector sources. At the baseline (2011) and midline (2013) surveys, caregivers were asked to recall where they had sought care for cases of diarrhoea in the previous two weeks. More than 18 percent care givers reported multiple sources (both private and public health services) to sought treatment for diarrhoea[9].

[8] In the Key Performance Indicators (KPIs) MI used diarrhoea incidence as 1.81 episodes / child/ year (lower side) and 2.2 (on higher side). There was no reliable reference available for CDMP districts. Therefore in the beginning MI had used incidence 1.71 based on GOI report Burden of Childhood diarrhoea (Estimation of the burden of diarrhoeal diseases in India, NCMH, GOI 2005, page 184). Incidence of diarrhoea varies as per the prevalence and in different surveys there is great variation in the 2 week child diarrhoea prevalence. Based on WHO methodology MI computed incidence for 15 CDMP districts.
The lowest was based on AHS 1.8 and from two sources DLHS and average prevalence of different surveys in CDMP districts it came to 2.2. *(Source: e-mail communication with MI and CIFF (Catherine Harbour) dated 6 August 2015).*

[9] *See Appendix 1*

The MI's MIS data was compiled by public sector providers including front line health workers (ASHAs, AWWs and ANMs) who began treating diarrhoea and began collecting MIS data about diarrhoea treatment as a result of the MI program. Particularly in the beginning of the program, as front line health workers were learning to use the forms, they did not all complete the forms correctly. The Data Quality Audit found that when front line health workers did not have stock of ORS or zinc, or when they did not have stock of reporting forms, the front line health workers may not have reported correctly all of the cases they treated.

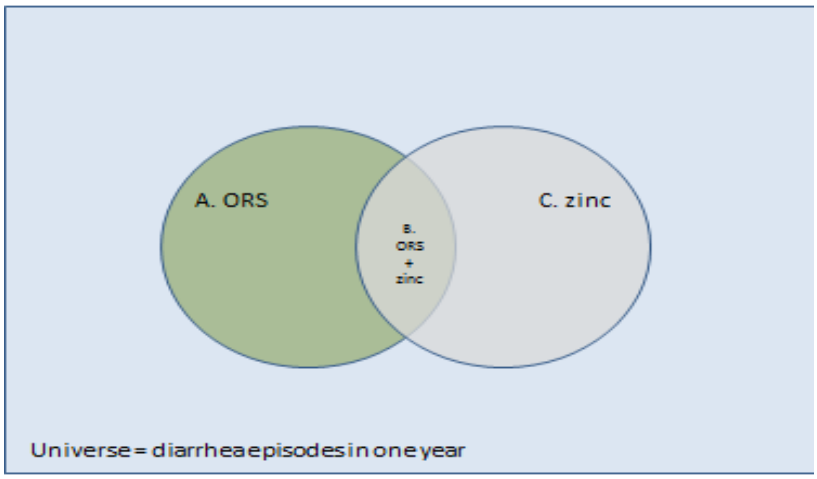
Impact Modelling

CIFF staff modelled the potential impact on deaths averted as part of the 2010 Investment Memo for the CIFF board. The Investment Memo (9 March 2010) modelled an optimistic expected child outcome of 7,200 cumulative deaths averted, and a cautious expected child outcome of estimated 4,200 deaths averted. These estimates were subsequently revised at several points during the life of the program. A Critical Path (4 November 2011) noted a goal of 2,566 deaths averted each year by 2015.

Scenarios

Three scenarios were developed to establish appropriate mixes of coverage information. The following table and Figure 2 provide the details of these scenarios.

Figure 2: Diarrhoea Prevalence & Treatment



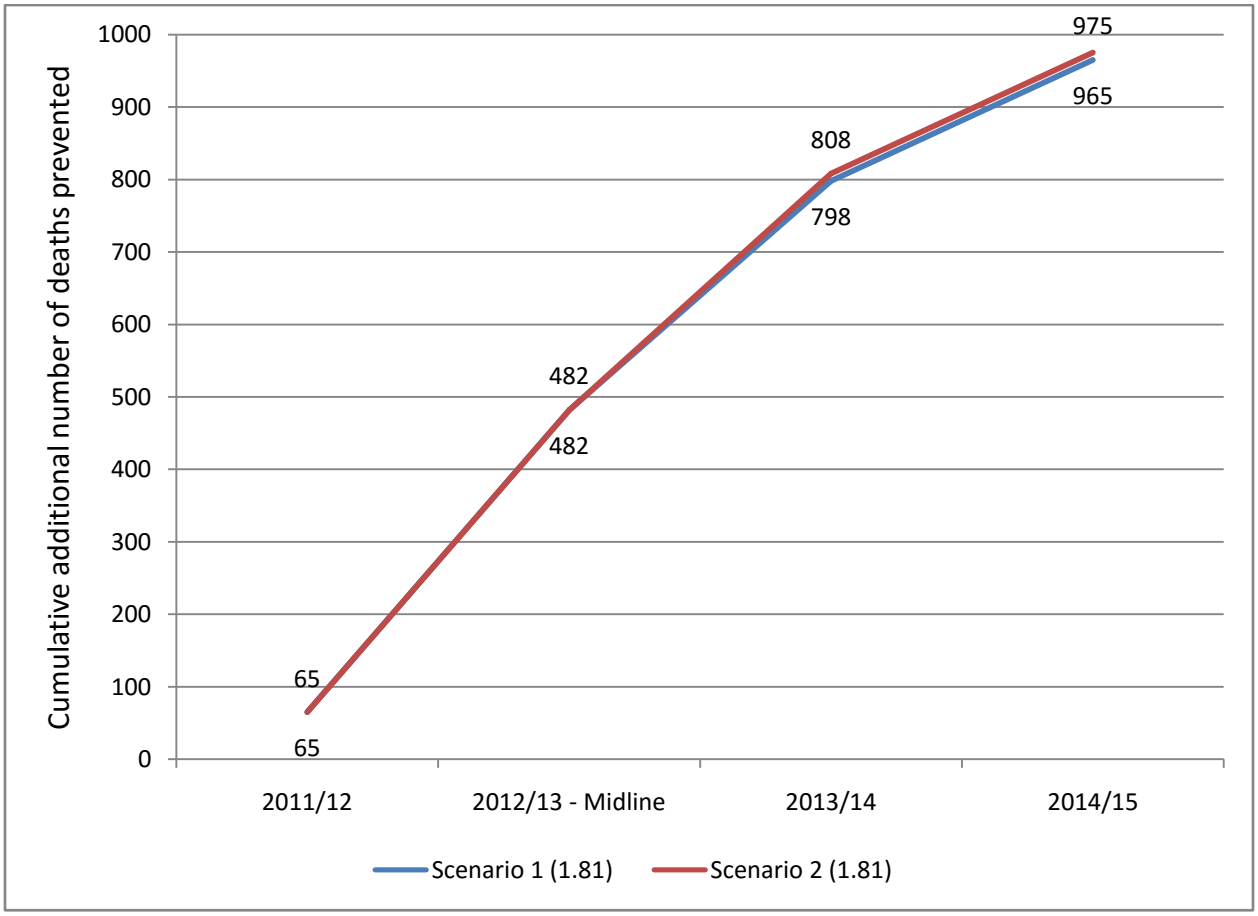
Table

Models	Descriptions
Scenario 1 *ORS & Zinc (A and A intersection with C, i.e., B))*	i. ORS coverage rate = Numerator would be (Numbers treated with ORS only + Numbers treated with ORS & Zinc) and ii. Zinc coverage rate = Numerator would be (Numbers treated with ORS & Zinc)
Scenario 2 ORS & zinc; ORS alone; zinc alone *(A+C; A union with C, which includes B)*	i. ORS coverage rate = Numerator would be (Numbers treated with ORS only + Numbers treated with ORS & Zinc) and ii. Zinc coverage rate = Numerator would be (Numbers treated with ORS & Zinc + those who received zinc alone)
Scenario 3 To achieve the 2010 Investment Memo cautious modelled estimate of 4,200 additional number of deaths averted (cumulatively) *(B set to 4,200)*	By working backwards, to achieve the 2010 Investment Memo cautious modelled estimate of 4,200 additional cumulative number of deaths averted, what are the coverage rates for ORS and Zinc to be accomplished after five years of program intervention?
Scenario 4* *(Scenario 1 with 40% and 60% higher coverage rates)*	These two models will help to see with a larger coverage rates calculated from MIS data *(greatly improved coverage)* for ORS & Zinc and with a "worst case" diarrhoea incidence scenario of 2.2 episodes per child per year.
Note	With common denominator = Total number of diarrhoea incidences/episodes in the population (among 2-59 month old children)

**: This model doesn't use JHSPH & SAS's 2013 measured coverage rates but purely depends on MIS data, whereas, all other models inherently used JHSPH & SAS's coverage rates.*

Results

Figure 1: Cumulative number of additional deaths prevented in children under-five relative to baseline year (2010/11) due to ORS & Zinc program intervention – *on the basis of incidence of 1.81 diarrhoeal episodes/child/year*

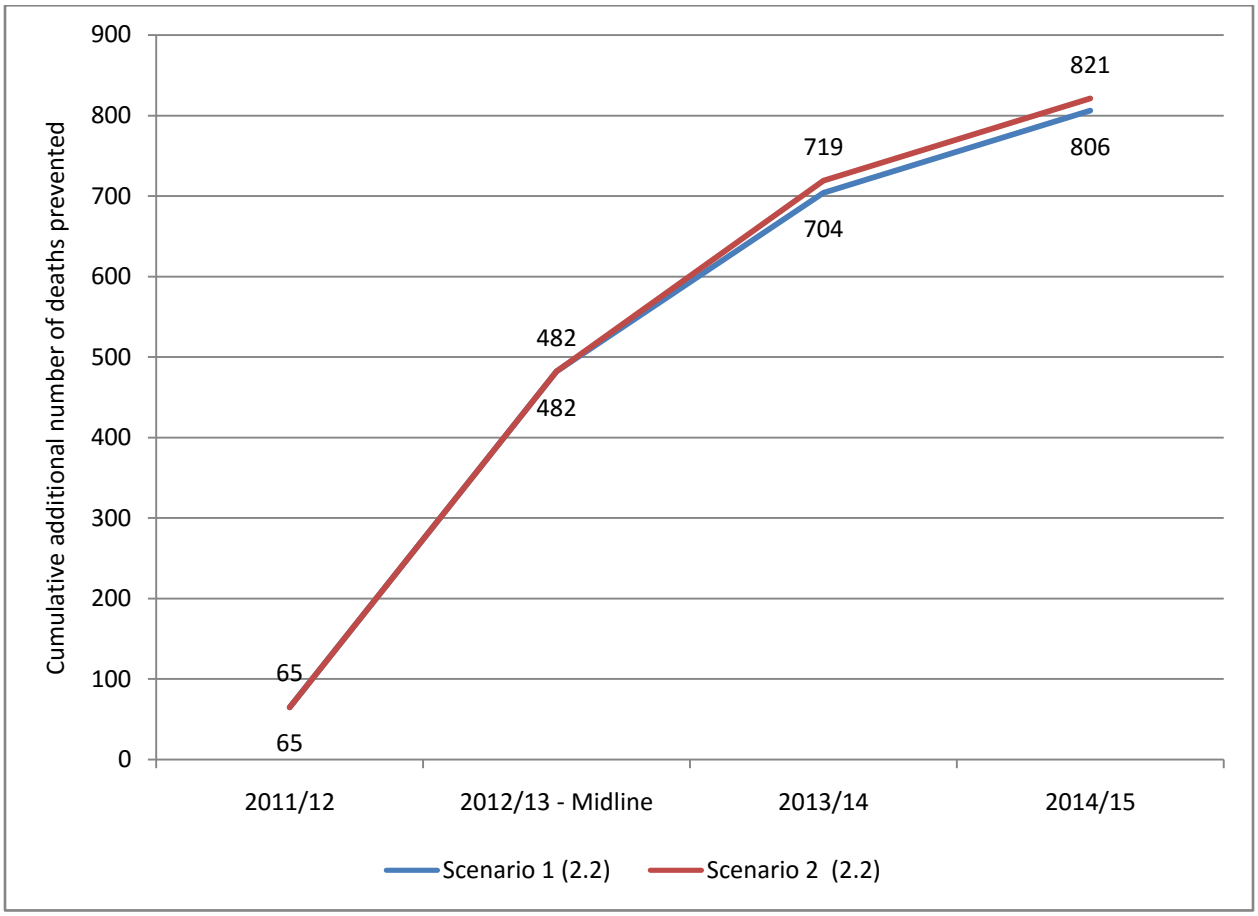


1. *LiST* computes the estimated number of under 5 year old children's lives saved due to scaling up of a particular program intervention over the intervention period. In our case the program intervention was distribution of ORS & Zinc for the treatment of diarrhoea affected children in 15 districts of Bihar. Complete details of both coverage rates and the estimated number of additional deaths prevented in children under-five years of age relative to baseline year 2010/11 are shown in Appendix 2 for different scenarios/models considered.
2. Estimated additional number of lives saved in children under-five age relative to impact year (base year = 2010/11) for Scenario 1, ORS & zinc together; and Scenario 2, ORS or zinc or both together are **not** very different. Under both scenarios, the program could able to avert less than 1,000 deaths cumulatively relative to baseline impact year.
3. The cumulative number of additional deaths averted under Scenario 1, the ORS & zinc model, which was the program's intended treatment for children under 5, is 965.
4. Overall, these estimated cumulative numbers of deaths averted are much lower than the 2010 Investment Memo cautious modelled estimate of 4,200 lives of children under-five saved

through the targeted intervention of ORS & Zinc distribution through the public sector for the treatment of diarrhoea in 15 districts of Bihar.

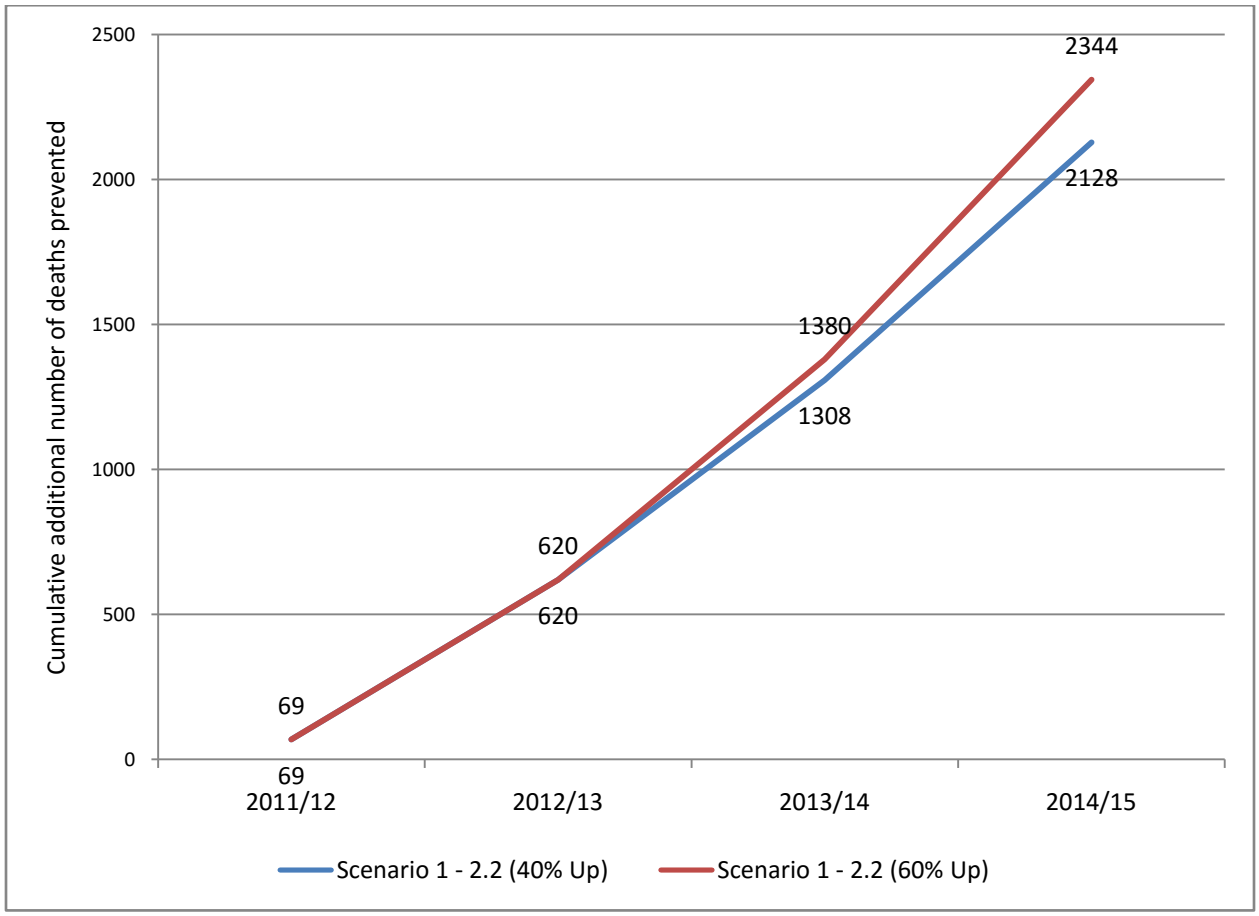
Results of the second set of models, with the higher estimated prevalence rate of diarrhoea, are shown in Figure 2.

Figure 2: Cumulative number of additional deaths prevented in children under-five relative to impact year (2010/11) due to ORS & Zinc program intervention – *on the basis of 2.2 diarrhoeal episodes/child/year*



1. This set of models is designed to understand the "worst-case" scenario since the denominator is on a higher side and kept the numerators the same (as in the case of previous set of models) while calculating the coverage rates for ORS & Zinc.
2. As expected, results from Scenario - 1 are at 806 deaths that could have averted during the five years of program intervention and from Scenario - 2, 821 deaths would have been averted.

Figure 3: Cumulative number of additional deaths prevented in children under-five relative to impact year (2010/11) due to ORS & Zinc program intervention – *on the basis of 2.2 diarrhoeal episodes/child/year with 40% and 60% increased ORS & Zinc coverage in MIS data.*



Note: Scenario 1 – 2.1 (40% Up) implies ORS+Zinc (together) and coverage grows 40% up from 2012/13 level; similarly, Scenario 1 – 2.1 (60% Up) implies ORS+Zinc (together) and coverage grows 60% up from 2012/13 level.

1. These two scenarios are constructed to understand the "extreme case" situation, i.e., worst possible diarrhoeal incidences (at 2.2 episodes/child/year) combined with the best possible treatment cases (i.e., 40% and 60% more than the coverage rates calculated from 2012/13 of MIS data in the year 2014/15).
    a. Calculated 40% increase in 2012/13 ORS coverage of 6.29% is equivalent to 8.80% population coverage in 2014/15.
    b. Calculated 40% increase in 2012/13 zinc coverage of 5.88 % is equivalent to 8.23% population coverage in 2014/15
    c. Calculated 60% increase in 2012/13 ORS coverage of 6.29 % is equivalent to 10.06% population coverage in 2014/15
    d. Calculated 60% increase in 2012/13 zinc coverage of 5.88 % is equivalent to 9.40% population coverage in 2014/15.

2. This provides an opportunity to measure hypothetically the impact of the program intervention if the ORS & Zinc coverage rates are peaked at these levels. Agree, these are quite ambitious targets for interventions in public health sector space.
3. As anticipated, if the intervention would have followed these two scenarios the impact would have been much higher by cumulatively saving more than 2,100 children (2,128 lives saved at 40% Up case scenario and 2,344 lives saved at 60% Up in coverage).
4. However, these results are significantly lower than the 2010 Investment Memo cautious modelled estimate 4,200 deaths averted.

Hypothetical Model (Scenario – 3)

In order to find the expected levels of coverage rates of ORS & Zinc to avert 4,200 additional cumulative number of deaths from diarrhoea, as the impact model in the 2010 Investment Memo estimated to be possible, a hypothetical model has been worked out. This was worked out "backwards" by suitably identifying appropriate coverage rates for ORS & Zinc. "Backward" calculation of coverage rates for ORS and Zinc was made by attempting several iterations in *LiST* to achieve the target of 4,200 deaths averted cumulatively. *(In a way by uniformly increasing the coverage rates for ORS and Zinc in order to reach a target of 4,200 deaths averted)*. The results of this model are as follows:

Table 1: ORS & Zinc coverage rates under public health sector to avert 4,200 additional deaths in Children under five years of age by intervention relative to baseline year (Total 0-60 months) – Combined impact of ORS and Zinc

	ORS Public sector Coverage (%)	Zinc Public sector Coverage (%)	No of additional deaths averted	Cumulative
2010/11	1.8	1.4	0	0
2011/12	3.0	2.5	65*	65
2012/13 – Midline	5.2	4.8	417	482
2013/14	14.6	13.5	1,502	1,984
2014/15	19.8	18.3	2,222	4,206

*Note: * Adjusted for the number of months/period program implementation in different groups of districts*

This result suggests that in order to achieve the 2010 Investment Memo cautious modelled estimate of 4,200 additional number of deaths cumulatively averted, the intervention would have had to increase its ORS coverage through public health sector from 1.8% in 2010/11 to 19.8% in 2014/15, and also would have had to increase Zinc coverage through public health sector from 1.4% in 2010/11 to 18.3% by 2014/15.

These coverage rates are found to be "ambitious" while looking at the field realities like working with public health sector where involvement of public health functionaries itself is a herculean task and erratic supply of ORS and Zinc at Govt procurement centres made things more worse.

Discussions

1. The modeled impact results (ranging from 806 to 975) fall short of the 2010 Investment Memo cautious modelled estimate of 4,200 deaths averted.
2. Coverage of ORS and zinc would have had to have increased dramatically to avert more than 2,000 deaths.
3. It seems that the 2010 Investment Memo cautious modelled estimate of 4,200 lives saved was an *unrealistic target* by not considering the ground realities. It is interesting to observe from JHU's projections that even at the increased coverage levels – from 19.7% in 2010 to 25.9% for ORS and from 3.7% in 2010 to 14.3% in 2015 for Zinc – by 2015 the program would have saved 3,415 diarrhoea related deaths among under-five children in Bihar, which is less than the 2010 Investment Memo cautious modelled estimate of 4,200.
    a. This suggests that there is a need to *critically assess* the methodology that was adopted to model the program's impact.
4. Computation of ORS & Zinc coverage rates pertaining to public health sector from JHSPH & SAS data for baseline and midline, the most important factor in this modelling activity, was a challenging one as data related to *public health sector* to be extracted with great difficulty.
5. Difficulties were also faced while using MI's MIS data to calculate the coverage rates. A large proportion of MIS data was reported in the "ORS& Zinc" category. However, *LiST* allows inputs for "ORS" (only) or "Zinc" (only) coverage rates, not "ORS + Zinc" (together) coverage rate. Thus, we can't accept a third category in MIS data for modelling purposes, which resulted in not sure whether to include "ORS only" or "Zinc only" during the initial phase of the program. Nevertheless, we suitably accommodated ORS+Zinc data into the analysis – please refer Page No 8 for the details under the scenario creations section.

    Table 2: Distribution of type of treatment administered (by ORS only, Zinc only and ORS+Zinc together) to total treated diarrheal cases reported by program MIS for different years

Year	A – ORS Only	B – ORS+Zinc	C – Zinc Only	Total
2011/12	7.17%	90.00%	3.2%	100.0
2012/13	6.03%	86.25%	7.72%	100.0
2013/14	25.27%	59.98%	14.75%	100.0
2014/15	76.36%	22.05%	1.59%	100.0

Source: Computed from MI's MIS data

    This table shows the distribution of type of treatment administered to total treated diarrheal cases as reported by MIS data for each year. It is clear from the table that during the initial phase, 90% of diarrheal cases were treated by providing ORS + Zinc together, which came down to 22% by the third year of the intervention, i.e., in 2014/15. One of the possible explanations to this phenomenon was due stock out of Zinc products during the later phase of the intervention field workers were access to only ORS.
6. *LiST* modelling activity had undergone a series of iteration processes before concluding with these four scenarios.

7. Assumptions to build d*ifferent scenarios we*re extensively discussed with staffs from CIFF and MI in July-September 2015.
8. Overall child mortality in Bihar has gradually declined over the life of the program. As per Annual Health Survey (AHS), child mortality has declined from 77 in 2010/11 to 70 in 2012/13. Nevertheless, applicability to the selected intervention districts may be minimal since these districts are quite remote, under-developed characterised with high relatively mortality conditions.

Challenges & Future Directions

This modelling exercise was a great learning activity. Following are some of the challenges, learning and suggestions as part of way forward:

MIS Data

1. MI trained providers according to childhood diarrhoea management guidelines and level of dehydration. However it is understood from MI that in the case of stock out, some providers may have recommended treatment by ORS (alone) or by zinc (alone) or by Oral Rehydration Therapy (ORT) and zinc. Within the MI MIS system where front-line workers reported the cases they treated, they may not consistently have distinguished among these different treatment recommendations. Also, community health workers may have had some difficulty to differentiate the data reporting protocol for ORS and Zinc when they completed the MIS forms. In the initial phase of the program, community health workers reported information under three categories, namely, ORS only, Zinc only and ORS & Zinc with a large proportion under ORS & Zinc.
2. For the "Zinc" (only) category, the field reports suggest that health workers generally advice patients to take ORTs (home-made solutions) along with Zinc intake or to get ORS from other sources. The potential impact of ORT in combination with zinc is not captured in *LiST* and is not captured in the model results, which may imply some level of additional benefits or effectiveness in treating diarrhoea cases.
3. Towards end, the program implementation was adversely affected by procurement and supply issues from Government side that resulted in stock-outs for several months. This is an important lesson while working with public health sector.

Lessons learned about MIS:

- ✓ Develop a data reporting protocol;
- ✓ Provide enough training to community health workers for quality reporting;
- ✓ Ensure enough supply of forms to conduct the monitoring timely reporting;
- ✓ Closely monitor data reporting especially in the initial phase of the program.

JHU's baseline and midline survey reports

1. Several inconsistencies were observed while analyzing information on "source(s) of treatment for diarrhoea" in these two datasets (baseline and midline).
2. There were *duplicates* or multiple answers reported by the respondents as they might have visited different places for the treatment. This needs to be handled with utmost care in future work of this kind: questions need to be framed to capture *single responses* for the source of treatment received for the last diarrhoeal episode.
3. The number of respondents who reported source of treatment were grouped into "unknown" categories, not distinguishing whether the treatment was obtained from the public or private sector, like:
    - Syrup unknown reported by 90 respondents;
    - Tablet unknown reported by 121 respondents
    - "Others" reported by 134 respondents of the total of 750 caregivers of children who reported incidence of diarrhoea two weeks prior to the midline survey (2013), which happens to be the denominator. Thereby, we miss several respondents from the numerator and hence have very small population coverage rates for ORS (1.83%[10] in 2010/11 – baseline and 5.20% in 2012/13 - midline) and Zinc (1.37% in 2010/11 - baseline and 4.80% in 2012/13 - midline).

***LiST* Module**

1. *LiST* module (Ver 5.31) is found to be more robust and stable compared to the previous versions.
2. Some issues are confronted while working with the *LiST* module. Perhaps, this could help to refine the software module.
    a. *LiST* primarily uses the coverage rates extracted from cross-sectional studies; however, to measure any program success (like the current exercise) it is highly likely that we would need to depend on MIS data to compute the coverage information. This flexibility for the use of *LiST* model is more appealing for program evaluation.
    b. Developers can support by providing appropriate guidelines on how to use MIS data to compute coverage rates for different intervention programs (especially how to extract coverage rates for ORS and Zinc separately from program MIS data).
    c. *LiST* considers coverage of ORS and zinc for estimation of lives saved. However, as per childhood diarrhoea management guidelines the recommended treatment is both zinc and ORS. It will be good if *LiST* developers consider using coverage of both zinc and ORS as well for lives saved modelling.
    d. *LiST* computes the estimated number of additional deaths averted in relative to impact year for a particular program for two age groups – neonatal age group (i.e., 0-1 month) and 1-59 months – NOT any other age break up. Thus, in the current exercise though the

[10] Eight respondents (care givers) reported of receiving ORS packets from public health functionaries out of 437 reported diarrheal cases in the baseline, JHSPH, 2010.

target population was children aged 2-59 months and the program was not designed to reach newborns, the results are recorded for 0-59 months.

e. One of the biggest challenges for *LiST* model is that it operates on residual deaths one-by-one interventions (in this case first ORS intervention -> Zinc intervention). In other words, it works more or less in a linear format whereas, epidemiologically this may not true. In this exercise, ORS coverage and Zinc coverage are modelled separately, however, Zinc would not be recommended as a stand-alone treatment for diarrhoea; it would only be recommended along with ORS or – should supply of ORS be unavailable – ORT.
f. *LiST* has been built on a primary assumption that mortality rates and cause of death structure will not change except in response to changes in coverage of intervention[11]. This assumption restricts the use of *LiST* model to a long-term projection purposes.

****

[11] *Fischer Walker and Neff Walker, BMC Medicine, 2014, 12:70*

Micronutrient Initiative (MI) Response

The following are MI responses on the report:

1) In the Results section, the lives saved have been compared with a target from the 2010 Investment Memo cautious model estimation of 4,200 lives saved. The lives saved in the program are less than these targets. We believe that the major reasons the number of lives saved is lower are as follows:
    a. In the program there has been an irregular supply of zinc and ORS which has affected the treatment of diarrhoea cases and has resulted in less than expected coverage of zinc and ORS. Beginning April 2014, for more than a year there was a complete stock out of zinc. This was because of the Government's inability to address health system challenges related to procurement. These challenges were beyond MI's control.
    b. The lives saved modelling is largely based on project MIS data, most of which is reported by community health workers. These community health workers are semi-literate women who have not previously been involved in systematic reporting for any program. Therefore, the quality of reporting might not be what is expected and there is likely under reporting of treated cases. Hence, the number of cases used for modelling lives saved is probably not a true reflection of reality.
    c. As mentioned in the report, the targets as per the CIFF investment memo are unrealistic therefore, it would have been better to compare lives saved with those achieved in similar programs.

2) In the table describing the scenarios (page 8), under scenario 4, an incidence of 2.2 episodes of diarrhoea per child per year has been used, which is the higher of the incidence rates employed. Modelling could have also been done using 1.8 episodes as has been done in other scenarios. It is recommended to mention as part of the description of scenario 4 in the report that 40% to 60% higher coverage rates have been used to offset the underreported cases from FLWs.

3) In the section on Challenges and Future Directions (page 14), under MIS data, lessons learnt using project MIS data have been mentioned (see the box in the report). MI during the project period has attempted to address most of these points. Therefore, if it is necessary to include this section in the report, then the following lessons may be more appropriate:

    a. CHWs are semi-literate women and need continuous hand-holding for quality reporting.
    b. There is under reporting from CHWs, which can be minimized by regular availability of supplies of zinc and ORS, reporting formats, and follow-up by block and district officials on reporting.

Appendix 1

The JHSPH research baseline (2011)/midline (2013) found:

- public sector care seeking is 6.7% at baseline and 13.2% at midline
- ORS coverage at baseline is 19.7% (both public and private providers), and is 25.9% at midline (both public and private providers) (JHSPH Table 4, p 11).
- Children with diarrhoea who got ORS from *public sector* sources at baseline is 9.3% (of 19.7% who received ORS at baseline), and at midline this is 21.2% (of 25.9%). This is based on the place from which caregivers procured treatment packets, among the Proportion of children administered ORS during this recent diarrheal episode.

Public sector packet procurement at baseline and midline was counted as having received ORS from any if the public-sector sources specified in the JHSPH survey; that is, from:

- a public health center, government hospital, or government dispensary
- an auxiliary nurse midwife
- an Anganwadi worker (AWW) or Anganwadi Centre (AWC)
- an Accredited Self-Help Activist (ASHA)

The baseline and midline data on source of ORS comes from a multiple-response survey item.

	BASELINE(2011)	MIDLINE (2013)
PHC / Govt hospital / Govt dispensary:	4 (4.7% of 86)	17 (8.8% of 194)
Auxiliary nurse midwives (ANMs/ sub centre):	0	4 (2.1% of 194)
Anganwadi worker (AWW)/ Anganwadi centre (AWC):	2 (2.3% of 86)	6 (3.1%)
ASHAs:	2 (2.3% of 86)	14 (7.2%)
Total:	8 (9.3% of 86)	41 (21.2%); 39 (20.1%) unique
Total diarrheal cases reported	437	750
ORS coverage from Public health functionaries	1.83% (8/437%)	5.2% (39/750%)

Analysis of the multiple-response survey item means there could be double-counting. Analysis of the baseline (2011) data found no double counting. At midline (2013), two caregivers reported approaching more than one public-sector source to get ORS, therefore, 39 unique respondents (20.1% of 194 caregivers) reported having gotten ORS from a public sector source.

Typically, in state like Bihar, more than 90% diarrhoea treatment is provided by private sector. From field observations, MI noted that ORS supplementation is largely from public sector health professionals, and diarrhoea treatment in private sector is mainly antibiotic injections, drips, etc. rather than with ORS supplementation.

Appendix 2

1. Results from Scenario 1 Model

1. *By Using Default Values of Affected Fractions and Effectiveness in LiST Software with diarrhoea incidence rate = 1.81*
2. *ORS coverage rate = Numerator would be (Numbers treated with ORS only + Numbers treated with ORS & Zinc)*
3. *Zinc coverage rate = Numerator would be (Numbers treated with ORS & Zinc) and*
4. *Common denominator = Total number of diarrhoea incidences/episodes*

Table 1:

No of additional deaths averted in Children under five years of age by intervention relative to baseline year (Total 0-60 months of program implementation) – Impact of ORS

Year	ORS - Public Sector Coverage (%)	Zinc - Public Sector Coverage (%)	Total No. of addl. deaths averted	Cumulative
2010/11 - Baseline	1.83^		0	0
2011/12	2.95	No change	105	51*
2012/13 - Midline	5.20^	No change	334	385
2013/14	4.63	No change	272	657
2014/15	3.73	No change	181	838

*Notes: * Adjusted for the number of months/period program implementation in different groups of districts [please see Appendix 3 for details of this adjustment]*
^: Computed from JHSPH, 2013 report
Coverage rates for 2013/14 and 2014/15 are computed from MIS data

Table 2:

No of additional deaths averted in Children under five years of age by intervention relative to baseline year (Total 0-60 months) – Combined impact of ORS and Zinc

Year	ORS - Public Sector Coverage (%)	Zinc - Public Sector Coverage (%)	Total No of addl. deaths averted	Cumulative
2010/11 - Baseline	1.83^	1.37	0	0
2011/12	2.95	2.51	132	65*
2012/13 - Midline	5.20^	4.80	417	482
2013/14	4.63	3.22	316	798
2014/15	3.73	0.83	167	965

*Note: * Adjusted for the number of months/period program implementation in different groups of districts*
^: Computed from JHSPH, 2013 report
Coverage rates for 2013/14 and 2014/15 are computed from MIS data

1.a By Using Default Values of Affected Fractions and Effectiveness in LiST Software with diarrhoea incidence rate = 2.2

Table 1.a:

No of additional deaths averted in Children under five years of age by intervention relative to baseline year (Total 0-60 months) – Impact of ORS

Year	ORS - Public Sector Coverage (%)	Zinc - Public Sector Coverage (%)	Total No. of addl. deaths averted	Cumulative
2010/11 - Baseline	1.83^		0	0
2011/12	2.95	No change	105	51*
2012/13 - Midline	5.20^	No change	334	385
2013/14	3.80	No change	191	576
2014/15	3.07	No change	118	694

*Note: * Adjusted for the number of months/period program implementation in different groups of districts*
^: Computed from JHSPH, 2013 report
Coverage rates for 2013/14 and 2014/15 are computed from MIS data

Table 2.a:

No of additional deaths averted in Children under five years of age by intervention relative to baseline year (Total 0-60 months) – Combined impact of ORS and Zinc

Year	ORS - Public Sector Coverage (%)	Zinc - Public Sector Coverage (%)	Total No. of addl. deaths averted	Cumulative
2010/11 - Baseline	1.83^	1.37	0	0
2011/12	2.95	2.51	132	65*
2012/13 - Midline	5.20^	4.80	417	482
2013/14	3.80	2.64	222	704
2014/15	3.07	0.68	102	806

*Note: * Adjusted for the number of months/period program implementation in different groups of districts*
^: Computed from JHSPH, 2013 report
Coverage rates for 2013/14 and 2014/15 are computed from MIS data

2. Results from Scenario 2 Models:

[Those who received ORS, plus those who received zinc (including those who received both ORS & zinc)]

1. *By Using Default Values of Affected Fractions and Effectiveness in LiST Software with diarrhoea incidence rate = 1.81*
2. *ORS coverage rate = Numerator would be (Numbers treated with ORS only + Numbers treated with ORS & Zinc) and*
3. *Zinc coverage rate = Numerator would be (Numbers treated with ORS & Zinc + those who received zinc alone)*
4. *Common denominator = Total number of diarrhoea incidences/episodes*

Table 1:

No of additional deaths averted in Children under five years of age by intervention relative to baseline year (Total 0-60 months) – Impact of ORS @ 1.81 incidence rate

Year	ORS - Public Sector Coverage (%)	Zinc - Public Sector Coverage (%)	Total No. of addl. deaths averted	Cumulative
2010/11 - Baseline	1.83^		0	0
2011/12	2.95	No change	105	51*
2012/13 - Midline	5.20^	No change	334	385
2013/14	4.63	No change	272	657
2014/15	3.73	No change	181	838

*Note: * Adjusted for the number of months/period program implementation in different groups of districts*

^: Computed from JHSPH, 2013 report

Coverage rates for 2013/14 and 2014/15 are computed from MIS data

Table 2:

No of additional deaths averted in Children under five years of age by intervention relative to baseline year (Total 0-60 months) – Combined impact of ORS and Zinc

Year	ORS - Public Sector Coverage (%)	Zinc - Public Sector Coverage (%)	Total No of addl. deaths averted	Cumulative
2010/11 - Baseline	1.83^	1.37	0	0
2011/12	2.95	2.51	132	65*
2012/13 - Midline	5.20^	4.80	417	482
2013/14	4.63	3.22	326	808
2014/15	3.73	0.83	167	975

*Note: * Adjusted for the number of months/period program implementation in different groups of districts*

^: Computed from JHSPH, 2013 report

Coverage rates for 2013/14 and 2014/15 are computed from MIS data

1.a By Using Default Values of Affected Fractions and Effectiveness in LiST Software with diarrhoea incidence rate = 2.2

Table 1.a:

No of additional deaths averted in Children under five years of age by intervention relative to baseline year (Total 0-60 months) – Impact of ORS @ 2.2 incidence rate

Year	ORS - Public Sector Coverage (%)	Zinc - Public Sector Coverage (%)	Total No. of addl. deaths averted	Cumulative
2010/11 - Baseline	1.83^		0	0
2011/12	2.95	No change	105	51*
2012/13 - Midline	5.20^	No change	334	385
2013/14	3.80	No change	191	576
2014/15	3.07	No change	118	694

*Note: * Adjusted for the number of months/period program implementation in different groups of districts*
^: Computed from JHSPH, 2013 report
Coverage rates for 2013/14 and 2014/15 are computed from MIS data

Table 2.a:

No. of additional deaths averted in Children under five years of age by intervention relative to baseline year (Total 0-60 months) – Combined impact of ORS and Zinc @ 2.2 incidence rate

Year	ORS - Public Sector Coverage (%)	Zinc - Public Sector Coverage (%)	Total No. of addl. deaths averted	Cumulative
2010/11 - Baseline	1.83^	1.37	0	0
2011/12	2.95	2.51	132	65*
2012/13 - Midline	5.20^	4.80	417	482
2013/14	3.80	3.29	237	719
2014/15	3.07	0.73	102	821

*Note: * Adjusted for the number of months/period program implementation in different groups of districts*
^: Computed from JHSPH, 2013 report
Coverage rates for 2013/14 and 2014/15 are computed from MIS data

3. Results from "Working backwards from 4,200" Model (Scenario 3):
[Those who received ORS, plus those who received zinc, with those who received zinc modelled as though they had also received ORS)]

1. *By Using Default Values of Affected Fractions and Effectiveness in LiST Software with diarrhoea incidence rate = 1.81*
2. *ORS coverage rate = Numerator would be (Numbers treated with ORS + Numbers treated with Zinc) and*
3. *Zinc coverage rate = Numerator would be (Numbers treated with ORS + those who received zinc alone)*
4. *Common denominator = Total number of diarrhoea incidences/episodes*

Table 1:

No of additional deaths averted in Children under five years of age by intervention relative to baseline year (Total 0-60 months) – Impact of ORS

Year	ORS - Public Sector Coverage (%)	Zinc - Public Sector Coverage (%)	Total No. of addl. deaths averted	Cumulative
2010/11 - Baseline	1.83^		0	0
2011/12	2.95	No change	105	51*
2012/13 - Midline	5.20^	No change	334	385
2013/14	14.59	No change	1239	1624
2014/15	19.84	No change	1717	3341

*Note: * Adjusted for the number of months/period program implementation in different groups of districts*
^: Computed from JHSPH, 2013 report
Coverage rates for 2013/14 and 2014/15 are computed from MIS data

Table 2:

No of additional deaths averted in Children under five years of age by intervention relative to baseline year (Total 0-60 months) – Combined impact of ORS and Zinc

Year	ORS - Public Sector Coverage (%)	Zinc - Public Sector Coverage (%)	Total No of addl. deaths averted	Cumulative
2010/11 - Baseline	1.83^	1.37	0	0
2011/12	2.95	2.51	132	65*
2012/13 - Midline	5.20^	4.80	417	482
2013/14	14.59	13.46	1502	1984
2014/15	19.84	18.31	2060	4044

*Note: * Adjusted for the number of months/period program implementation in different groups of districts*
^: Computed from JHSPH, 2013 report
Coverage rates for 2013/14 and 2014/15 are computed from MIS data

4. Results from Scenario 1 Model (40% Up)

[Hypothetically, with larger coverage rates (40% up in 2014/15 from 2012/13 coverage rates calculated from MIS) for ORS & Zinc coupled with "worst-case" incidence of diarrhoea episodes/incidences at 2.2]

Table 1.a:

No of additional deaths averted in Children under five years of age by intervention relative to baseline year (Total 0-60 months) – Impact of ORS

Year	ORS - Public Sector Coverage (%)	Zinc - Public Sector Coverage (%)	Total No. of addl. deaths averted	Cumulative
2010/11 - Baseline	1.83^		0	0
2011/12	3.01	No change	105	51*
2012/13 - Midline	6.29	No change	442	493
2013/14	7.50	No change	555	1048
2014/15	8.80	No change	665	1713

*Note: * Adjusted for the number of months/period program implementation in different groups of districts*

^: Computed from JHSPH, 2013 report

Coverage rates for 2013/14 and 2014/15 are computed from MIS data

Table 2.a:

No of additional deaths averted in Children under five years of age by intervention relative to baseline year (Total 0-60 months) – Combined impact of ORS and Zinc

Year	ORS - Public Sector Coverage (%)	Zinc - Public Sector Coverage (%)	Total No. of addl. deaths averted	Cumulative
2010/11 - Baseline	1.83^	1.37	0	0
2011/12	3.01	2.79	139	69*
2012/13 - Midline	6.29	5.88	551	620
2013/14	7.50	7.10	688	1308
2014/15	8.80	8.23	820	2128

*Note: * Adjusted for the number of months/period program implementation in different groups of districts*

^: Computed from JHSPH, 2013 report

Coverage rates for 2013/14 and 2014/15 are computed from MIS data

5. Results from Scenario 1 Model (60%Up)

[Hypothetically, with larger coverage rates (60% up in 2014/15 from 2012/13 coverage rates calculated from MIS) for ORS & Zinc coupled with "worst-case" incidences of diarrhoea episodes/incidences at 2.2]

Table 1.a:

No of additional deaths averted in Children under five years of age by intervention relative to baseline year (Total 0-60 months) – Impact of ORS

Year	ORS - Public Sector Coverage (%)	Zinc - Public Sector Coverage (%)	Total No. of addl. deaths averted	Cumulative
2010/11 - Baseline	1.83^		0	0
2011/12	3.01	No change	105	51*
2012/13 - Midline	6.29	No change	442	493
2013/14	8.20	No change	616	1109
2014/15	10.06	No change	785	1894

*Note: * Adjusted for the number of months/period program implementation in different groups of districts*

^: Computed from JHSPH, 2013 report

Coverage rates for 2013/14 and 2014/15 are computed from MIS data

Table 2.a:

No of additional deaths averted in Children under five years of age by intervention relative to baseline year (Total 0-60 months) – Combined impact of ORS and Zinc

Year	ORS - Public Sector Coverage (%)	Zinc - Public Sector Coverage (%)	Total No. of addl. deaths averted	Cumulative
2010/11 - Baseline	1.83^	1.37	0	0
2011/12	3.01	2.79	139	69*
2012/13 - Midline	6.29	5.88	551	620
2013/14	8.20	7.60	760	1380
2014/15	10.06	9.40	964	2344

*Note: * Adjusted for the number of months/period program implementation in different groups of districts*

^: Computed from JHSPH, 2013 report

Coverage rates for 2013/14 and 2014/15 are computed from MIS data

Appendix 3

MI's intervention was rolled out in phase manner, i.e., program was started in the first set of five districts for six months before rolling out in the second set of five districts. Finally, the intervention in the final set of five districts started after one year completion of the program. The results obtained from *LiST* are pertaining to 15 district data and for a full year. Thus, the phased intervention resulted in an adjustment in the results of number of additional deaths averted in children under-five years of age for the year 2011/12. Result for this particular year was adjusted for population and time-lapsed for the program implementation in the second and third sets of five-districts.

As previously mentioned, this adjustment was made ONLY to results for the year 2011/12. To adjust population, proportions of population in these three sets of five-districts have been computed. Since there is no time lapse in the program implementation in the first set of five-districts the number of additional deaths averted from this set of districts can be calculated by multiplying population proportion with total number of additional deaths averted (from *LiST* output) for this particular year. Contribution to the total number of additional deaths averted from the second set of five districts is calculated by multiplying population proportion with total number of additional deaths averted (from *LiST* output) and adjust for time-lapse, i.e., six months which is equivalent to 0.5. The number of additional deaths averted for the third set of five-districts was adjusted to '0' as there was no intervention in 2011/12. Following table provides the calculation details:

LiST output provides a total of 105 additional number of deaths averted for the year 2011/12.

Implementation Phase	No of districts	Popln. Proportion (%)	No of addl. deaths averted, 2011/12	Description
Phase 1 (Started in Aug 2011)	5 - districts	36.54	105*36.54% = 38	Full year intervention in 2011/12
Phase 2 (Started in Mar 2012)	5 - districts	24.97	105*24.97%*0.5 = 13	Six months intervention in 2011/12
Phase 3 (Started in Sep 2012)	5 - districts	38.49	0	No intervention in this set of five-districts for the year 2011/12
Total		100.00	38+13+0 = 51	

Appendix 4

List of differences in *LiST* modelling between current (2015) and JHU modelling (2013)

Sr No	Items	Current Modeling	JHU, 2013
1	Software Version used	V5.31 (June, 2015 version)	Older version
2	Changes in new version software	Among other changes, default values are revised[12]	
3	Input data for *DemProj* and *LiST* modules	Used latest 15-*district* age-sex data from Census, 2011	Used *State* age-sex old data from UN data source
i	Total fertility rate (input to Models)	3.91 (2010)*, 3.79 (2011)*, 3.69 (2012)*, 3.61 (2013)***, 3.54 (2015)***	3.06 (2010), 2.94 (2011), 2.82 (2012), 2.70 (2013), 2.60 (2014), 2.50 (2015)
ii	Sex ratio at birth	110.01**	112
Iii	Neonatal mortality rate in 2010 (baseline)	36.5^	31.0
Iv	Infant mortality rate in 2010 (baseline)	57.5^	48.0
V	Under 5 mortality rate in 2010 (baseline)	81.1^	64
vi	Maternal mortality ratio in 2010 (baseline)	305^^	230

*: Reported from Annual Health Surveys (three rounds)

**: Reported from Sample Registration System (SRS), Registrar General of India for Bihar state (Number of male births per 100 female births);

^: Reported from AHS, 2010/11 (compiled for 15 prog. implementation districts);

^^: AHS, 2010/11 for Bihar state

*** These are estimated (projected), not measured, values for 2013 and 2015.

[12] http://livessavedtool.org/images/downloads/Spectrum%20Update%20List.pdf