Clinca 205 Solution Efficiency Study Project

Final Report
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Cambodia

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1 Executive Summary

The Clinca 205 Efficiency Project was specifically designed and implemented by Indigenous People's Health Association (IPHA) to gather health data to illustrate the actual health impact of Clinca 205, and to explore the effectiveness of Clinca 205 as a low-cost, community level, safe water solution for use in developing country contexts in terms of such health impacts *(through the Cluster Randomized Controlled Trial (CRCT) dimension of the project)*. The project team is headed by Andrew Martin (Manager and Advisor to the IPHA Board of Director).

The project entailed the clustered random assignment of villages into four separate implementation Arms. The data gathered from this project has identified the specific/ fast health improvement impacts of Clinca 205 in a variety of village level contexts and environmental conditions. The design of the project also explored the impacts of other variables in relation to reducing the prevalence of waterborne diseases *(for a more detailed analysis of the health impact on the target groups see the detailed Data Analysis section under Annex 1)*.

The target area for the CRCT aspect of the project was 42 villages across 4 Districts of Ratanakiri Province, covering 4,091 rural households. The project was implemented in close collaboration with the Provincial Department of Rural Development, the Provincial Health Department, five public Health Centres, and 96 village level community health workers.

Data was collected from project baseline/ end-line surveys, village level community health worker reports, and public health facilities/ provincial level health data sources. The high survey coverage rates far exceeded universally accepted minimums for scientific standards required for credibility of the data collected, adding to the quality of the data modelling and the understanding of the target groups.

In the baseline, over 53.5% of households surveyed reported at least one household member currently experiencing diarrhea *(defined as diarrhea within the preceding 12 hours [Spot Prevalence], and 58.1% having a household member who experienced at least 1 case of diarrhea in the prior 3 days [Time Prevalence])*. On the whole, the aggregate sample experienced 1.088 cases of diarrhea per household at the time of the baseline survey. However, when only households having at least one case of diarrhea were included in the averaging *(a more accurate indicator of disease clustering and actual disease burden),* the per household Spot Prevalence and Time Prevalence rates jump to 2.03 and 2.12 per household, respectively.

Analysis of the full baseline-endline data clearly indicated a very significant and strong health impact from Clinca use on the household 3-day diarrheal prevalence rate. The results indicate that a household with an average household size, average number of children, and average income, which received Clinca 205 could expect to have a 56.5% lower 3-day diarrheal prevalence rate as a consequence of drinking Clinca treated water, as compared to an average household *(control group)* not drinking Clinca treated water. The use of Clinca treated water also has an even greater health improvement impact on households with children. While an average household with an above average five children would usually have a diarrheal prevalence rate of 22% or higher at the household level as compared to an average household with the average 3 children, with the use of Clinca treated water such a household would likely have an average rate 53% lower than a similar household without Clinca due to the apparently stronger impact of Clinca upon households with high numbers of children *(an additional 18.5% lower rate above that of households with Clinca and 3 children, but the initial rate for 5 child households is already higher than average)* largely offsetting the expected increase in diarrhea correlated with the additional children.

Interestingly, it was observed that Clinca 205 did not differ in its impacts for households based on their water sources. Also the possible enhancing effect of Clinca 205 used together with ceramic water filters, as hypothesized in previous projects, does not appear to be present *(Clinca treated water used in addition to the use of ceramic water filters has no noticeable additional health impacts, as compared to only Clinca treated water use, i.e. ceramic water filter use has very limited additional health improvement impact)*.

2 Project Objective

While two past small-scale Clinca based pilot projects in the province have indicated a demand for Clinca 205 from households, considering the design of the previous projects it has not been possible to establish the health impacts of Clinca 205 in a normal use context to a robust and acceptable standard according to current standards and practice in the health field. The current project was specifically designed and implemented by the IPHA with the aim of filling this information gap and providing official health data to illustrate the actual health impact of Clinca 205 to a scientific and accepted threshold.

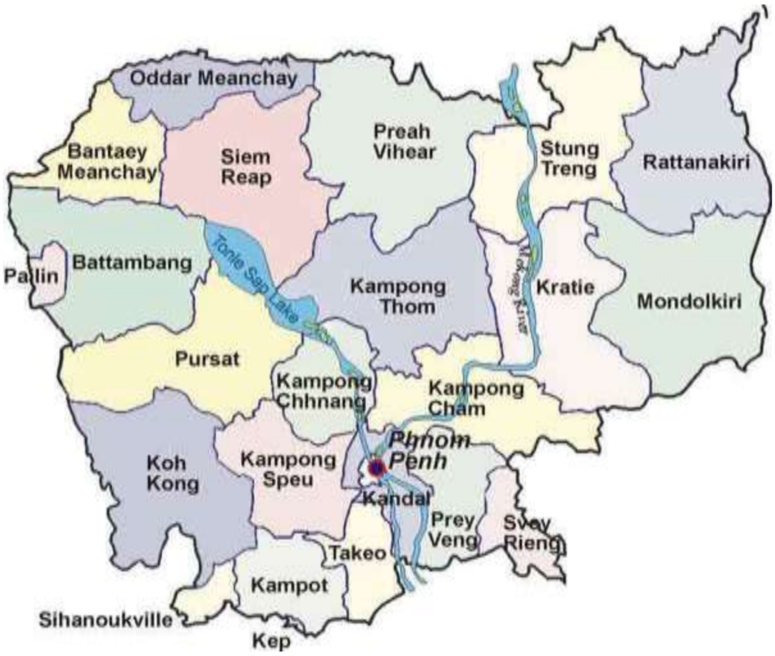
In order to achieve this end, as a fundamental standard, evidence establishing the effectiveness of a health intervention was required in the form of a Cluster Randomized Controlled Trial (CRCT), wherein clusters are randomly assigned to either receive the intervention *(Intervention Group)* or to not receive the intervention *(Control Group)*, and the results of the two groups are compared to see the health differences between the two. The CRCT utilized for this Project, basically shares all the same qualities of the traditional CRCT. However, for this project, randomization was done at the village level *(villages [i.e. clusters] were randomized into either the Intervention Groups or Control Groups so that all households in a village were in the same group)* while primary measurements were done at a household level within each village. This CRCT approach has the benefits of not only determining the individual household level impacts, but, because of the randomization at the village level, it is also able to determine the village/ community level variables, while also making implementation across large areas and large populations logistically feasible.

In the end, by selecting the randomized, controlled approach it has been possible to isolate the specific impacts of Clinca 205 against the background of other effects on household diarrheal rates, while at the same time fully establishing the direct impacts on household diarrheal rates that are created by Clinca 205 and determining other effects that both increase and decrease Clinca’s effectiveness. The full project overview, which was one of the primary planning documents for this project, is attached hereto as Annex 2 for reference.

3 Project Background

3.1 Provincial Overview

Ratanakiri province is located in the remote northeast of Cambodia. It borders the provinces of Mondulkiri to the south and Stung Treng to the west and the countries of Laos and Vietnam to the north and east, respectively. Ratanakiri is sparsely populated; its 170,000 residents make up just over 1% of the country's total population. Ratanakiri is among the least developed provinces of Cambodia. Over half of Ratanakiri's population is comprised of indigenous groups belonging to two distinct linguistic families; the main groups are the Austronesian speaking Jarai and the Mon-Khmer speaking Brao, Kreung, Tampuan, and Phnong.



Map 1 & 2: Location of Ratanakiri Province in Cambodia and its position in relation to neighboring countries.

Most of the indigenous residents of Ratanakiri are subsistence farmers, practicing slash and burn shifting cultivation. Many families are beginning to shift production to cash crops such as cashew nuts, mangoes, and tobacco; a trend that has accelerated in recent years. Larger-scale agricultural production occurs on rubber, coffee, and cashew plantations. Other economic activities in the province include gem mining and commercial logging *(both legal and illegal)*.

3.2 Health and Water Access Overview

Health indicators in Ratanakiri are the worst in Cambodia. Malaria, tuberculosis, intestinal parasites, cholera, diarrhea, and vaccine-preventable diseases are endemic. Ratanakiri has Cambodia's highest rates of maternal and child mortality, with 22.9% of children dying before the age of five. Ratanakiri also has the country's highest rates of severe malnutrition. Ratanakiri residents' poor health can be attributed to a variety of factors, including poverty, remoteness of villages, poor quality medical services, and language/ cultural barriers that prevent indigenous people from obtaining medical care. The province has one referral hospital, 11 Health Centres, and 18 Health Posts. Medical equipment and supplies are minimal, and most health facilities are staffed by nurses or midwives, who are often poorly trained and irregularly paid.

Ratanakiri is one of the least developed provinces in Cambodia. Most of Ratanakiri's residents do not have access to safe/ potable water, (61.1%) obtain water from springs, streams, ponds, or rain; much of the remainder (32.2%) obtain water from dug wells. Only 5.5% of Ratanakiri residents obtain water from sources that are considered safe *(purchased water, piped water, or tube/ piped wells)*.

The results of the Baseline Survey in relation to the water usage trends among the project's target groups largely fit with those expected. The data showed high concentrations of well usage, and significant shifts to free flowing water sources as alternatives. Within the survey sample, roughly 69% of households reported using some type of well as their primary water source, with 24% using free flowing water sources *(rivers [11.29%]; local streams [13.08%])*. However, when it comes to alternative sources *(sources used when primary sources become unusable)*, there was a marked shifted towards free flowing water sources, with well use decreasing to roughly 48% and free flowing water source use increasing to 43.3% *(river [15.94%]; local stream [27.45%])*.

Also from the Baseline Survey data, it was observed that the rate of clean water technology ownership appears to be very limited, with the ownership of any clean water technology being predominately that of Ceramic Water Filters distributed in the course of prior NGO activities. Roughly 72% of households reported owning no clean water technology. Contrastingly, 22.5% of households reported owning a ceramic water filter *(though the actual use of the filter was not measured),* 1.3% using chlorine for water treatment and 3.8% using another type of technology or approach *(e.g. boiled water with local herbs, etc.)*.

4 Project Details

4.1 Project Intervention Districts Overview

<table><tr><td>
</td><td>This project was implemented in a total of 48 target villages in 5 Districts of Ratanakiri Province (Koun Mom, Borkeav, Lumpat, Oyadav and Vuen Sai), covering 4,091 households in the target villages

Following the Cluster Randomized Controlled Trial methodology 42 target villages have been randomly assigned to four branch Arms in order to determine the effectiveness of Clinca 205 from a health intervention perspective. In addition to this a further six villages, with high population density, were selected for the Social Entrepreneur Model implementation Arm.</td></tr></table>

The table below gives an overview of the assignment of target households across the five Districts of intervention:

District	***No. of Villages***	***No. of Households***
Koun Mom	*7*	*736*
Lumpat	*9*	*851*
Borkeav	*17*	*838*
O'Yadav	*9*	*862*
Vuen Sai (SEM)	*6*	*804*
Total	***48 villages***	***4,091 households***

The population of Ratanakiri Province is approximately 170,000; the project covered a population of approximately 24,546 people, representing 14.43% of the population *(4,091 households, based on 6 people per household)*. The target villages span a wide geographical area including mountainous regions, river plains, and basins, and cover a variety of indigenous groups including Kreung, Jarai, Tampuon, Kachok and Lao.

4.2 Local Authorities

Prior to the project implementation, IPHA held several meetings and discussions with relevant stakeholders to obtain necessary understanding and permission to implement this project. The project has been well received by senior provincial/ local government leaders. An official project Memorandum of Understanding was established between the IPHA and the Ratanakiri Provincial Department of Rural Development (PDRD), who are the project's main sponsoring government department *(this is the government department responsible for water in rural areas)* and they provided additional information, data, and support when necessary (attached hereto as Annex 5). The IPHA also obtained an official Letter of Support from the Provincial Health Department (PHD) in relation to interacting with public health facility staff and village level community health workers to facilitate data collection and conduct health education sessions (attached hereto as Annex 6).

The project was organized and implemented by IPHA with 10 health facility staff *(from 5 Health Centres)*, 2 PHD staff; 2 PDRD staff; 96 VHSGs *(2 per target village)*, 48 Village Leaders and 46 Commune Council members *(local government staff)*.

4.3 Implementation Steps

Objective 1: Conduct Baseline and End-line Surveys

<u>Implementation of Activities Related to the Objective:</u>

Baseline Survey Forms: Survey forms and standardized survey implementation protocols were designed based on the variables and indicators needed for the project's data analysis. The survey forms were translated into Khmer by the IPHA and then verbally translated back to the Project Field Manager and the project's Coordinating and Statistics Manager to ensure accuracy and completeness prior to implementation (attached as Annex 3 hereto).

Recruitment of Surveyors: Due to the large geographical area and the number of households covered by the project a decision was taken to recruit 50 Undergraduate students from Build Bright University in Ban Lung, the provincial capital of Ratanakiri province. The students received orientation on the project and training on how to conduct surveys, interviews, and data collection (*many had previously participated in NGO or government surveys in the province*).

Baseline Survey Training: A total of 50 students took part in a 2-day training session held at Build Bright University in order to prepare for the Baseline Survey. The Project Field Manager and the Project Assistant Field Manager collaborated with senior IPHA staff members to facilitate the training sessions. The surveyors were allocated to one of five Survey Teams on the first day of the workshop, according to the following criteria:

- Language skills appropriate to the population/ IP groups in the target villages
- The number of surveyors per group being adequate to survey the number of households in the target District
- At least 2–3 female surveyors allocated to each group.

Key definitions were agreed for consistent/ appropriate use in the target population's indigenous languages *(Khmer, Laos, Tampuon, Jarai, and Kreung)* between Team Leaders and surveyors. These definitions included - diarrhea, household, income etc. It was not possible to write indigenous translations, as these languages have no written scripts. However, the Project Field Manager and Project Assistant Field Manager confirmed verbally with the 5 Survey Team Leaders and indigenous surveyors that all were confident to explain the survey *(especially the WHO standard definition of diarrhea)* in their respective indigenous language.

Results of Surveyor's Training Field Tests: Field practice during the second day of the training session indicated an average time of 12–15 minutes was necessary to complete the household survey, which were very promising times. There were no problems with the relatively more complicated diarrhea or education questions. A few issues were observed during the training field tests:

- Surveyors not introducing themselves
- Surveyors not explaining the survey prior to asking questions
- Surveyors not reading questions exactly as printed on the forms which then confused the respondent and lengthened the time taken to complete the survey
- Surveyors leaving fields blank and not writing '0'
- Surveyors not checking survey forms are complete *(all questions answered)* prior to leaving respondents houses.

All of these issues were resolved with all Surveyors during the subsequent reflection session.

Baseline Surveys: Baseline surveys took place in Mid December 2012 for randomly assigned villages. Outlined below are the surveying techniques that were followed by Survey Teams when in the target villages. These instructions were provided to Survey Team Leaders during baseline training:

- Upon arriving at the target village, the Survey Team assembles at the community meeting facility. This was the Pagoda, Commune Meeting Hall or another structure determined by the Team Leader when in the field
- The Survey Team divides into two sub-teams, each surveying households working away from the meeting point in opposite directions along the main road
- When the end of the village was reached, the surveyor's walked back through the village to the meeting point checking households along the way that were previously not occupied
- Two *'Sweeper Teams'* also operated from either direction of the meeting point and concentrated on surveying households in side-streets only
- If respondents were unable to accurately answer the question, surveyors asked respondents to provide an estimate, and then go to the next question.

The Baseline Survey was implemented in all target villages, with an average coverage rate of 70% of households in target villages for all randomly assigned CRCT villages. Completed survey forms were transferred to the IPHA's Ban Lung office on a daily basis by the Project Assistant Field Manager. Completed forms were then verified and checked for any missing data and survey identification numbers were inserted. The survey forms were then scanned into electronic PDF format and transmitted to the Project Coordinating and Statistics Manager for distribution to the Data Team in Phnom Penh for further verification and inputting.

End-line Survey: The End-line surveys took place from the 18th to 23rd January 2013 for the randomly assigned CRCT villages. The surveying techniques detailed above for use during the Baseline surveys were followed in exactly the same way by all Survey Teams when in the target villages conducting the End-line Survey. The End-line Survey was implemented in all target villages, however this survey **only** focused on households that were previously surveyed during the Baseline.

Prior to deployment in the field, Survey Team Leaders prepared household lists by village for those households previously surveyed during the Baseline Survey. This process allows for a direct comparison to any change in that household's health status during the project implementation period.

The End-line survey achieved an average coverage rate of 78% of previously surveyed households in target villages for all randomly assigned villages. Completed survey forms were transferred to the IPHA's Ban Lung office on a daily basis. Completed forms were then verified and checked for any missing data and survey identification numbers were inserted. The survey forms were then scanned into electronic PDF format and transmitted to the Project Coordinating and Statistics Manager by 24th January for distribution to the Data Team in Phnom Penh for further verification and inputting. (The Endline Survey Form is attached as Annex 4).

Report on Changes, Challenges or Achievements:

The livelihoods of communities in Ratanakiri primarily revolve around various rice, soybean, and cassava farming activities, i.e. sowing, harvesting etc. which are currently taking place. This means that at present a large percentage of the target communities are living semi-permanently at their farms, away from their villages. This made it difficult for the Survey Teams deployed to achieve the target 80% to 90% coverage rates during the Baseline Survey. In an effort to overcome this issue and ensure more villagers were available, the survey Team Leaders pre-announced their work plan to the Village Health Support Group (VHSG) members and the Village Chiefs who collaborated with them in assembling villagers.

Achieving Household Saturation: Team Leaders collated all completed survey forms; counted the number of households surveyed, and checked the percentage of households surveyed against the total village household numbers provided by the Village Chief prior to leaving the village. This helped to ensure that a high (70%+) coverage rate of households had been achieved.

If the villages were located close-by and saturation had not been achieved then the team returned to the village in either the morning or the afternoon and resumed surveying those household that were not previously available. If the villages were remote villages then the Survey Team slept in the village and resumed surveying those households that were not available the previous day *(this process could also start in the morning and continue in the afternoon depending on the team's work plan).*

Depending on coverage rates that were reported daily to the Project Field Manager, teams were also requested to return the following day and re-survey villages that had not achieved an acceptable (70%+) coverage rate. One team completed their allocated village surveys quickly and with good coverage rates and was requested to travel to a neighboring District and assist another team surveying the more remote villages.

The high coverage rate of the surveys far exceeded universally accepted minimums for scientific standards required for credibility of the data collected, and also added to the quality of the data modeling, and understanding of the target groups.

Objective 2: Gather relevant village level data through VHSG reporting, project monitoring, and Health Centre Records.

Implementation of Activities Related to the Objective:

Due to the limited duration of the project and the construction of the statistical analysis, it was necessary to gather data from multiple sources to effectively analyze the actual health impacts of Clinca 205. This was complemented by close monitoring of activity implementation to ensure adherence to agreed Protocols and project guidelines to prevent leakages across the different intervention groups.

Village Health Support Group (VHSG) Training: To ensure the collection of relevant quality village level health data the project staff facilitated the orientation and training of 96 VHSGs *(2 per target village)*. The one-day training workshops took place in the four District capitals. The training covered both basic instruction for all VHSGs involved in the VHSG data gathering and monitoring support activities, Health Education intervention, as well as instructions relevant to the VHSGs from the different Project Arms. The average attendance at the health education sessions was 41 people per village, per session. Farming commitments and lack of available participants limited the attendance rates in the 22 villages where sessions were held.

Deployment of Village Level IPHA Monitors: The IPHA assigned three dedicated staff to act as Village Level Monitors to visit all target villages within a 2-week period. The assigned staff monitored the frequency/ quality of project health education activities and conducted monitoring surveys for a small sample *(approximately 10%)* of village households during each visit. During the monitoring visits IPHA staff also collected VHSG health data reports.

Collection of Health Centre Data: Senior IPHA staff and the Project Field Manager orientated relevant staff from the public Health Centres providing health services to the target villages. Health Centre staff members also participated in the VHSG training. The Health Centre staff collaborated with project staff and provided relevant health data for the target villages concerning the previous 6-month period.

Monitoring: In addition to the IPHA village level monitoring staff, the project's Field Manager and Assistant Field Manager conducted numerous, random/ unannounced project monitoring visits at all stages of the project's implementation. These monitoring visits indicated that Clinca was being used in a high percentage of households and was being used in the correct manner, as instructed to villagers during the initial distribution event in the 22 villages assigned to the Clinca Arms and reinforced again during the VHSG training sessions.

Comparison of Data: VHSG diarrheal data was considerably higher when compared to diarrheal case data reported by the District Health Centre, but lower than that obtained from the household survey. Project staff believe the data provided by both VHSGs and the District Health Centres to be accurate. However, the data obtained from the household survey would be more representative of actual village level cases of diarrhea, whereas the Health Centre data is more likely to be indicative of Health Centre utilization rates rather than of actual village level cases of diarrhea, with empirical evidence indicating that remote and poor villagers are not likely to travel the long distances to seek treatment at the District Health Centre. The diarrheal prevalence data gathered from the household survey demonstrated a surprisingly higher prevalence rate, with diarrhea so omnipresent in daily village life it may be safely assumed that reporting to health officials *(at village or facility levels)* only occurs in severe cases of diarrhea, or when it is present in addition to other symptoms.

Data Entry: The aggregate data gathered from the village and District Health Centers formed the Level 2 data set in addition to prior village allocation and prior project data, and was incorporated into the multilevel linear regression model along with the house-hold level survey data sets (Level 1) to form a comprehensive multilevel data set required for analysis.

Objective 3: Conducting Relevant Interventions for all Project Arms.

<u>Implementation of Activities Related to the Objective:</u>

Following the CRCT methodology, 22 of the 42 target villages were assigned Clinca 205 for point-of-use (POU) water treatment at the household level. The Clinca 205 was distributed by the IPHA to all 22 assigned target villages between the 25th and the 27th of December, in collaboration with the Village Chiefs and the VHSGs from the target villages. The table below details the numbers and percentages of households in the target villages that received Clinca during the distribution:

Project Arm	District	Village	Number of Households	Number of Households that Received Clinca	Percentage of Household Coverage in the Village
Clinca Only	Kon Mom	Sre Angkrong III	132	121	92%
		Srey Poch Tuit	135	89	66%
	Borkeav	Kachok	74	74	100%
		Chrung	41	41	100%
		Dan	34	34	100%
		Pa Ar	36	32	89%
		Chreak	44	44	100%
		Smach	29	29	100%
	Lumpat	Dei Lo	123	120	97%
	Oyadav	Blor	105	64	60%
		Pok Po	110	84	76%

Clinca & Health Education	Borkeav	Sala	62	49	79%
		Pa Ar	68	68	100%
		Cheth	49	49	100%
	Lumpat	Kaloang	50	45	90%
		Katieng	105	105	100%
	Oyadav	Tung	66	46	70%
		Takok Chray	94	75	80%
		Pril	94	47	50%
		Takok Phnong	123	81	66%
		Padal	144	75	52%
	Kon Mom	Neang Dei	43	39	90%
	Total Households		**1,752**	**1,411**	**80.5%**

Table 1: Number and percentages of households that received Clinca in the 22 target villages.

Clinca Distribution and Project Arm Assignment:

As per the project design, the Clinca was distributed to 22 villages that formed the Clinca Arms, these were then divided into two Project Arms:

- Villages with only Clinca 205 and usage instructions provided
- Villages with Clinca 205, usage instructions and complementary health education provided.

From the target villages 11 villages were provided with a combination of Clinca, usage instructions and health education, and 11 villages were provided with Clinca and usage instructions only. This approach enables the project team to identify the health impact of Clinca alone and the impact of Clinca combined with complementary health education. The actual health impact of Clinca can then be further analyzed when compared to the data collected from the other project Arms: villages with no Clinca - with only complementary health education provided and villages with no intervention at all *(the control group).*

This was incorporated into the distribution. For villages assigned to the Clinca and health education project Arm the VHSGs presented a detailed health education session to recipients, whilst for the villages assigned to the Clinca only project Arm, recipients received only Clinca usage instructions during distribution.

VHSGs from the villages assigned to the Clinca and health education project Arm presented complementary weekly relevant health education sessions to recipients (in their indigenous languages), during which they also presented Clinca usage instructions; whilst for the villages assigned to the Clinca only project Arm, the VHSGs collected relevant health data only.

Report on Changes, Challenges or Achievements:

There were two main challenges faced by the project team with Clinca distribution:

The late release of the Clinca from the Cambodia Customs Department caused the commencement of activities to be delayed. Whilst the Clinca arrived in Cambodia on the 18th November 2012 it was not released by the Customs Department until the 20th December 2012. This was firstly due to the participation of President Barack Obama in the ASEAN Summit held in Phnom Penh, which resulted in US Security Services closing down the airport for 3 days, and secondly to the inadequate performance of the freight forwarding agents. The Cambodia based project staff had severe difficulties with the freight forwarding agents selected by the project's Japan based staff. After considerable unnecessary delays Cambodia based project staff had to intervene to facilitate the processing of the Clinca through the Customs process. The Clinca was eventually released by the Customs Department on the 20th December 2012. Once released it took 8 days for the Cambodia based project staff to get the Clinca packaged, transported to Ratanakiri Province and distributed to the target villages.

The unexpected delay of the Clinca being released by the Cambodia Customs Department then caused a further problem for the Ratanakiri team. Distribution had previously been planned to commence just prior to the sowing season, the delays however meant that distribution occurred when some target villages were commencing their farming season, resulting in some households not having family members in the village to participate in the distribution. This was mainly evident in Pril (50%), Padal (52%), Blor (60%), Takok Phnong (66%), and Sre Poch Tuit (66%) villages, and resulted in lower Clinca coverage rates. Due to the design of the project it is not possible to go back to target villages at a later date as this threatens the credibility of project data. The coverage rate still far exceeds universally accepted minimums for scientific standards required for credibility of the data and can be adjusted in the finalization of the data model design.

Monitoring conducted by the project's senior staff indicated that Clinca was used correctly as per the instructions given during the distribution of Clinca and via VHSGs during health education sessions.

Objective 4: Analysis and Reporting of Impact Objectives

In order to ascertain the success of the project it is important to review the progress made in relation to achieving the project's Goal: To establish the health impacts of Clinca 205 on household health in relation to waterborne disease in normal use circumstances.

The Cluster Randomized Controlled Trial (CRCT) approach is the correct methodology to ascertain the positive health impacts of Clinca 2005 in relation to reducing waterborne disease in normal use, real life environments. The CRCT method will allow the actual health impacts of Clinca 205 for households and community levels to be identified without contamination of the results by factors such as income, social status of households, water source, and other variables. This is achieved through the randomized assignment approach of the CRCT design. This approach holds to the highest scientific standards for determining the actual impact of health orientated interventions and adheres to the international standards of reputable health institutions worldwide.

This project's methodology was designed based on the study structures set for determining the true health impacts of interventions as used by international organizations including WHO, UNICEF, etc. The reason behind the incorporation of this dimension of the project is that whilst many water solutions have demonstrated strong impacts on water quality in laboratory environments, the impact of these water solutions has sometimes not led to the expected health impacts at the households/ individual level. Undertaking this study will give a clear understanding of the performance of Clinca 205 Solution in a real life, developing country, rural poor environment and identify the additional impact of variables such as providing complimentary health education along side the use of Clinca 205.

The analysis of data has been achieved through the implementation of the below activities:

1. **Inputting of Survey Data into STATA Data Set Form:** All completed survey forms are converted into a STATA data set by the data team.
2. **Combining of Level 1 and Level 2 Data Sets:** Household level survey data sets (Level 1) are combined with village and district level information data sets (Level 2) by the Data Team to form a complete data set.
3. **Creation of CRCT Analysis Multi-level Models:** Creation of initial models for statistical analysis.
4. **Review and Model Testing:** Approval of the Model is received from outside Advisors with expertise in statistics. The Models are then tested and fitted using prior pilot project data, dummy data, and baseline data.
5. **Analysis, Results and Interpretation:** Respective statistical analysis is undertaken using STATA 12 for the multi-level. The results are then converted into a presentable form and interpretation of/ supplementary analysis undertaken.
6. **Drafting of Data Analysis Report:** After analysis was complete the results and data were incorporated into the Final Report.

<u>The analyzed data demonstrated that the use of Clinca 205 Solution treated water has the following health impacts:</u>

- Strong health impacts in terms of household diarrheal prevalence with a decrease of, on average, 56.5% for a typical household;
- Stronger impacts for households with children, seemingly cancelling out the usual higher rates of diarrhea amongst households with larger numbers of children, bringing their diarrheal rates to the same level as typical households using Clinca treated water; and
- Consistent effectiveness across all types of water sources encountered in the study area.

5 Results and Analysis

5.1 Context and Discussion

Every year an estimated 1.5 million children under the age of 5 die from diarrheal related diseases - a mortality rate greater than HIV-AIDS, malaria and measles combined (Johansson & Wardlaw, 2009). Globally, over 2 billion cases of diarrhea occur each year with diarrhea itself being the leading cause of malnutrition in children under 5 (World Health Organization, 2009), a condition resulting in health, educational and livelihood impacts throughout the rest of that child's life (K. Brown, 2003). Moreover, the impacts of diarrhea are not just limited to the sufferer but also spread to the household as well with past estimates in African nations that found each episode of child diarrhea in a household cost between US$2.63 – US$6.24 in terms of lost productivity and treatment expenses (Rheingans et al., 2012). Finally, diarrhea is not only a disease in itself, but also a cause of subsequent disease due to its impact on the immune system over recurrent diarrheal episodes.

As daunting as the problem of diarrhea may sound at this point, addressing its causes is in reality a great opportunity for achieving quick, significant impacts on households health and livelihoods in a short period of time with life changing effects. As noted by the Mills-Reincke Multiplier, reductions in exposures to diarrheal water-borne diseases leads directly to improvements in other disease rates and also mortality from other diseases, not just diarrheal diseases (Botting et al., 2010). Moreover, with decreases in diarrheal loads, households become not only healthier, but also more financially stable (Rheingans et al., 2012).

While this study only directly considers the impacts of Clinca 205 on household diarrheal rates, with some emphasis on the effects on households with children, its critical to consider this together with the problem of diarrhea in the world today and its lasting impacts on the survival, health and economics of individuals and households. If Clinca 205 is able to substantially decrease the number of times a child gets diarrhea it is not just bringing down a number; it is allowing that child to have better nutrition, grow taller and stronger, experience less sickness from other diseases due to a stronger immune system, achieve better education results ,and have the chance of a better life in the future. If Clinca 205 can decrease the household diarrheal rate from 0.8147 to 0.3535, it is not simply getting lower numbers on paper, but leading to a likely decrease of more than 50% in the number of diarrheal cases in that household, a large decrease in the costs of medications and treatment for diarrhea, and improved financial stability since there are less work days lost to diarrhea sickness or the care of children with diarrhea, and a general improvement in the overall quality of life in that household.

As we move forward through the results of this study it is important to keep these impacts and real world effects in mind. For while we must, from a professional standpoint, talk about much of these things in terms of numbers, we must always make sure that we look at them from the perspective of the lives those numbers reveal, and the way that they impact and improve those lives at present and into the future.

5.2 Diarrheal Impacts

Despite the limited time period of the study, Clinca 205 has demonstrated significant and substantial impacts on household level diarrheal rates within the surveyed population. The results of the study show that average households [1] using Clinca 205 had household diarrheal rates 56.5% lower than similar average households that were not using Clinca 205. In more simple terms, for 100 households without Clinca 205 there would be an expected 82 cases of diarrhea over 3 days. But with similar households using Clinca 205 there would only be an expected 35 cases, a decline of 47 cases of diarrhea from using Clinca, which is set out in Table 5.2-1 below.

	Household Time Prevalence Rate (3-Day)	Likely Cases Per 100 Households (3-Day)
No Clinca (Control)	**.8147**	**82** cases of diarrhea
Clinca 205 Only	**.3535**	**35** cases of diarrhea
Percentage Change with Clinca 205 from Control (%) (Cases per HH)	**56.5%** Decline	**47 less** cases of diarrhea

Note: the above numbers are based on average decreases for average households with other variables controlled. Please reference Data Annex I for specific details.

In terms of comparisons to other interventions in the field, the diarrheal impacts of Clinca 205 are very impressive. For example, the impacts of Clinca 205 of 56.5% exceeded the 46% decline in diarrheal disease of a large, retrospective UNICEF 2006 study on ceramic water filter efficacy in Cambodia (J. Brown & Sobsey, 2006), though it is important to note that the UNICEF study was not randomized and as such the results are considered significantly less reliable than this Clinca 205 Study. Additionally, a 2008 randomized controlled trial of ceramic water filters in Cambodia found a similar 49% decline in diarrheal disease as compared to a control group after controlling for variable and cluster effects using multilevel models (J. Brown, Sobsey, & Loomis, 2008). However, the results of that study are still considered a bit questionable considering the small size of the study sample: roughly 58 households for each project Arm for a total of 176 households. It should be noted that both of these studies were significantly longer than the current study with the 2008 study being implemented over 18 weeks and the UNICEF study over a number of years, so the fact that Clinca 205 had such profound effects in a short period should go towards its credit.

Overall, the effects of Clinca on diarrheal rates as seen in this study surpassed those found in all past field studies for ceramic water filters though most of these comparative ceramic filter studies were either non-randomized *(thus making the causations and results questionable)* or had small sample sizes. The one exception with a greater reported effect than Clinca 205 is a rather infamous 2004 study of ceramic water filters in Bolivia that claimed a 70% decrease in diarrheal rates (Clasen, Brown, Collin, Suntura, & Cairncross, 2004). However, this Bolivia

[1] For more details on the statistical analysis and exact meaning of average household within the model, please refer to Annex 1 of this document.

study has largely, and rather rightly, been rejected by the professional community due to the fact that the sample size was far too small by any professional standard (only 25 households per study arm for a total of 50 households as compared to close to 200 by other similar studies and 1,676 households tracked under this study), that the study failed to provide any information on how the households were selected for the study, and that adequate statistical adjustments where not done with the results for village effects and household cluster effects as well as additional confounding variables.

That study aside, Clinca 205 has demonstrated high efficacy, largely exceeding those of past studies on ceramic water filters, which are considered to be the most viable household point of use solution in the field currently. Assuming that these impacts can be sustained or increased over the long-term use of Clinca 205 in the field, it can be assumed that significant positive knock-on effects could likely be seen on child mortality, stunting and malnutrition as a result of the sustained decrease in diarrheal rates that would result.

5.3 Impacts with Educational Intervention

A rather surprising result of the field study of Clinca 205 was the impact of complementary health education on the effectiveness of Clinca to reduce diarrhea in households. Average households using Clinca 205 without any educational intervention (which was composed, as noted earlier, of basic health and hygiene education as well as re-instruction on how to use Clinca 205 properly for Clinca 205 & Education villages) could be expected to have diarrheal rates 56.5% lower than average households without Clinca 205. However, average households using Clinca 205 and additional health education intervention sessions in their village only saw a 9% reduction in expected diarrheal rates as compared to average households without Clinca 205. This means that while 100 average households without Clinca 205 would be expected to have 82 cases of diarrhea and 100 average households with Clinca 205 only 35, the same number of average households with Clinca 205 and the education intervention would be expected to have 75 cases of diarrhea, all of which can be seen in Table 5.3-1 below.

	Household Time Prevalence Rate (3-Day)	Likely Cases Per 100 Households (3-Day)
No Clinca (Control)	**.8147**	**82** cases of diarrhea
Clinca 205 Only	**.3535**	**35** cases of diarrhea
Clinca 205 & Education	**.7425**	**75** cases of diarrhea
Percentage Change with Clinca 205 & Edu from Control (%) (Cases per HH)	**9%** Decline	**7 less** cases of diarrhea
Percentage Change with Clinca 205 & Edu from Clinca 205 Only (%) (Cases per HH)	**110%** increase	**40 more** cases of diarrhea

Note: the above numbers are based on average decreases for average households with other variables controlled. Please reference Data Annex I for specific details.

It is important to note at this time that the exact cause of this difference cannot be 100% proven from the current study, although some potential causes can be ruled out and a likely cause does seem to be available.

Firstly, it does not appear that this effect is coming as a result of the health and hygiene education portion of the education intervention since if the health and hygiene education portion was the cause of this difference then this effect should also happen with households that received education but not Clinca 205 (Project Arm 4). However, there was no difference between households that received education and not Clinca and households that received no interventions (control). Therefore, this would seem to rule out any effects from the health and hygiene education portion of the education intervention. Alternatively, it could be argued that perhaps there is a negative effect of some interaction between Clinca 205, and health and hygiene education. However, since there is no possible mechanism for such a special interaction between the two this could be rejected as well.

What seems to be likely is that there is some type of effect resulting from the Clinca use instruction portion of the education intervention and the use of Clinca 205. Since both Clinca 205 Only and Clinca 205 & Education Project Arms received the same instruction on using Clinca at the start of the project, it is probably not the instructions themselves but the adherence to those instructions that is likely the cause. Based on field observations and monitoring reports, it does seem that households using Clinca 205 in villages with the education intervention sessions had higher rates of specifically following the Clinca 205 instructions, in this case meaning that they would place Clinca 205 in water for the required 6 hours and then would remove the Clinca and place it in a new container of raw water to clean, or sometimes just take it out after the required 6 hours and begin drinking the water. On the other hand, observations and monitoring seems to indicate that households with Clinca and no education were more likely to use Clinca in a continuous use manner (placing Clinca 205 in a container continuously and simply filling up the container with additional water whenever water is taken out) and/or an elongated use manner (leaving Clinca 205 in the water until the water runs out and not measuring the amount of time). However, this is only observational and much remains to be determined.

Given that Clinca 205 is currently being marketed as having the ability to be moved to new water containers after 6 hours in order to produce more water in a day, and given the fact that many households in rural, resource poor environments often move water into smaller containers for periodic storage or transport on treks over days, it will be very important to determine the exact details on Clinca 205's effectiveness in different circumstances and under different use methods so that its performance in various situations can be understood for future projects. This topic is still being researched with the available data and continuing fieldwork.

5.4 Impacts for Households with Children

Interestingly, Clinca 205 appears to have a more significant impact on households with larger numbers of children than households with average numbers of children. While Clinca 205 decreased diarrheal rates for average households by 56.5%, for otherwise average households with large numbers of children, Clinca 205 appears to cause a 61.5% decrease in diarrheal cases as compared to average households with large numbers of children but no

Clinca. As can be seen in Table 5.4-1 below, households with large numbers of children initially have higher rates of diarrhea than average households, as can be seen by the 100 cases of diarrhea per 100 households compared to 82 cases for those with an average number of children. However, the difference between Clinca average households with average or large numbers of children is very small; 35 cases as compared to 38 cases.

This would seem to indicate that Clinca 205 has greater effects on diarrheal rates in children than those of adults. Given, as noted earlier, that much of the mortality from diarrhea and negative diarrheal effects of stunting and malnutrition occur almost entirely in children, if this effect from Clinca holds it could definitely lead to significant impacts on the long-term health and success of children in the developing world.

	Household Time Prevalence Rate (3-Day)	Likely Cases Per 100 Households (3-Day)
No Clinca (Control)	**.8147**	**82** cases of diarrhea
Clinca 205 Only	**.3535**	**35** cases of diarrhea
No Clinca (Control) with large number of children	**.9957**	**100** cases of diarrhea
Clinca 205 with large number of children	**.3835**	**38** cases of diarrhea
Percentage Change with Clinca 205 from Control both with large number of children (%) (Cases per HH)	**61.5%** Decline	**62 less** cases of diarrhea

Note: the above numbers are based on average decreases for average households with other variables controlled, and for households with 1 standard deviation higher number of children. Please reference Data Annex I for specific details.

While there is no way to determine the exact reason why Clinca 205 is working so well for households with larger numbers of children under the scope of this study, one possible hypothesis would be that, compared to adults, children may be getting more of their diarrhea from drinking water sources than adults who get it to a greater degree from non-water sources and Clinca is making such water safer. Alternatively, it may also be possible that due to lower immunity resistance or overall health children are more vulnerable to waterborne diseases and that Clinca is eliminating those diseases children are more vulnerable to. While either case would seem logical and fit with current health research, it is not possible under the current study to determine exactly what the mechanism for this effect is.

5.5 Impacts by Water Source

Despite its plausible basis, the varying impacts of the effectiveness of Clinca 205 upon water from different types of sources could not be identified in the results of this project. Despite looking at the data and field reports from a variety of perspectives and testing different statistical approaches, there were no consistent trends that could be found that show that Clinca has any increased/ decreased effects on water from different sources.

Moreover, in general the types of water sources categorized in this study *(river water, stream water, well water, spring water, etc.)* did not show any significant impacts on diarrheal rates. The one exception to this was for households that used well water as a secondary water source, which had a significant correlation with higher diarrhea rates. However, this is likely an indicator that the households do not have good alternative water access, since wells often go dry or decrease in water quality during the dry season and households usually only continue using such wells if they have no alternative water sources available to them.

More simply put, it is possible that because there are very good water quality wells and very bad water quality wells, as well as very good quality river water and very bad quality river water across all the project's target villages and that we cannot identify the effects because our categories are too broad *(we would need more specific categories, for example to have pre-identified/ tested good water quality rivers, bad water quality rivers, good water quality wells, bad water quality wells, etc.).* This issue may be explored more in-depth in future studies that are specifically designed to investigate this issue in environments with pre-identified bad/ good quality water sources.

5.6 Impacts with Ceramic Filter Interaction

Despite possible indications in prior studies, Clinca 205 did not demonstrate any increased effectiveness when used in combination with ceramic water filters. That said, Clinca also did not show any reduced effects so the average household 56.5% comparative decrease was the same whether or not the household owned a ceramic water filter. While approximately 22% of households said they owned a ceramic water filter, in the analysis the ownership of a ceramic water filter did not lead to any significant differences in diarrheal rates. More simply, households with ceramic water filters and Clinca had basically the same results as households with only Clinca.

<u>It is important to note</u> that this Study was not designed to investigate the effectiveness of ceramic water filters, so the results identified here are only observational within the context of the Clinca 205 project. Moreover, in this study we only measured if a household had a ceramic water filter, and not whether they were using it. So the results observed definitely question the additional effectiveness of Clinca 205 used in addition to ceramic water filters in the field, however, this should be considered in terms of the limitations of the projects design as stated above.

6 Conclusion

Throughout the implementation of project activities the project design was adhered to and implementation occurred as planned with effective randomization and adherence to pre-specified instructions and structure provided by the IPHA, with the guidance from the Nikken/KMC team.

The results strongly show that Clinca 205 has a significant impact on household diarrheal rates, with an average household experiencing a 56.5% decrease in diarrheal rates when compared to a similar average household without Clinca 205. This effect was found to be diminished when combined with the Educational intervention - the exact mechanism for which could not be exactly determined under this study. However, Clinca 205 showed increased impacts when used by families with larger numbers of children, decreasing their diarrheal rates from a higher than average prevalence rate to a rate almost the same as families with the average number of children.

Overall, the household level positive health impacts of Clinca 205 were found to be exceedingly high for both a field trial and for such a short implementation period. The results of the study strongly indicate that Clinca 205 can serve as an effective clean water/ diarrheal intervention at the household-level in real world circumstances *(i.e. resource poor, water access limited, waterborne disease endemic regions)*. Moreover, the impacts of Clinca 205 appear to be greater than those usually seen by other household point of use clean water interventions in the field *(i.e. ceramic water filters)* in terms of diarrheal impacts. That said, the duration of the project was too short to draw any long-term effect conclusions from the data both in terms of Clinca 205 itself and the usage trends for households.

Considering the general effectiveness of Clinca 205 under this study, and more importantly it's seemingly greater impact on child health within the household, the product would appear to have great potential to impact under 5 child mortality rates for households using it, since diarrhea is the second highest cause of such mortality as noted earlier. Moreover, if Clinca 205 proves to be able to maintain its effectiveness over the medium and long term, it is likely that significant benefits could be had in relation to child nutrition, with additional indirect benefits for individuals and households from better child health and the resulting improved job and educational performance in the long term.

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ANNEXES

ANNEX 1: Data Analysis

1 Reference of Key Statistical Terms and Concepts

Population: In statistical terms, population is used to denote the entire group of people/households/etc. for being considered under that study. For this project, the population is the estimated 3,398 households that reside within the Project villages. Since the population is so large and not all of them can be surveyed, details on the population are gathered through statistics using data from a sample of that population.

Sample: A sample is a portion of the population, usually selected at random, from which data or other information is gathered. This data/information is then used to make conclusions and estimates of the data/information for the population via statistical methods. For this baseline survey, the sample was 2,233 households selected out of all project villages.

Observation: An observation in statistics is the data for one entity (in this case it is one Household in the survey) across all the measured variables at one point of time. In the context of this document, an observation is the information for 1 household in the data.

Mean: In statistics, and this document, a mean is the usual term for the average of a sample or population. Typically, this is accomplished by summing the values for all observations in the data and then dividing by the number of observations.

Standard Deviation: The concept of standard deviation in statistics is a complicated one, but for the purpose of this document a very simplified explanation is given. While the mean says where the average of the data/sample is, it does not say where most of the observations (data points) will be found. Under almost all situations, most data is not the same value as the mean. To get a picture of how the observations are distributed around the mean, we have the standard deviation, which loosely says what the average distance from the mean for the data (the exact mathematical calculation for Standard Deviations is a bit too complicated for this text but can be found in any statistical textbook). Typically, under a normal distribution, 95.45% of all observations should be within 2 standard deviations of the meant, and 99.37% within 3 standard deviations of the mean.

Confidence Intervals (CI): Confidence Intervals (CI) (most commonly 95% Confidence Level Intervals) is a range of for the data value of a specific variable in which the true value will occur with a certain probability. For a 95% Confidence Interval, the true value of the target variable will be within that range 95%. This is often used when determining the mean of a variable for a population based on the results of a sample. Note that if 100% of the population is in the sample, the Confidence Interval is 100% assuming the measuring tool is completely accurate.

Outlier: While there is no set definition for outliers in mathematic terms, the concept is well understood operationally. Simply speaking, an outlier is a data point/observation that has an extreme value very far from the other data points in the sample. To provide a simple definition for outliers in this document, outliers are used to note data points that are more than 3 standard deviations from the mean for the sample. While some small amounts of outliers are expected with all data, too many outliers can be indicative of non-normal distributions and require data checking and transformations.

Skewness: Simply put, skewness is the non-symmetry of data around the mean. With a standard distribution, it is expected that the number of observations larger than the mean should be the same as the number of observations smaller than the mean. If there are more observations larger than smaller, or small than larger, then the distribution is considered to be skewed. Skewness usually indicates that the data is not normally distributed and requires adjustment in statistical approaches.

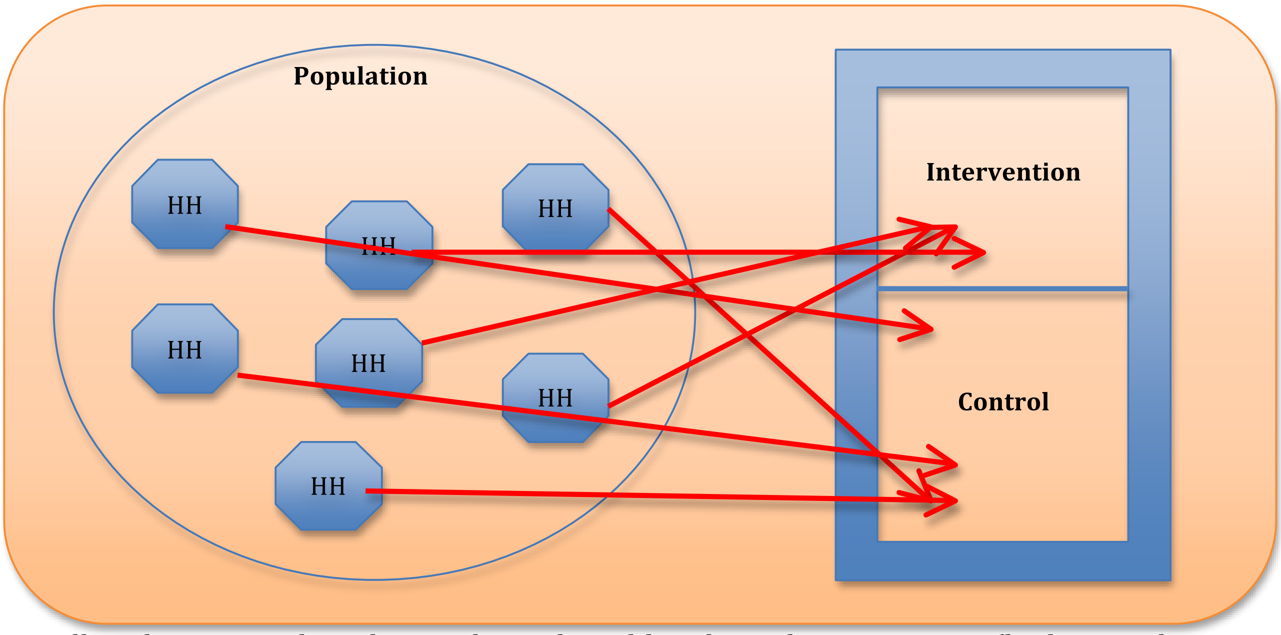
Randomized Controlled Trial (RCT): A randomized controlled trial is a specific type of scientific experiment, and the gold standard for a clinical trials. RCT are often used to test the efficacy of various types of intervention within a patient/individual population. The key distinguishing feature of the usual RCT is that study subjects at the individual level are randomly allocated to receive one or other of the alternative treatments under study.

Cluster Randomized Controlled Trial (CRCT): A cluster randomized controlled trial is a type of randomized controlled trial in which groups of subjects (as opposed to individual subjects) are randomized. Advantages of cluster randomized controlled trials over individually randomized controlled trials include the ability to study interventions that cannot be directed toward selected individuals and the ability to control for "contamination" across individuals (e.g., one individual's changing behaviors may influence another individual to do so.
Disadvantages compared with individually randomized controlled trials include greater complexity in design and analysis, and a requirement for more participants to obtain the same statistical power.

2 Explanation and FAQ for Statistical Approach

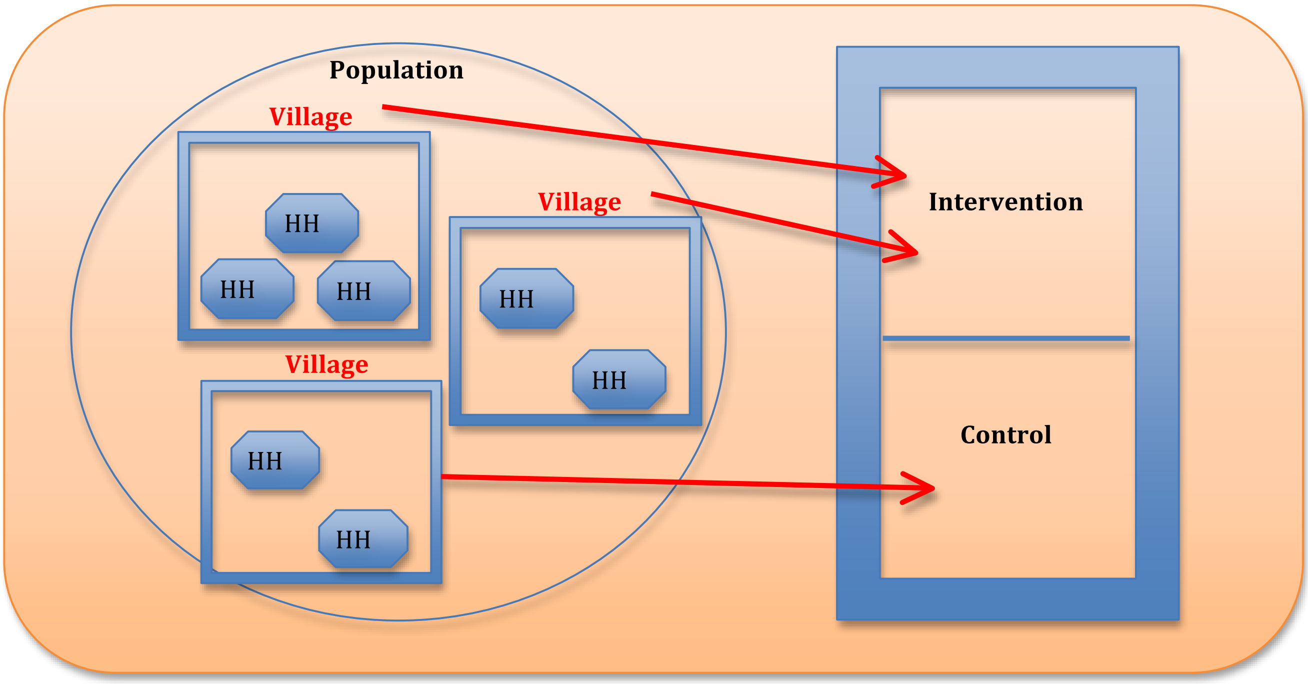
2.1 Key assumptions and differences between simple sampling, randomization and CRCT

Chart 1: Typical Randomization Case (e.g. RCT)



Usually, when we analyze data in the real world with any basic statistics (looking at the means (averages) of different groups, comparing changes over time, etc.) we need to assume that the many different individuals in the sample are basically randomly selected from the same population (the larger group which we are looking at). So, if, for example, we are randomly selecting 10,000 people for our survey on the population of Tokyo it doesn't matter what Ward they come from if we select them randomly and every person in Tokyo has an equal chance of being in our survey no matter what ward they are in. If the sample size is large enough, and the sampling is fairly balanced and random, then the statistics are sound (basically as a result of the Law of Large Numbers, more information can be found here). This structure fits with Chart 1 above.

Chart 2: Clustered Randomization Case (e.g. CRCT)



However, for a Clustered Randomized Controlled Trial (CRCT) the selection of individuals (i.e. households) is not random since it is based on what cluster (i.e. village) the individual is in (see Chart 2 above). So, if a household is in a Control village, it has 0% chance of being selected for Clinca same as a Education Only village. So even though the clusters are randomized, the individuals are not random, and therefore if we tried to use statistics on household level data as if it was a normal, random selection situation, our statistics would be very flawed.

Unlike with the simple case seen in Chart 1, for the CRCT of Chart 2 the possible effects from 1 village on households in that village will be located in only 1 Project Arm and cannot be in multiple Project Arms (since each village is randomly assigned to only 1 Project Arm). As such, if adjustments are not made for those village effects, they could bias the data results of the households (since some changes across groups of households could be coming from their being in the same village and not the household variables such as Clinca, Income, etc.).

It is because of this difference that in CRCT designs more complicated and sophisticated statistical approaches need to used; approaches that adjust for the fact that the level that is randomized (village; Level 2) is higher than the level where the data is being gathered and analyzed (household; Level 1).

2.2 So why was a CRCT approach chosen? Why not just randomize all households (RCT approach)?

Simple Answer:

Good question and there is a good reason. While it is easy to manage the randomizing of patients in a hospital on an individual basis as is done for most medical RCT studies, this approach is often almost impossible for community level studies and in order to do a large scale community level study, as this project did, it was necessary to use a CRCT design (the approach which is currently being implemented for most similar type studies internationally) from a practical sense.

Detailed Answer:
There are basically 3 major issues that make CRCT approaches the only option for large-scale community level studies to a scientific standard.

a) First, and most importantly, is the social costs of projects. For most cases, participants in the study will very quickly realize what group they are in (intervention group such as the Clinca Only group; or a control group like Control in this study). In a village setting where there are delicate and complicated social-political structures between village households and village elders/leaders, having a neighbor get something for free while another gets nothing can cause problems in the village system. Moreover, as past studies trying this approach have shown, this often causes high rates of dropouts for Control Groups in the village and for many villages to chose not to participate in the study (thus possibly causing more bias in the samples). For a village level randomization, this problem is averted by having all individuals in the village get the same intervention/status, and very rarely do issues arise between villages due to distances and different, non-integrated social structures.

b) Secondly, there is the problem of leakages (one group getting exposed to an intervention it is not supposed to have). When a certain intervention is given to a whole village, there is no risk of households sharing information or interventions with control households in the same village. If individuals in the same village where randomly put into control or intervention groups, there would be a risk of them sharing information or products, which would then lead to the contamination of the study design and resulting data. Moreover, in some cases, such as the Education Intervention in this study, individual randomization is completely impossible with a village due to obvious leakages by the very nature of the intervention itself.

c) Finally, there is the issue of costs and scale. Implementing multiple interventions/controls in the same village with randomized households would require multiple trainings and split-monitoring for village level staff. Instead of one village staff needing to be trained for one group, he/she would need to be trained for multiple groups. Moreover, since he/she would have information on both interventions/controls as well as the individuals in each group, it would create another possible point of bias and data contamination (in more scientific terms we would say that the recorder would be unblinded). This would then also require very complicated organization at each village level as well as very specific tracking of all households at the village level in all villages, increasing costs and making large scale studies very, very difficult to implement. By choosing a CRCT approach, costs become substantially less, the project design far simpler to implement, and large numbers of villages easier to manage.

2.3 What is the difference between a basic statistical approach (e.g. comparing averages across groups, etc.) and a Multi-Level Model (MLM)?

Simple Answer:
Simply put, an **Multi-level Model (MLM)**, also known as hierarchical model or mixed-model, is made for situations where we are doing analysis for data that is being

gathered on one lower level and randomization is being done on a higher level (in this case randomization is at the higher **village level** and data is being gathered at the lower **household level**). **MLM** makes this possible by adjusting the household data for the effects of the village level data, so that the true household level effects can be seen for the different variables. In these type of cases, if simple statistical comparisons were used (e.g. comparison of means, etc.) the results would likely be inaccurate or flawed since the household level trends may be showing a lot of the variation from the village level instead of the effects of the household variables (such as household income, size, and Clinca 205 use which are trying to been analyzed).

Detailed Answer:
In typical statistics (including gathering averages, comparing means, simple regressions, etc.) it is assumed that the variables (such as income, health, family size, etc.) are **independently and identically distributed** (a.k.a. "i.i.d."), meaning that each of the random variables are independent of each other and have the same probability of happening. While this assumption is true for the villages (since they are randomly selected from the same population), it cannot be true for the households because their being chosen was dependent on what village they were in.

If we decided to use typical statistics in this case above , we would have been using measurements from households assuming that they were all i.i.d. when in fact groups of households were being chosen from specific villages, and there are effects from these villages that are affecting everyone in the same village but not households in other villages. As a result, their is a high chance that effects of household variable (like the effects of Clinca) could appear to be very significant or very insignificant simply because of the random effects of the villages, and not the actual effects of the household variables.

What MLM approach does to solve this is make two statistical models: one model for looking at the individual level (households; Level 1); and one model for looking at the cluster level (villages; Level 2). It then inserts the model for the cluster level (villages; Level 2) into the individual level (households; Level 1) so that the data and analysis for the individual level is adjusted (i.e. controlled) for the effects of the village level. Simply put, MLM finds the effects of the each village on the households in that village, then controls for them so that all the households are more closely the same and when we look at them we only need to consider the household variables (making it easier to see the household impacts).

2.4 Can't we just use an "simple" comparison of averages of diarrhea rates or diarrhea rate decreases across the Project Arms for this study?

Simple Answer:
Sadly, no. If a simple analysis like that was conducted comparing differences or averages of the Project Arms, it would either be completely meaningless (meaning that there would be nothing that could be seen in the data or trends; in other words a bunch of statistical white noise), or else may lead to seemingly significant trends that in reality

might be not as significant or completely false (see *"Solar Drinking Water Disinfection (SODIS) to Reduce Childhood Diarrhoea in Rural Bolivia: a Cluster Randomized, Controlled Trial", Mausezahl, et al., 2009* for details on past CRCT studies where the simple approach was used but more robust MLM analysis showed the results to be flawed/false).

Detailed Answer:
There are two primary reasons why this is the case:

1. All households in each Project Arm are affected by the village they are in, and these affects can strongly effect the households level data and are not considered or adjusted for with simple approaches;
2. The sample sizes varied from village to village resulting in some villages having more households in the sample than other villages, and as a consequence the village level effects from some villages would be more highly seen in the unadjusted household data than other villages and thus biasing any easy comparisons between the Project Arms.

Basically, because of the above two reasons (and others more complicated and not addressed herein), a simple analysis will be very biased towards certain villages and likely be showing mostly Village Level effects rather than household level effects (which is what the impacts and Clinca are being measured at). Since the village level variations have very large impacts on the prevalence rates (this can be seen by the comparatively large variance at the village level in Table 3.3.1-2 in the Data Annex compared to the households level variance), by not adjusting for the village level impacts the household level impacts that are trying to be seen will be buried in the background "noise" of village level effects so that it is very likely that any changes seen without adjustments will be the results of random variations between villages and not the impacts of Clinca on households.

2.5 What exactly is the MLM analysis doing with the Final Model under this Study?

Simple Answer:
Simply put, the MLM analysis looked at Clinca 205s impacts on household 3-day diarrheal prevalence rates for average households in the survey sample by comparing the average households without Clinca 205 (Control) with average households with Clinca 205 (Clinca Only). The Clinca Only average diarrheal rates were then compared to the average Control diarrheal rates to see the effects of Clinca (since the sole difference between these two controlled groups was only the Clinca).

Detailed Answer:
In this case, average household means households with the average number of household members, number of children, and per capita household income, and not having any Education Intervention. The model then took the households in this group and compared them against each other grouped based on if they had Clinca 205 or did not (basically, it was comparing equivalent households from the Control Arm with the Clinca Only Arm). Based on this, the model then calculated out a likely average/expected impact of having Clinca 205 through this comparison.

Then, in order to see the percentage impact, we took the average diarrheal prevalence rate for the Control Group and compared it to the expected average diarrheal prevalence rate for the Clinca Only Group.

The same type of process was then completed using the Clinca & Education Group and then again with Clinca and Ceramic Water Filter use; all of which were again compared with the Control Group.

2.6 Why is such a complicated approach being used in Cambodia? Why did past Pilot Projects use a simple approach?

Simple Answer:
Developing world contexts are usually more complicated then developed ones. Moreover, the statistical approach has to fit the study design no matter what the context is.

Detailed Answer:
The first question is a very common one found in this sector too often people in development have an antiquated perception that since the environment that a study is being done in is underdeveloped and not sophisticated, that any analysis for the data from such areas should also be simple and unsophisticated. This image is blatantly wrong and a bit dangerous.

In reality, statistical analysis in these context requires HIGHER levels of sophistication and statistical complexity simply because the contexts and variables are often less structured and more complicated than in the developed world. For example, in the developed world the similarities between two neighboring towns in terms of health access can often be assumed since both are equal distances from the same Health Center, in the developing world they may be vastly different since the access road for one town may be completely paved by a past government project while the other has a dirt road, because it is a opposition party village, that is impassible in the wet season. To statistically analyze the health in these two towns, a sophisticated, adjusted model is necessary in the developing world context while a simple model is fine in the developed world. As such, often time more underdeveloped contexts require more complicated statistics (that said, there is also a tendency for some to use simple models with many types of data [e.g. government data] and analysis in the developing world. This is often the result of the unreliability and lack of depth of the data and also the lack of qualified persons in many organizations to analyze the data; which brings the results of such analysis in to question for many reviewers; a case that really doesn't apply to the current study as the data was self-gathered and models designed and checked beforehand).

More importantly though, the statistical approach, above all, must fit the structure of the study and the objectives of the analysis. In the past pilot projects, the primary aim was on the testing and results of a business model using Clinca 205. As such, the product was sold using an SEM approach and with households choosing to purchase it. Because of this objective (determining the business viability of Clinca) and the structure of the project (sales and voluntary purchases usually by higher income and socially connected households), it was not possible to objectively and scientifically determine the health impacts of Clinca simply because the structure of the project prevented such analysis from being done (basically you can't implement sales on a small scale and study impacts at the same time since their is so much confounding between many variables such as income, social status, Clinca use, education, literacy, etc.). So, since a robust or advanced analysis was not possible due to the structure of the project, a simple observational comparison was made between the average diarrheal rates of different households with or without Clinca was made, though as was stated in the prior projects this was neither statistically nor scientifically robust/significant, and simply observational. While a more thorough statistical analysis would have been better, this was not possible because the project was not designed for it (i.e. the survey technique for the market analysis would not work for scientific health impact analysis, the providing of Clinca to households was very much biased by the vary fact that it was based on a households willingness to buy, the project was conducted in 3 villages/cities with different implementation approaches in each village/city as a result any statistical analysis would have been impossible due to cluster randomization size (n=3) and the fact that there where no consistent approaches to compare, etc.).

Basically, this is a matter of apples and oranges. In the past, simple statistical analysis was done because those projects where not designed to be statistically robust or significant, and were meant for different objectives (determining marketability and potential market for Clinca 205). The Clinca 205 Efficacy Study, however, was specifically designed to determine the health impacts of Clinca 205 to a scientific, statistical standard, and as such the study was designed in a sophisticated manner to determine those impacts to international standards using accepted statistical approaches. To attempt to do so with the same simple approaches used in the pilot projects would not only be ineffective, but likely considered fraudulent since it would be understood that any person who understood statistics and did that analysis would have known that the results would have been fundamentally flawed.

2.7 Couldn't we still try and use a "simple" comparison of the different Project Arms with controls and adjustments?

Simple Answer:
Well, yes, but it would take a very long time, have a high potential for mistakes, and would in the end be doing the exact same things statistically as the MLM approach.

Detailed Answer:
For a brief coverage of what this would mean, in order to do a "simple" comparison of means for this case and this data, the first necessary step would be to create a individual models for each of the 42 project villages to control for each villages effects on the households in each of the villages including the intra-cluster correlations (ICC) between them. This would require basically 42 fitted models as well as 42 independent error rates for each village model impacts. These village effects would then need to be applied to the individual household data results under each village. Next, in order to combine all the household data together, algorithms/models would need to be created for combining the data while adjusting for the different error rates for the village effects on each of the households. Finally, weight adjustments would also need to be made for the

household data since some villages had larger samples than other villages, thus getting larger effects for those villages' village level effects.
In the end, this would result in a model that would be adjusting for the village level effects and errors, weighted by sample size, on the household level data; exactly the same thing as the MLM except in a less precise way and less stable.

3 Overview of Study Population Characteristics

3.1 Overview of Population, Sample and Baseline Survey Findings

The baseline survey covered a total of 2,233 households across 42 villages. During the planning stages of the project, estimates and selection of the number of villages were made based on the available National Commune Database numbers. However, upon the tallying of the actual household numbers from Village Chiefs following the completion of the Baseline Survey, it was found that National Commune Database statistics had overestimated actual village household numbers by roughly 20% leading to a shortfall in the number of total households in the sample when compared to the predicted household total. That said, since the original estimates calculated by the Team had purposefully oversampled (meaning we already had a larger sample than necessary to increase statistical power) by close to 60%, this event did not have significant effects on project activities nor any effect on the full statistical analysis.

Table 1.1-1: Sampled Household Statistics at the Village Level by District

	# of HH	Average Sample HH per Village	Average HH Size	Std. Dev.	Percent of Sample
Bar Kaev	785	46.2	7.7	3.8	35.2%
Koun Mom	426	60.9	5.2	2.1	19.1%
Lumpat	570	63.3	5.5	2.5	25.5%
Ou Ya Dav	452	50.2	7.4	3.5	20.2%

While the average sampled households per village were roughly 53 households, this rate varied significantly between the 4 districts as can be seen in Table 1.1-1 above. Likewise, the average number of persons per household within the sample also varied significantly between districts, from a high of 7.7 persons to a low of 5.2 persons'; seemingly correlated to lower sampled households per village though neither this nor any possible reason could be ruled in or out based on the data gathered. The sample mean for household size stood at 6.6 persons per household with the population mean with a 95% CI of 6.5 to 6.7 persons per household. While these distributions may be of interest in future studies, these district level differences should not have any substantial effects on the project data or results interpretation thanks to the randomized structure of this Project and random distribution.

3.2 Income Status

The results of the baseline survey largely support Ratanakiri's position as one of the poorest provinces in Cambodia. As can be seen in Table 1.2-1, the average per capita income for households across the full survey sample stands at roughly $5.91

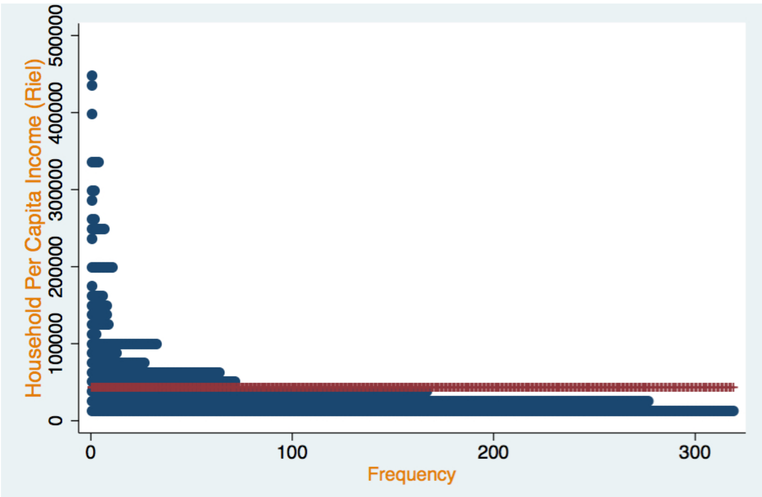
per month with the mean for the population within a 95% CI of $5.45 to $6.36. When combined with the average household size based on the results of Section 2.1 prior, this combined average household monthly income for the sample results in an estimated monthly income of $39.60, and correspondingly gives the population a possible mean range, using the 95% CI for both the mean household size and per capita income, of $35.42 and $42.61.

Table 1.2-1: Aggregate Household Mean Per Capita Income and Percentiles

	Average Monthly Per Capita Income	Std. Dev.	Skewness
Agg. Households	R23,629 ($5.91)	43,205	5.461
Percentiles	25%	50%	75%
	R4,000 ($1)	R10,000 ($2.50)	25,000 ($6.25)

That said the income variable in the form of "Declared Income" in the survey is heavily skewed as can be seen by the 5.461 Skewness score in Table 1.2-1 (a normal distribution has a Skewness of "0"). This is shown graphically in Figure 1.2-2. As can be seen in the chart, the vast majority of household incomes fall between R100, 000 and 0 (although there were no "0" income households), and a large amount of households exist below the average income level. This is largely the result of a large amount of outlier observation points between R200, 000 through to R450, 000, which causes the mean to be disproportionately pulled higher by a few weighty observations. After extensive investigation into these outliers, it was determined that these were neither survey nor inputting errors, and most importantly were likely accurate representation of some comparatively high income households existing within the sample. While the non-normal distribution of the income variable can be corrected through later transformations of the data, there still remains to be seen whether or not these outliers are clustered within certain Project Arms, or distributed evenly across the sample; a point that will be considered later in this section.

Fig. 1.2-2: Weight Distribution of Income Across all Households

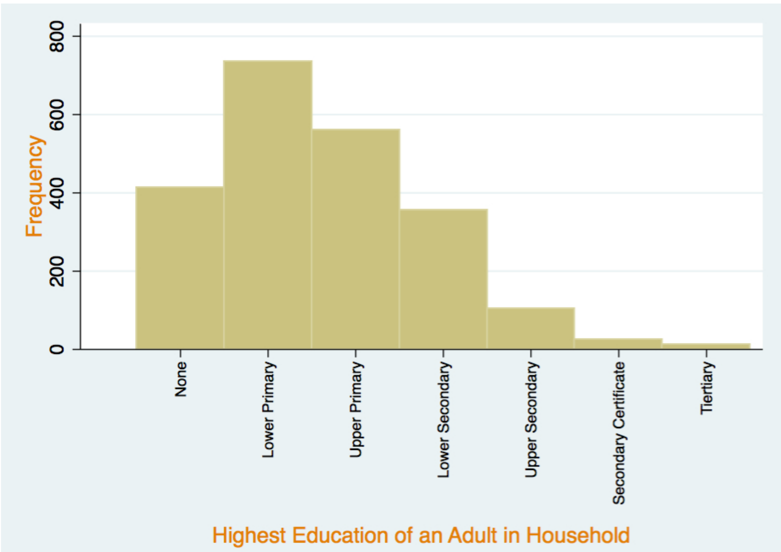


Note: Red-line indicates the point of the mean. Length of blue lines represent number of observations.

Due to the fact that income in Cambodia is difficult to quantify as a result of high levels of subsistence farming, bartering, and other unique aspects of the village economic system, particularly for indigenous peoples, it is necessary to use other enhancing income and wealth indicators to augment the standard indicator of "declared income". For the purposes of this study, it may be necessary in the analysis phase to control for income effects within the model and as such indicators were selected to not so much establish the income or wealth level of the household, but rather to form a relative comparator between households. For this reason, declared income was considered to be a valid indicator despite the possibility of inaccuracy (while people tend to exaggerate or underreport such income, statistically this is often done at consistent rates across a population so it may still be valid for level comparisons). To control for possible inaccuracies with the income variable, 3 additional variables often correlated with wealth status and income were also chosen to help control for the wealth differences effect; specifically, number of motorbikes owned by household, type of house roofing, and highest level of education of an adult in the household. The actual accuracy and predictive nature of these variables will be discussed in more depth later.

3.3 Highest Levels of Household Adult Education

Fig. 1.3-1: Weight Distribution of Income Across all Households



The results for the highest level of education attained by an adult in the household, a key indicator of household education and common correlate of income, largely fit within expected ranges as can be seen in Fig 1.3-1 below. Roughly 19% of the households reported having no adults with any formal education with over 33% of households having the highest level of education being Lower Primary (Grades 1-3 of Elementary School) and 25% with education of Upper Primary levels (Grades 4-6 of Elementary School). Interestingly, Lower Secondary achievement was rather high (16%) though those actually achieving Upper Secondary remain very low (approx. 5%).

3.4 Water Usage Characteristics of Population

Unlike much of Cambodia, Ratanakiri is prone to severe, yearly droughts during its dry season, often resulting in shifts from normal water sources to alternative water sources. As such, it was important in the survey phase to establish not only the primary water sources, but also the alternative water sources used since there is likely a shift from primary to more hazardous alternative sources (such as streams and rivers that are often more polluted than the various types of wells) during certain periods. This expectation was largely supported by the household level data of the

Baseline Survey with high concentration of wells being used as a primary water sources and free flowing water sources as alternatives.

Within the survey sample, roughly 69% of households reported using some type of well as their primary water source with 24% using free flowing water sources (rivers

Fig. 1.4-1: Primary Water Sources by % of Households Using

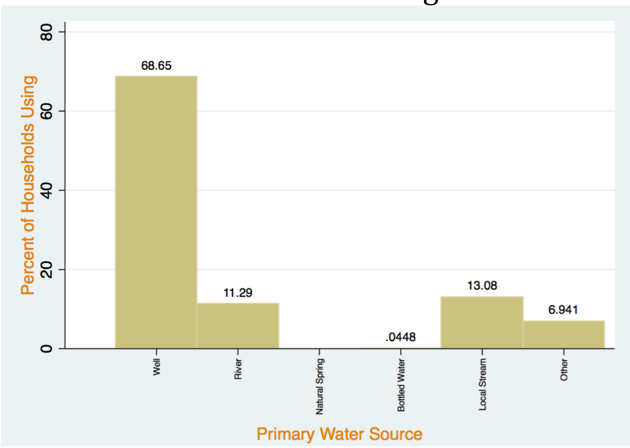
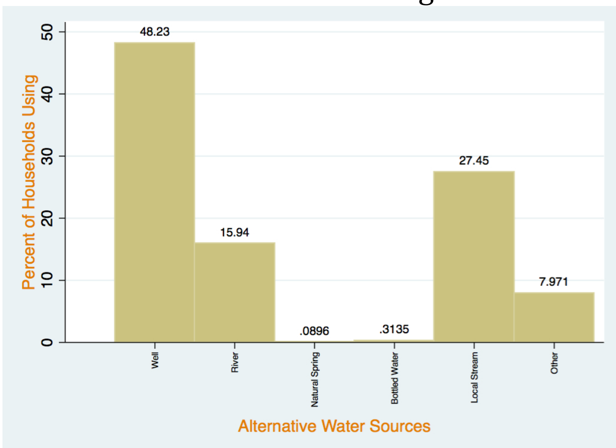
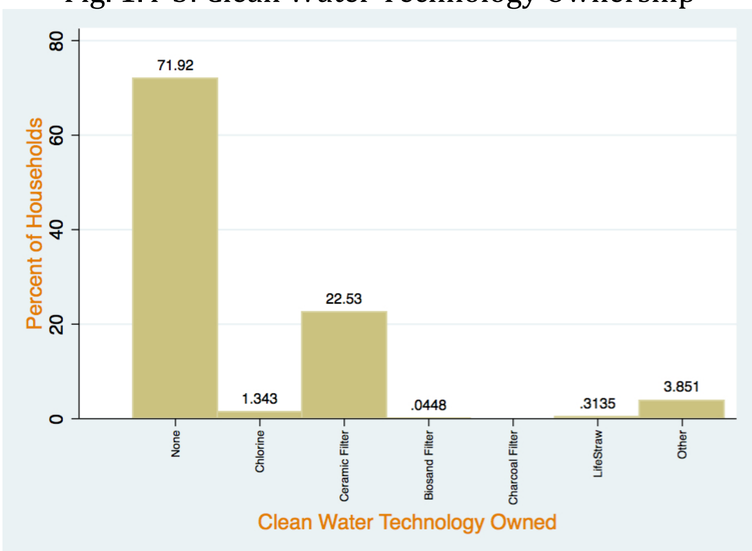


Fig. 1.4-2: Alternative Water Sources by % of Households Using



[11.29%]; local streams [13.08%]), as can be seen in Figure 1.4-1. However, when it comes to alternative sources (sources used when primary sources become unusable; note: households were able to report the Primary and Alternative Sources as the same if their Primary Source was always used), there was a marked shifted towards free flowing water sources with well use decreasing to roughly 48% and free flowing water source use increasing to 43.3% (river [15.94%]; local stream [27.45%]). This shift to free flowing water sources that can easily be contaminated with water borne diseases largely syncs with increases of water borne diseases and Acute Watery Diarrhea (a.k.a. cholera) outbreaks in the Dry Season.

Fig. 1.4-3: Clean Water Technology Ownership



As was expected based on prior projects and studies in the field, the rate of clean water technology ownership appears to be very limited with the ownership of any clean water technology being that of Ceramic Water Filters distributed in the course of prior NGO activities. As can be seen in Figure 1.4-3, roughly 72% of households reported owning no clean water technology. Contrastingly, 22.5% of households reported owning a ceramic water filter (though the actual use of the filter was not measured), 1.3% using chlorine for water treatment and 3.8% owning another type of technology or approach (e.g. boiled water with local herbs, etc.).

3.5 Prior Population Health State

In the baseline, over 53.5% of households surveyed reported at least one household member currently experiencing diarrhea (defined as diarrhea within the preceding 12 hours; (i.e. Spot Prevalence), and 58.1% having a household member who experienced at least 1 case of diarrhea in the prior 3 days (Time Prevalence)(Table 1.5-1). On whole, the aggregate sample experienced 1.088 cases of diarrhea per household at the time of the survey, indicating the general Spot Prevalence rate. However, when only households having at least one case of diarrhea are included in the averaging (a more accurate indicator of disease clustering and actual disease burden), the per household Spot Prevalence and Time Prevalence rates jump to 2.03 and 2.12 per household, respectively.

Table 1.5-1 Summary of Prevalence Statistics

	% of Households	Household Diarrheal Average	Std. Dev.	95% CI for Population
Agg. Households	100% (100%)	1.088 (1.232)	1.504 (1.558)	1.02 - 1.15 (1.16 - 1.29)
Households with 1 or more Diarrheal Cases	53.5% (58.1%)	2.036 (2.121)	1.518 (1.515)	1.94 - 2.12 (2.03 - 2.20)

Top number indicates Spot Prevalence Rates; parenthesis are Time Prevalence Rates.

As can be seen in Figure 1.5-2, Spot Prevalence rates for the sample are largely concentrated at 1 or 2 cases per household, together representing 41.15% of total households. This distribution increases slightly with Time Prevalence with rates of the 1 or 2 case households increasing to 43% of total households.

Fig. 1.5-2: Household Spot Prevalence by Diarrheal Case Count

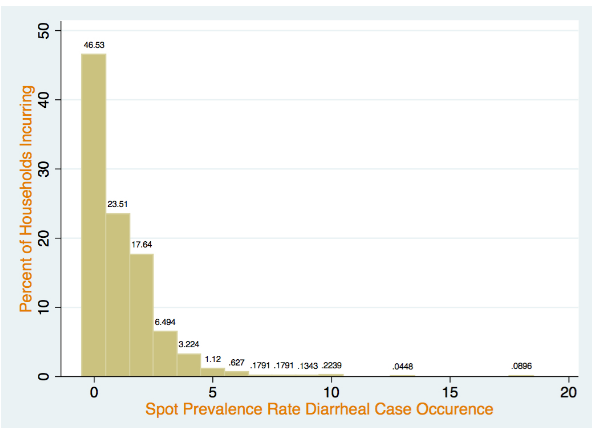
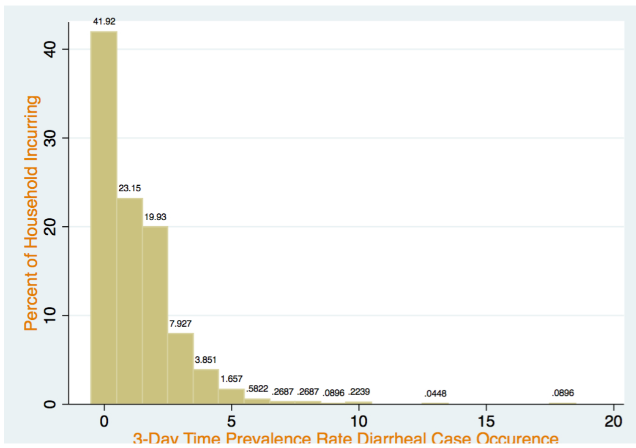


Fig. 1.5-2: Household Time Prevalence by Diarrheal Case Count



Diarrheal rates among household adults were higher than those of children with a Spot Prevalence average of 0.602 adult cases per household (Figure 1.5-1) as compared to 0.535 child cases; a difference also reflected in Time Prevalence Rates. Out of all households, 20% experienced only adult cases of diarrhea while 12.8% experienced only child cases of diarrhea, and 20.7% of households experienced both child and adult cases simultaneously. The differences between the adult can mostly be accounted for by the fact that within the sample there were households without any children, but no households without any adults.

Table 1.5-4 Summary of Adult & Child Prevalence

ADULT	% of Total Households	Household Diarrheal Average	Std. Dev.
Agg. Households	100% (100%)	0.602 (0.675)	0.978 (1.006)
HH with 1 or more Diarrheal Cases	40.7% (44.5%)	1.476 (1.518)	1.028 (0.998)

CHILD	% of Households	Household Diarrheal Average	Std. Dev.
Agg. Households	87.2% (87.2%)	0.535 (0.616)	0.831 (0.903)
HH with 1 or more Diarrheal Cases	33.5% (36.7%)	1.392 (1.464)	0.777 (0.834)

4 Methodology

4.1 Methodological Structure and Approach

As a fundamental standard, evidence establishing the effectiveness of a health intervention must be in the form of a **Randomized Controlled Trial (RCT),** wherein individuals are randomly assigned to either receive the intervention (**Intervention Group**) or to not receive the intervention (**Control Group**), and the results of the two groups are compared to see the health differences between the two. As a result of the randomization, the two groups can be said to be equivalent in the distribution of different characteristics (income, health status, age, etc.) within their sample, and, as such, the difference in health between the groups can be logically concluded to be a result of the intervention as it is the only characteristic difference between them. While this approach is easiest in small clinical settings, the randomization of individuals in large-scale field studies is very difficult if not impossible in most circumstances. Instead, what is commonly used is a special type of RCT referred to as the **Cluster Randomized Controlled Trial (CRCT).**

The CRCT, which has been utilized for this Project, basically shares all the same qualities of the RCT except for its approach concerning the randomization. For the CRCT randomization occurs at a higher-level cluster than the individual being measured in the study. For this project, this means that randomization was done at the village level (villages where randomized into either the Intervention Groups or Control Groups so that all households in a village were in the same group) while primary measurements were done at a household level within each village. Unlike the typical approach, CRCT has the benefit of not only determining the individual household level impacts, but because of the randomization at the village level, it is also able to determine the village/community level impacts as well, while also making implementation across large areas and large populations feasible logistically.

4.2 Selection of Initial Sample

The Clustered Randomized Controlled Trial segment of the Project includes 4 of the province's 9 Districts, located within the catchment areas of four Health Centers. An overview of the basic district level statistics is provided in Table 2.4.2-1, below. Due to statistical requirements on the number of individual clusters and limitations due to the supply of Clinca 205 available under the project, it was necessary to maximize the number of clusters (i.e. villages) by placing a limit on the total household population of villages enrolled into the study. Based on calculations considering the project area and amount of Clinca 205, a criteria of villages less than 160 households was set and 4 villages became ineligible for inclusion in the project. Additionally, 4 ethnically outlier villages (small villages of ethnic groups forming minorities within minority areas) where also eliminated due to confounding and outlier risks from their inclusion due to their autonomy from existing community structures. In the end 42 villages fell within this criteria and were included in the project

Table 2.1.2-1: District Level Project Characteristics

	Project Villages	Project HH
Bar Kaev	17	785
Koun Mom	7	426
Lumpat	9	570
Ou Ya Dav	9	452

4.3 Stratification

Due to the studied variables of the project and the nature of the project area, it was necessary to stratify the randomization so that equal numbers of villages with certain characteristics where distributed into each Project Arm. Though the assignment of each stratus to each Intervention Arm was set in a balanced manner, the actual distribution of the villages of each stratus in the districts was set prior to the project as a result of geographic location and prior public sector projects. Table 2.1.3-1 sets out the distribution of the different strati type villages in each district. As this one aspect of the Project could not be randomized, it will be controlled for within the hierarchical modeling in the final analysis phase based on this data. That said, much of the bias or skewing due to the stratified characteristics will have been mitigated through equal inclusion in each Project Arm.

Table 2.1.3-1: Well Development and Remote Status Village Distribution by District

	FS Well Development Villages	Non-FS Villages	Remote Villages
Bar Kaev	4	13	0
Koun Mom	0	2	5
Lumpat	5	4	0
Ou Ya Dav	3	5	1

4.4 Project Intervention Arms

As noted in prior sections, the study utilized 4 distinct Project Intervention Arms (Project Arms) in order to be able to explore the various impacts and confounders of the target primary and secondary interventions; specifically, Clinca 205 and the education intervention connected thereto. As is standard in CRCT approaches, Project Arm 1 was designated as a "Clinca Only" arm in which the primary intervention was provided and Project Arm 4 was designated as a no intervention "Control" arm. Since many health intervention projects in the field include some type of community or household education activity, it was considered important to determine the augmenting effects of education with the Clinca 205 distribution and to balance that with an education only arm so that the education confounding effects could be controlled for to see the Clinca 205 effects clearly. As such, a Clinca & Education Project Arm and Education Only Project Arm were also created.

4.5 Random Assignment into Project Intervention Arms

As a fundamental aspect of a CRCT design, it is necessary for the assignment of clusters to the 4 Project Arms be done through a fully randomized process. Towards this end, a protocol for randomization was created in which each village in the study was give a randomly generated number using the random number generation function in Microsoft Excel, and was then organized in descending order according to the value of their generated random number. Villages were then assigned to the various Project Arms through a step-wise count assignment wherein the village with the highest random number value was assigned to Project Arm 1, the next highest value to Project Arm 2, and so on and so forth in a revolving manner.

Based on the detailed protocols set out in the randomization, the random assignment of villages into the 4 Project Arms was completed; the results for which can be seen in Table 2.1.5-1 below. While slight concentrations of villages can be seen in Bar Kaev for the "Clinca Only" Arm and Ou Ya Dav for the "Clinca & Edu" Arm, these distributions did not deviate from the variation within the normal distributions that would be expected out of such a randomization process.

Table 2.1.5-1: Village Assignment to Project Arms by District

	Clinca Only	Clinca & Edu	Edu Only	None
Bar Kaev	6	3	4	4
Koun Mom	2	1	2	1
Lumpat	1	2	3	3
Ou Ya Dav	2	5	1	1

4.6 Monitoring and Data Collection

Due to the nature of the intervention and the study design of this project, it was necessary to not only collect baseline and end-line data at the household level, but to also collect necessary indicator and control data at the village level for the controlling of cluster level effects.

At the household level, data utilized in the study analysis was collected through two survey implementations; a baseline survey conducted in December 2012, and an end-line survey in January 2013. As the measurement of diarrheal case prevalence under these surveys formed the most important aspect of subsequent impact analysis, predetermined health sector guidelines were used for the surveying and measuring of these indicators including the use of the standard diarrheal definition as defined by the World Health Organization (WHO) and adherence to the 12HR-3Day Spot-Time Prevalence Rate standards for diarrheal prevalence studies (Schmidt et al., 2011). In surveying the households in the project, a longitudinal panel approach was taken in which only households surveyed in the baseline were marked for inclusion in the end-line. As such, expected dropouts occurred with households from the baseline to end-line, a point discussed in a subsequent section.

At the village level, aggregate data for each village was compiled through the village health volunteer (a position under the Ministry of Health, Cambodia) and the district health center. For the village health volunteer this aggregate data was in the form of weekly tallying of diarrheal cases within their village and collected at two week intervals by the project monitoring staff. For the district health center, with the end-line survey registers of diarrhea related health visits by residents from project villages was compiled for the months of the project and some months prior. These registers contained no personal or private information on the actual patients or households, but rather were simple aggregate counts of total patients from each village.

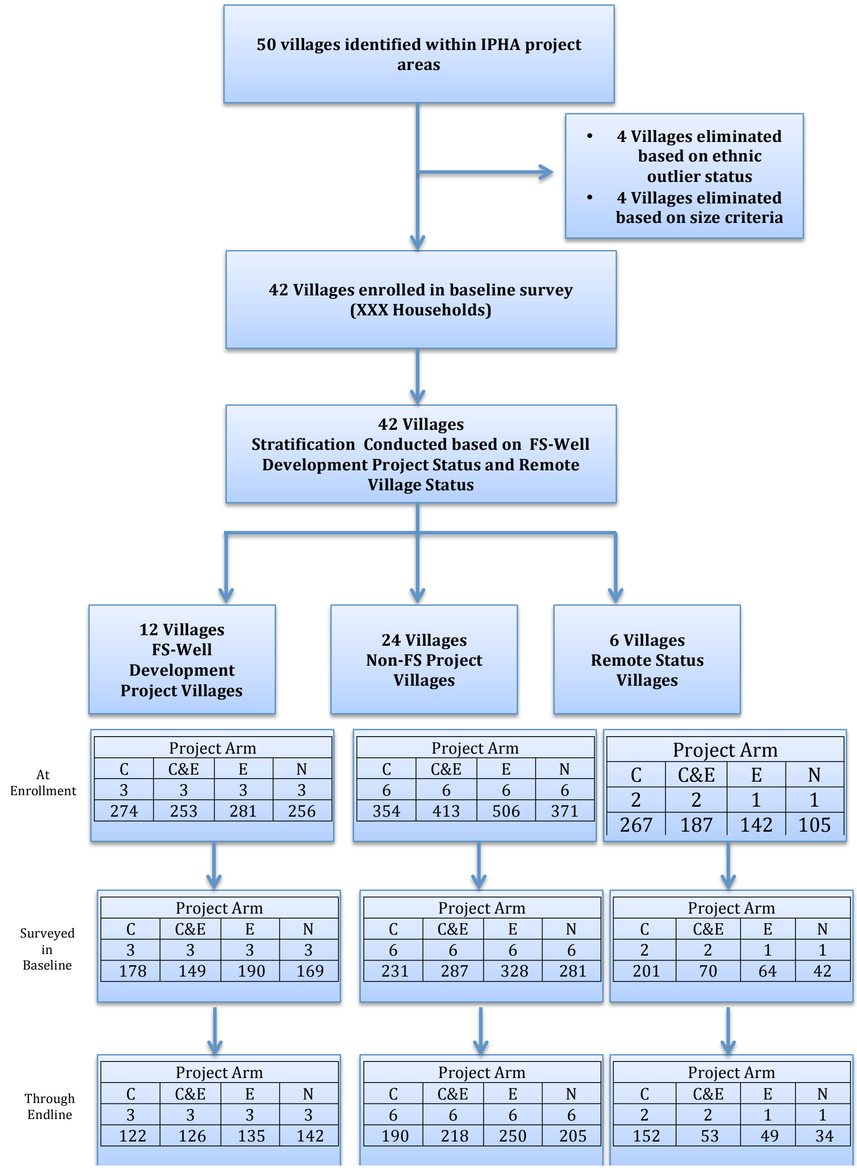
Finally, during the course of the project, monitoring visits were conducted by the project monitoring team, collecting health volunteer compiled data (as noted earlier) and conducting small sample monitoring surveys of households within the monitored villages (usually 10-15 households). This was conducted weekly with all project villages being covered over a 2-week period cycle. Monitoring surveys were used primarily for monitoring and project management activities, and were not included as data in the final analysis.

5 Results

5.1 Participation and Dropouts

At the onset of the project, 42 villages were enrolled in the study with a total of 3,409 households covered. While villages remained enrolled throughout the course of the project with no drop outs occurring, loss of households within the survey did occur due to the longitudinal panel data survey approach chosen for this study. The

Fig. 3.1-1: Surveyed Household Flow Chart



process of selection, enrollment and loss rates are set out in Fig. 3.1-1 below, in compliance with the CONSORT statement guidelines for CRCT studies.

As can be noted by a tallying of the numbers therein, the baseline survey achieved an average village survey rate of 65% of village households. In the end-line survey, which was limited to only households that had participated in the prior baseline, approximately 76% of the baseline households were able to be included in the end-line survey, for a total data sample of roughly 50% of village households on average. Initial analysis of the households lost to the endline has shown no apparent trends or predictive indicators. As such they have been treated as quasi-random dropouts from the survey.

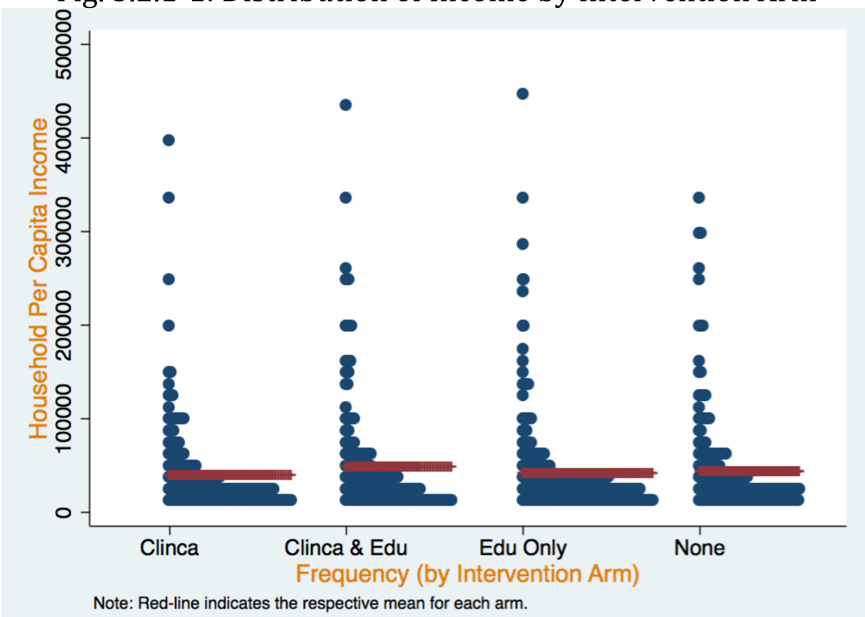
5.2 Baseline Characteristics and Assumptions

5.2.1 Distribution of Wealth and Education Across Project Arms

In conducting any type of randomized design, a primary concern is with disparities across Project Arms that could cause bias or skewing during comparative analysis. This is particularly key in a CRCT approach as the foundation is the fundamental assumption that the randomization process produces a random distribution within the different arms and that this holds to expected distributions for the population. In simple terms, it assumes that the aggregate statistics for each of the Project Arms will be more or less the same.

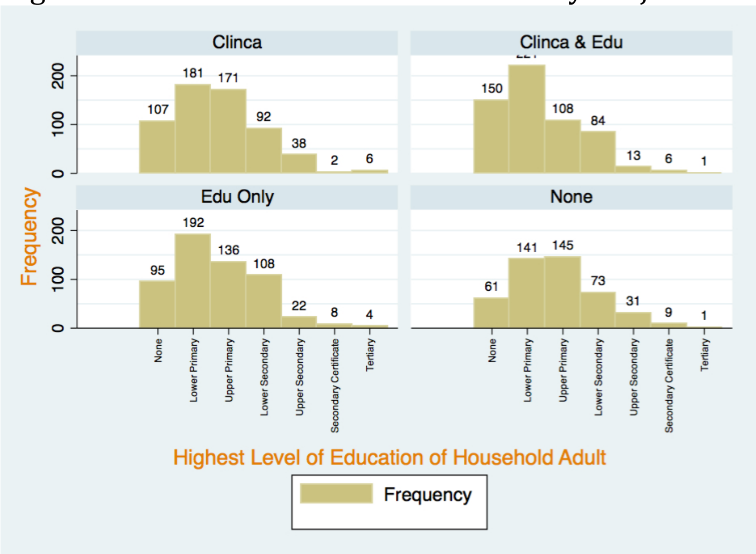
In order to ensure that this assumption is well founded and to make sure no unexpected biases have crept into the assignments of villages, a comparison of variables was made across the 4 Project Arms, the results of which are discussed below.

Fig. 3.2.1-1: Distribution of Income by Intervention Arm



While there were some initial concerns as to possible issues with the concentrations of outlier incomes within only certain Project Arms, analysis of the spread of incomes across the 4 Project Arms showed this not to be the case (Fig. 3.2.1-1). While a large number of extreme outlier observations can be seen (depicted as single round points at the top of the chart), these outliers occur rather consistently and evenly across all Arms. Since the issue for the Project is not so much the presence of outliers, but the differences between the Project Arms at baseline, it can be said that these outliers will not have any substantial effects on the full analysis and that the assumptions hold. Moreover, when looking at the income means across the 4 Project Arms (indicated by the red bars in the chart), it can be seen that the means largely are at the same level across the board, thus also indicating equivalent distributions to a large degree.

Fig. 3.2.1-2: Household Adult Education by Project Arm



In terms of household adult educational attainment, some slight disparities between the Project Arms do exist as can be seen for Lower Primary Education in Fig. 3.2.1-2. However, as these distributional differences remain within the expected 95% interval spread (the possible variation in the None category from the mean of the other Project Arms is within a simulated 2-standard deviations) and both the aggregate distributions of Clinca and Non-Clinca households are normal, this small statistical difference does not pose any problems for the Project.

While there are some small issues with the high occurrence of outliers with the income variable and a slight deviation in the distribution of education in one Project Arm, detailed analysis of these issues shows them to not have any significant impacts on the Project data nor on the data analysis approaches used in this study.

One final issue to be addressed is that of the correlation of indicator variables. Under the assumptions of the model regarding the inclusion of variables for indicating household wealth, the ownership of a motorbike, type of roof of the housing and household education should provide information on the wealth status of the household. Since household income is also considered to be a key indicator of household wealth, by logical inference a correlation between these variable should be seen (this assumption is key to the use of multiple imputation for missing data in later analysis). These assumptions were tested by running a correlation matrix of all the variables using the STATA correlation functions.

Table 3.2.1-3: Correlation Matrix Table for Wealth Status Indicators

	HH Income	Motorbike Ownership	Type of Roof	Education
HH Income	1.000			
Motorbike Ownership	0.0633	1.000		
Type of Roof	-0.0053	0.0123	1.000	
Education	0.1119	0.1100	-0.0039	1.000

Based on the results there of, which can be seen in Table 3.2.1-3 above, both motorbike ownership (0.0633) and education (0.1119) had significant correlations with household income (with correlations of 1 meaning perfect correlation and 0 no correlation), though by far education was the strongest correlate. The type of roofing, however, did not show a significant correlation (-0.0053) and was in an illogical direction, indicating that the very limited correlation seen may be the result of weak surrogate variables or randomness. As such, type of roof variable was not used in the Project analysis models.

5.2.2 Distribution of Water Sources and Technologies Across Project Arms

Fig. 3.2.2-1: Primary Water Source Rates by Project Arm

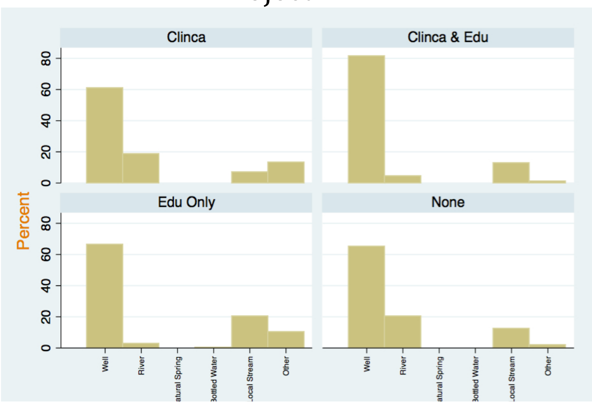
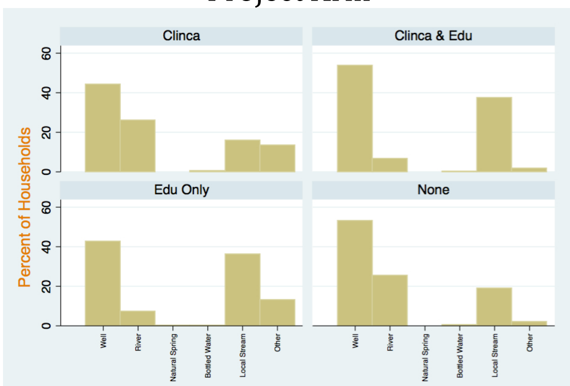
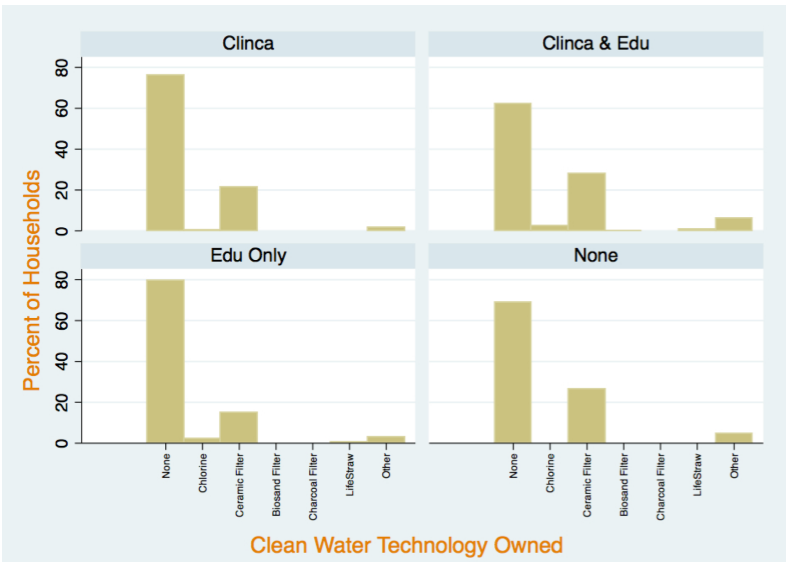


Fig. 3.2.2-2: Alternative Water Source Rates by Project Arm



A visual comparison of the distribution of Primary water sources across the 4 Project Arms can be seen in Figure 3.2.2-1. The data shows similar distributions across each arm with large concentrations in wells for all arms. While river usage differed somewhat between arms, this difference was limited and conveniently distributions are mimicked between

Fig. 3.2.1-3: Clean Water Technology Ownership by Project Arm



intervention–control groups (distribution for Clinca & Edu is similar to Edu Only; Clinca Only is similar to None). As such, there appear to be no issues of significance between the Project Arms. These slight differences appear to repeat themselves again in Alternative Water Sources data, as seen in Figure 3.2.2-2, though again distribution are mimicked between intervention – control groups.

The distributions of water technology ownership across the 4 Project Arms is largely consistent with no significant deviations, which can be seen in Fig 3.2.2-3.

The results of the survey in terms of water usage trends largely fit with those expected based on prior studies and work in the field with high concentrations in well usage, and significant shifts to free flowing water sources as alternatives. In relation to distributions of water sources and technologies across the Project Arms, no issues were found.

5.2.3 Distribution of Diarrheal Prevalence Across Project Arms

Very slight differences were seen in the distribution of cases between the 4 Project Arms mainly in the concentration of 1 case households and 2 case households, as can be seen in Figure 3.2.3-1 and Figure 3.2.3-2. However, the mean case rates remained largely the same across all Arms and as such these small discrepancies are what would be expected as a result of randomization and not indicative of any potential clustered biases. Besides this one potential point, no other issues were found with the data.

Fig. 3.2.3-1: Spot Prevalence Case Distribution by Project Arm

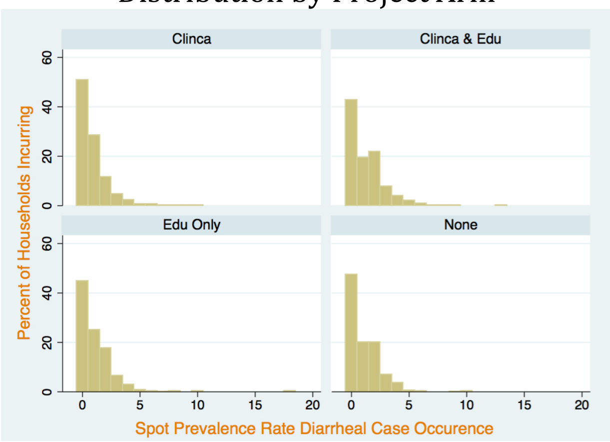
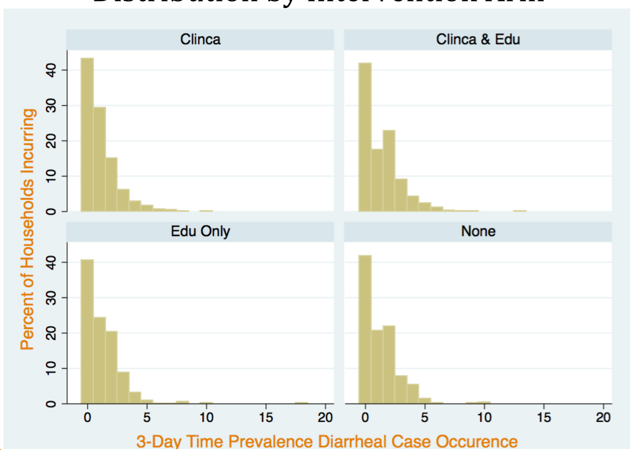


Fig. 3.2.3-2: Time Prevalence Case Distribution by Intervention Arm



Diarrheal Spot and Time Prevalence rates were, on the whole, at the high levels expected prior to project implementation. Based on the distributions across Project Arms, there appear to be no significant statistical issues with the data arising from the randomization process. The choice of Ratanakiri Province to implement the project due to its high rates of diarrhea within the population, based on the prior experience of the Project Team, appears to have been highly justified given the rates observed within the survey sample and the likely rates within the target population based on the given 95% Confidence Intervals. Given these very high prevalence rates, and assuming the accuracy of the effectiveness of the Clinca 205 product, it was considered highly likely that statistically significant impacts of the intervention would be observed within the Project should they exist.

5.3 Statistical Analysis

Under the study's analytical models, Household 3-Day Diarrheal Prevalence Rates (number of household members with a diarrheal case within the previous 72 hours) for surveyed households were analyzed in relation to the presence or non-presence of Clinca 205 in the household as well as other relevant and interactive variables.

Multilevel mixed-effects linear models were fitted to adjust to the hierarchical structure of the study design (village clusters). An initial model (**Model 1**) included only the design factors with no other intervention or control variables. As a subsequent model, (**Model 2**) built upon Model 1 by inserting the primary intervention variable, Presence of Clinca, which was measured at the household level. Further models included potential confounders (selected a priori: number of household members, number of children in household, etc. at baseline) a full list of which can be found in Table 3.1.3-2 below. A forward progressing, additive approach was then used to fit different control and interaction variables according to theory and their explanatory ability under the model, resulting in the final fitted model of this study (**Final Model**). A full set out of the model in simple multilevel regression form together with the objective of the model stage are set out in Table 3.1.3-1 below.

Table 3.3-1: Statistical Analysis Progressive Models with Exploratory Objectives

	Equation	Objective
Model 1	$Y_{ic}=\beta_0+\mu_c+\varepsilon_{ic}$	Base comparison model for variance calculations
Model 2	$Y_{ic}=\beta_0+\beta_1X_{1ic}+\mu_c+\varepsilon_{ic}$	Initial model looking at Clinca 205 effect
Model 3	$Y_{ic}=\beta_0+\beta_1X_{1ic}+\beta_2X_{2ic}+\beta_3X_{3ic}+\mu_c+\varepsilon_{ic}$	Model 2 with standard control variables
Model 4	$Y_{ic}=\beta_0+\beta_1X_{1ic}+\beta_2X_{2ic}+\beta_3X_{3ic}+\beta_4X_{4ic}+\mu_c+\varepsilon_{ic}$	Analysis of children in household effects
Model 5	$Y_{ic}=\beta_0+\beta_1X_{1ic}+\beta_2X_{2ic}+\beta_3X_{3ic}+\beta_6X_{6ic}+\beta_7X_{7ic}+\beta_8X_{8ic}+\beta_9X_{9ic}+\mu_c+\varepsilon_{ic}$	Analysis of water variable effects
Model 6	$Y_{ic}=\beta_0+\beta_1X_{1ic}+\beta_2X_{2ic}+\beta_3X_{3ic}+\mu_c+\mu_1X_{10c}+\pi_1X_{11ic}+\varepsilon_{ic}$	Analysis of education intervention effects and interactions
Model 7	$Y_{ic}=\beta_0+\beta_1X_{1ic}+\beta_2X_{2ic}+\beta_3X_{3ic}+\beta_4X_{4ic}+\beta_5X_{5ic}+\mu_c+\mu_1X_{10c}+\pi_1X_{11ic}+\pi_2X_{12ic}+\pi_3X_{13ic}+\varepsilon_{ic}$	Compiled analysis of multiple effects and corresponding interactions
Final Model	$Y_{ic}=\beta_0+\beta_1X_{1ic}+\beta_2X_{2ic}+\beta_3X_{3ic}+\beta_4X_{4ic}+\beta_9X_{9ic}+\mu_c+\pi_1X_{11ic}+\pi_2X_{12ic}+\varepsilon_{ic}$	Full fitted explanatory model based on results of prior modeling
	Note: "Y" = Household 3-Day Diarrheal Prevalence Rate; "c" denotes the cluster (i.e. village) in which the i^{th} individual in the sample resides. Variable list can be found in Table 3.1.3-2 below.	

Fitting of the model and subsequent evaluation was done using the *xtmixed* command set of STATA 12, utilizing a maximum likelihood estimation approach. As neither the model nor the sample size were unreasonably large or complex, the standard expectation maximization algorithm approach was selected as the estimation procedure with a 20 iteration limitation on convergence prior to transitioning to a gradient-based estimation method. That said, all estimations within the study were accomplished within 8 iterations and consequently the gradient-based estimation method never occurred.

The intracluster correlation coefficient (ICC) and follow up estimates for sample size were calculated after data collection to validate the degree of clustering and prior design assumptions for the sample size. ICC and k were estimated from the unscaled variance of the xtmixed multilevel mixed-effects linear model of the Final Model. This provided a resulting ICC of 0.03317 within a confidence interval (CI) of 0.00522 and 0.06112; safely well below the assumed likely ICC of 0.1 considered in the designing of this study and calculating of the sample size. The statistical analyses were performed using ICCVAR estimation module of the STATA 12 statistical software package.

Table 3.3-2: List of Variables and Coefficient Estimations by Model

Explanatory Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model Final
Fixed								
Constant	.0170	.0836	.0922	-.0222	.0332	.0671	.0799	.0409
Household Variables (Level 1)								
X_1 Clinca (Dummy)	-	-.2031*	-.2152**	-.2154**	-.2068**	-.3375**	-.3383**	-.3514**
X_2 Income Per Capita +	-	-	.0531*	.0504*	.0555*	.0520*	.0497*	.0494*
X_3 Number of Household Members +	-	-	.2189**	.1470**	.2208**	.2206**	.1625**	.1644 **
X_4 Number of Child Household Members +	-	-	-	.0412**	-	-	.1403**	.1380 **
X_5 Ceramic Water Filter Ownership	-	-	-	-	-	-	.0197	-
X_6 Primary Water Source: River/Stream	-	-	-	-	.0791	-	-	-
X_7 Primary Water Source: Well	-	-	-	-	.0496	-	-	-
X_8 Secondary Water Source: River/Stream	-	-	-	-	-.0751	-	-	-
X_9 Secondary Water Source: Well	-	-	-	-	.1339*	-	-	.1476**
Village Variables (Level 2)								
X_{10} Health and Use Education	-	-	-	-	-	.0290	.0082	-
Interactions (Single & Cross- Level)								
X_{11} Clinca with Village Education	-	-	-	-	-	.2520*	.2803*	.2964**
X_{12} Children in Household with Clinca	-	-	-	-	-	-	-.1210 *	-.1151*
X_{13} Ceramic Water Filter with Clinca	-	-	-	-	-	-	-.0391	-
Random (Variance)								
σ^2 (Household-level; Level 1)	.0634	.0678	.0513	.0428	.0435	.0455	.0373	.0308
Percent of Household Variance Explained [-2 (log-likelihood)]	N/A	0	19.2%	32.4%	31.4%	28.3%	41.2%	51.4%
σ^2 (Village-level; Level 2)	.9363	.9323	.8992	.9018	.8972	.8980	.8972	.8970
Percent of Village Variance Explained [-2 (log-likelihood)]	N/A	0.5%	4.0%	3.7%	4.2%	4.1%	4.2%	4.2%
Percent of Total Variance Explained	N/A	0%	4.9%	5.5%	5.9%	5.6%	6.5%	7.2%

* significant at the .05 level   * significant at the .01 level +denotes a variable transformed onto a standard score scale

Note: The dependent variable (Household 3-Day Diarrheal Prevalence Rate) was transformed onto a standard score scale so coefficients represent standard deviations from the mean of that variable (i.e. beta coefficients).

5.3.1 Diarrheal Impacts of Clinca 205 (Household 3 Day Prevalence Rates)

Summary

Despite the limited time period of the study, Clinca 205 appears to have demonstrated significant and substantial impacts on household level diarrheal rates within the surveyed population. Under the estimations of the Final Model, Clinca 205 possession by a household was correlated to a highly significant (99.9% significance) .3514 standard deviation decrease in the average household 3-day diarrheal prevalence rate for households using Clinca as compared to the aggregate rate for all households.

In more practical terms, a household with an average household size, average number of children, and average income, which received Clinca 205 could expect to have 56.5% lower 3-Day Diarrheal Prevalence Rate than the average household in the population with a 95% CI of 83% to 29%. Given that Clinca 205 was the only randomized intervention across Clinca 205 families, this study indicates that this decrease is the result of Clinca 205 use.

Detailed Results

Multiple progressive models where used in evaluating the impacts of Clinca 205 and other relevant variables over 7 model stages, culminating in the study's Final Model, the progression of which can be seen in Table 3.1.3-2 above. Across all models in which it was included, the presence of Clinca 205 within a household was heavily correlated with lower rates of household diarrheal prevalence from an initial coefficient of -.2031 in the initial crude model of Model 1, to the final more solid -.3514 coefficient of the Final Model, in which controls, confounders and interactions where controlled for. In order to isolate the impacts of the Clinca 205 intervention from the general noise of the data, several influential variables were controlled for. As can be seen in Models 2 through 7, a progressive step approach was used adding relevant variables to the model and ascertaining their importance based on theory, significance, and explanatory value in terms of model variance. While the controlling of per capita household income and household size improved the robustness of the model within providing much information on particular aspects of Clinca 205 use or impacts, much of the remaining variables, particularly that interaction of Clinca 205 and the education intervention, provided a number of particular insights on Clinca 205 use and impacts within specific contexts; a point to be considered under subsequent headings.

In terms of general model robustness and explanatory value, the model appears to be strong and interpretive with significance levels beyond the P=.001 (99.9%) mark and accounting for 51.4% of variance at the household level (i.e. variation between households). That said, the model remains limited in interpretive ability towards variation between villages, accounting for only 4.2% of variance at that level and consequently 7.2% of overall variance. While this does not jeopardize the noted impacts of Clinca 205 under this study, it is an important issue in relation to the health state of the population and diarrheal disease thereof, and indicates that regional and community level nature of these diseases. That said, it is possible that Clinca 205 impacts on village level variation may be seen with more time though this is beyond the scope of the project at hand considering its short duration.

5.3.2 Diarrheal Impacts of Clinca 205 with Education Intervention (Household 3 Day Prevalence Rates)

Summary

An interaction between the use of Clinca 205 and education sessions within the possessing household's village appears to be greatly suppressing the impact of Clinca 205 for such households. The results seem to indicate that an average household using Clinca 205 and having education sessions in their village on hygiene and Clinca use is on average going to see only a 13.3% decline in household diarrheal rates as opposed to the 56.5% of households using Clinca as a whole once adjusting for this interaction. The exact mechanism of this interaction could not be determined from the data and will require follow-up research.

Detailed Results

While the education intervention in itself did not provide a significant nor substantial impact on diarrheal rates, the interaction of educational intervention and Clinca use had an incredible influence on Clinca 205 health impacts in a suppressive manner. When Clinca 205 and the education intervention where combined, the education intervention was correlated to a 43.3% increase in mean household diarrheal rates, counteracted by 56.5% mean decrease of Clinca 205 for an aggregate mean decrease of 13.3%. This effect is highly significant at the 99% level with the interactive effect likely being within a wide 95% CI between 13.1% and 82% for the Clinca effect after controlling for the education interaction. Once adjusted for, the education intervention appears to have provided greater precision to the impacts of Clinca 205, leading to both a strengthening in the Clinca variables coefficient and narrowing of the variable's 95% CI.

While it is unclear exactly what aspect of the education intervention is affecting Clinca 205's impacts in the field, there is a high likelihood that it may be arising out of the usage instructions that make up an aspect of said education intervention. However, it must be emphasized that this is just a preliminary hypothesis and that further analysis and data collection would be necessary to ascertain the true cause of this interaction.

5.3.3 Diarrheal Impacts of Clinca 205 for Households with Children (Household 3 Day Prevalence Rates)

Summary

Clinca 205 appears to have comparatively stronger impacts with households with larger numbers of children as opposed to those at the mean. While an average household with an above average 5 children would usually have a diarrheal rate 22% higher than the average, with the use of Clinca 205 such a household would have a rate 53% lower than the average due to an apparent stronger impact of Clinca in households with high numbers of children (an additional 18.5% lower rate than households with Clinca and 3 children) largely offsetting the expected increase in diarrhea correlated with the additional children.

Detailed Results

As is widely understood in the health sector, children, particularly young children, are more prone to diarrheal diseases than their adult counterparts. As such the fact that a standard deviation higher number of children in a household (i.e. a 5 child household) would on average have a 22% higher prevalence rate for diarrhea in an otherwise average household than an average household with 3 children. However, in the data results from the study it appears that Clinca 205 has a interactive effect relative to the number of children, wherein a standard deviation higher number of children in the household corresponds to an additional 18.5% decrease in average diarrheal rates for the group, largely offsetting the usual 22% average increase and when combined with the full impact of using Clinca (56.5% average lower mean) a gross 53% average lower diarrheal rate mean is seen for such households despite the effects of larger numbers of children. Although the exact mechanism of this effect is uncertain with this limited study, the effect is highly significant across the whole model.

5.3.4 Diarrheal Impacts of Clinca 205 by Water Source (Household 3 Day Prevalence Rates)

Summary

Despite theoretical likelihood, there does not appear to be significant effects of general water source types on diarrheal rates nor on the effectiveness of Clinca 205. The exception to this was the use of some type of well as a secondary water source, which is strongly correlated with higher diarrheal rates though no interactive effects were seen between that source and Clinca use.

Detailed Results

As can be seen in Section 2.3, water sources, both primary and alternative, were mostly that of wells with the remainder comprised almost entirely of free flowing water sources (rivers, creeks, etc.). Each water source for both primary and alternative water source, respectively, where converted into dummy variables and included as predictors under Model 5. Despite the plausibility behind water sources as predictors of household diarrheal rate, only one water source was statistically significant, wells as a alternative/secondary water source, with a significant impact based on it's coefficient. Moreover, the variables provided little explanatory value in terms of household level variance and as such all but the Secondary Well Water Source dummy variable were dropped from the model.

5.3.5 Diarrheal Impacts of Clinca 205 with Ceramic Water Filter Interaction (Household 3 Day Prevalence Rates)

Summary

Despite possible indications in prior studies, no significant beneficial interactions were seen with the use of ceramic water filters and Clinca concurrently. Moreover, no significant impacts from ceramic water filter use were observed on household diarrheal rates.

Detailed Results

In past Clinca projects within Cambodia, anecdotal information was encountered relating to possible interactive benefits from the use of Clinca 205 with ceramic water filters. In order to follow this up, aspects of the study design where targeted towards determining whether this interaction existed as it could possibly be very beneficial to the use and future marketing of Clinca 205. As noted in Section 2.3, approximately 22% of households reported the possession of a ceramic water filter with that average largely carrying over into Clinca households. Despite this fact, neither a ceramic water filter dummy variable nor a Clinca-ceramic water filter interaction variable was statistically significant, as can be seen within x_{13} and x_5 of Model 7, nor either of their coefficients of any substantial amount to be considered in comparison to other variables. As such, both were dropped from the Final Model.

6 Conclusions

6.1 Overview of Implementation and Assumptions

Throughout the implementation of project activities the project design was adhered to and implementation occurred as planned with effective randomization and adherence to pre-specified instructions and structure. Based on the results on the analysis of the distribution of different project variables across the randomized Project Arms in Section 3.2., it appears that Project Arms were more or less equivalent prior to the intervention and that the randomization was effective and non-biased.

As a result, since all variables and factors (other than Clinca and the Education Intervention) where prior variables randomly distributed across all Project Arms, and that random distribution was unbiased and effective based on the analysis, it can be concluded that any effects from the assigned interventions (Clinca and Education Intervention) were the caused results of those interventions either directly or indirectly (this logical conclusion being the foundation of science and RCTs).

6.2 Clinca 205's Impacts on Household Diarrheal Prevalence

The results of the study indicate that Clinca 205 has a very strong and significant impact on household diarrheal rates, with an average household with no other interventions experiencing a 56.5% decrease in 3-day diarrheal case prevalence as compared to a similar average household without Clinca 205. This effect was found to be diminished when combined with the Educational intervention; the exact mechanism for which could not be exactly determined under this study. However, Clinca 205 showed increased impacts when used by families with more than average numbers of children (4 or more children), decreasing their diarrheal rates from a higher than average prevalence rate to a rate almost the same as families with average number of children (53% and 56.5% lower than the average without Clinca 205 use; respectively).

Overall, the household level positive health impacts of Clinca 205 were found to be exceedingly high for both a field trial and for such a short implementation period. The results of the study strongly indicate to a scientific standard that Clinca 205 can serve as a highly effective clean water/ diarrheal intervention at the household-level in a real world (i.e. resource poor, water access limited, waterborne disease endemic regions) context. Moreover, the impacts of Clinca 205 appear to be greater than those usually seen by any other type of clean water interventions in the field (ceramic water filters, chlorine tablets, etc.) in terms of community and household impacts. That said, the duration of the project was too short to draw any long-term effect conclusions from the data both in terms of Clinca 205 itself, as well as the usage trends for households.

ANNEX 2: Project Overview

Project Title: Clinca 205 Solution Efficiency Study Project.

Project Location: 5 Districts, Ratanakiri Province, Cambodia *(see the table below for more details)*.
Project Duration: 12th December 2012 until 31st January 2013
Project Budget: $90,000 USD
Project Partners: Indigenous Peoples Health Association (IPHA), the Provincial Department of Rural Development, and the Provincial Department of Health.

Project Goals:

1. To establish the health impacts of Clinca 205 on household health in relation to water borne disease in normal use circumstances;
2. To pilot a centralized Social Entrepreneur Model (SEM) based drinking water production system in target villages to establish the operational feasibility and health impacts of the SEM approach.

Project Objectives:

Objective 1: Conduct Baseline and End-line Surveys
Objective 2: Gather relevant village level data through VHSG reporting; project monitoring, and Health Center Records.
Objective 3: Conducting Relevant Interventions for all Project Arms.
Objective 4: Analysis and Reporting of Impact Results

1. Background

The province of Ratanakiri in the northeast of Cambodia is one of the least developed regions of the country. Indigenous people (IP) namely the Tampuen, Krung, Brou, Kavet, Lun, Jaray, and Kajok still make up the majority of the population but in-migration of ethnic Khmer from the low-land has significantly changed the demographic make-up of the province. Within the past five years the population has increased by 35% to over 170,000 people. Health services are provided by 11 Health Centers, 18 Health Posts providing minimum package of activities and one referral hospital that provide the complementary package of activities. Compared to low-land provinces with much higher population density health facility coverage is very low. The existence of eight IP groups with distinctly different linguistic and traditional beliefs/ practices makes the province a complex operating environment.

The use of numerous IP languages is a significant barrier for the largely low-land, Khmer-speaking government health service providers. Many of the IPs, especially women, children, and the elderly, do not speak the national language, Khmer. Also, traditional belief systems of IPs and the approaches of “modern” health care diverge. In the recent past knowledge about services provided by public health facilities was very low among IP villagers and in case of sickness or delivery, people would avail themselves to village-based traditional services. This has slightly improved over the past few years, specifically in IPHA target villages due to project components that focus on working with VHSGs, Villages Elders and health care providers/ authorities on health issues affecting the IP communities.

2. General Health Overview

Limited or no access to primary health care: Some of the IP communities are so far away from the Health Centers (e.g. 56kms away) that this distance makes it almost impossible for these IP communities to access primary health care services. Lack of transportation options and the poor road networks, especially during the rainy seasons makes it very difficult for them to travel long distance to access the available health services. This problem is compounded by very limited outreach services by government health providers. This leaves the communities no alternative but to use traditional healers and traditional birth attendants. Distance from the health facility was cited by women of child bearing age (15-49) as one of the main factors hindering them from accessing health care. In the 2005 Cambodia Health Demographic Survey (CDHS) report, rural women i.e. 42.3% were twice as likely to have problems related to distance to health facility and needed transportation as urban women i.e. 21.9%.

The 2010 CDHS report reveals a reduction in the percentage of rural women 39% having problems related to distance to health facility, the percentage of women faced with this problem in Ratanakiri/ Mondulkiri was slightly higher in 2010 at 62.1% as compared to 2005 at 60. 4%. The average of women who had problems related to distance to the health facility in Ratanakiri/ Mondulkiri was more than twice higher than the rural average of 24.9%.

Low utilization of available health facilities and services: Due to no/ limited access by some of the IP communities, lack of money to pay for the health *services (official and non-official charges)*, language barriers which significantly discourages IP women from utilizing the health services and bad attitude/ treatment by some health service providers. Due to lack of money for treatment, 59.6% of women in Ratanakiri/ Mondulkiri still sought the assistance of Traditional Birth Attendants during child delivery as compared to the rural average of 32.5% as indicated in the 2010 CDHS report.

Out-patient Departments/ Population Accessing Public Health Services

	Population	**Out-patients** (new cases) **Accessing Public Health Care**	**Health Service Utilization Index** (new cases)
Province 2007	128,108	116,231	0.91
Province 2011	172,547	130,014	0.75

Source: Health Information System, Ministry of Health

3. Low Access to 'Safe' Water & Poor Hygiene and Sanitation Practices

Access to safe drinking water in the province is low, exact figures are not available but it can be estimated at lower that 30%. This is the responsibility of the PDRD but they do not assume this responsibility. Previous NGO interventions had dug wells and installed hand-pumps, however many had fallen into disrepair and were therefore not used by the communities. Many people still source water from rivers and traditional water sources. Many of the communities have poor hygiene and sanitation practices, this can be attributed to traditional practices, low education levels and extremely limited health education by health care *providers (if done it is not in the local community languages)*. The combination of the above makes the populations vulnerable to water borne diseases. Diahorrea is one of the most common health problems, Acute Watery Diahorrea *(AWD)* affects thousands in the province annually. The Cholera *(called AWD for political purposes)* outbreak that struck the province in 2010-11 and the weak government response starkly illustrated the current lack of effective, coordinated planning/ response mechanisms in the province.

4. Project Design Details

Given the seasonal clean water access problems for households in Ratanakiri there is a need for safe water solutions both at the household and community levels. While two past small-scale pilot projects in the province have indicated a demand for Clinca 205 from households, considering the design of the previous projects it was not possible to establish neither the health impacts of Clinca 205 in a normal use context nor the viability of the Social Entrepreneur Model (SEM) approach itself in typical low resource environments.

The current project was specifically designed with the aim of filling this information gap and providing official health data to illustrate the actual health impact of Clinca 205. and to explore the scaling-up of Clinca 205 and SEM based provision of Clinca 205 as an effective, low-cost water solution across Cambodia and other developing country contexts both in terms of health impacts *(through the Randomized Controlled Trial results)* and SEM effectiveness *(through the SEM Arm of the project)*.

The data gathered from this project will identify the specific health improvement impacts of Clinca 205 in a variety of village level contexts and conditions. The design of the project explores the impacts of other variables *(e.g. presence of wells, age of household members, complementary health education, etc.)* in relation to reducing the prevalence of waterborne diseases when combined with Clinca 205.

The project is based on a cluster randomized controlled trial methodology, which was designed to determine the effectiveness of Clinca 205 as a clean water solution for resource poor communities with established clean water access problems. The project will cover 48 villages within 5 District of Ratanakiri Province. The projects target villages cover a population of approximately 4,091 households. The project will entail the clustered random assignment of villages into 4 separate implementation arms and the non-random assignment of villages into the remaining SEM Arm:

- Villages with only Clinca 205 and usage instructions provided
- Villages with Clinca 205, with usage instructions and complementary health education provided
- Villages with only complementary health education provided
- Villages with no intervention at all (control group); and
- Villages with Clinca 205 water provided through the SEM approach.

5. Methodology

The project will utilize a **Cluster Randomized Controlled Trial (CRCT)** structure with 5 separate implementation arms:

- Villages with only Clinca 205 and usage instructions provided
- Villages with Clinca 205, with usage instructions and complementary health education provided
- Villages with only complementary health education provided
- Villages with no intervention at all (control group); and
- Villages with Clinca 205 water provided through the SEM approach.

This project methodology was designed based on the study structures set for determining the true health impacts of interventions as used by the international organizations including WHO, UNICEF, and OXFAM, etc. The reasoning behind this approach is that many water solutions, while laboratory environment results have shown strong impacts on water quality, these impacts have sometimes not led to the expected health impacts at the households/ individual level.

Randomized Controlled Trial Method: The CRCT method will allow the actual impacts of Clinca 205 for households and community with no contamination of the results from such factors as income, social status of households, water source, and other variables thanks to the randomized assignment approach of the CRCT design. This approach holds to the highest scientific standards for determining the actual impact of health interventions impacts and is in adherence to the international standards of reputable health institutions worldwide.

Social Entrepreneur Model (SEM): While the CRCT approach is able to scientifically establish the actual health impacts of Clinca 205 apart from environmental and background effects, it is not capable of being an effective, sustainable water provision methodology itself. The Social Entrepreneur Model on the other hand is a provision method that may potentially provide such effectiveness and sustainability. For this reason, the SEM will be tested in one Arm of the project to determine its effectiveness as a practical and sustainable means for providing water in resource poor settings. It is hoped that if the effectiveness of Clinca 205 as an intervention against water borne disease and the viability of the SEM approach can both be established under this project, it will provide the information necessary for the use of Clinca 205 under the SEM approach for providing clean safe water and combating waterborne diseases in high poverty, low access conditions under future ODA projects.

Partnership and Networking: To maximize project impact/ sustainability and ensure the effective implementation of project components within the culturally diverse context of Ratanakiri, the Project is being implemented through ***Indigenous People's Health Action (IPHA)***, a local NGO with strong existing governmental and social networks within the project's target areas. The IPHA will be utilizing existing networks and personnel at the village level to effectively implement project activities while building upon existing structures and institutions at the Village, Commune and District levels.

Utilizing Existing Structures: The project activities will strengthen existing government sanctioned community health workers/ Village Health Support Group (VHSG) members and Health Center data staffs capacity to collect/ analyze water borne diseases data. The project will utilize VHSGs at the village level for monitoring/ health data collection related to water borne diseases/ diarrheal disease cases. This will include bi-weekly support/ supervision of VHSGs in their activities during the course of the project. This will result in higher quality data being reported to the project and government Health Centers, leading to better identification of the incidence of water borne diseases for government collected health data. Project staff will also visit target Health Center's on a bi-weekly basis to collect and discuss relevant data with staff.

Monitoring and Evaluation (M&E): M&E forms an integral part of the project and is integrated into the project design at various key stages, this will ensure that potential problems are identified and addressed quickly. Monitoring, reviewing and reflecting upon work that is being or has been carried out on a regular scheduled basis ensures that the project remains dynamic and responsive to changes in the projects operating environment.

6. Target Villages

The Project will cover a total of 42 target villages randomly assigned to four project branch Arms in order to determine the effectiveness of Clinca 205 from a health intervention perspective. Another six villages with high population density have been selected for the SEM implementation Arm. The below table details all project target villages and their assignment to the individual project Arms:

Project Arm	District	Village	Population	Ethnicity
Clinca Only	Kon Mom	Sre Angkrong	698	Lao
		Serei Mongkol	554	Lao
	Borkeav	Kachok	530	Kachok
		Chrung	397	Tampuon
		Dan	387	Tampuon
		Pa Ar	640	Tampuon
		Chreak	358	Tampuon
		Smach	227	Tampuon
	Lumpat	Dei Lo	728	Khmer/ Lao
	Oyadav	Blor	463	Jarai
		Pok Po	435	Jarai
Clinca & Health Education	Borkeav	Sala	384	Jarai
		Pa Ar	1,073	Tampuon
		Cheth	435	Tampuon
	Lumpat	Kaloang	247	Kreung
		Katieng	682	Kreung
	Oyadav	Tung	315	Jarai
		Takok Chray	437	Jarai
		Pril	394	Jarai
		Takok Phnong	565	Phnong
		Padal	742	Jarai
	Kon Mom	Neang Dei	145	Lao
Health Education Only	Borkeav	Kreang	753	Jarai
		Saleav	116	Tampuon/ Jarai
		Ya Soam	508	Jarai
		Kli	426	Tampuon
	Lumpat	Ou Khan	427	Khmer/ Lao
		Kachanh	548	Kreung
		Ul	716	Tampuon
	Kon Mom	Phoum II	694	Khmer
		Sangkom	651	Lao
	Oyadav	Pok Touch	447	Jarai

No Intervention	Borkeav	Kok	530	Tampuon
		Leu Han	527	Jarai
		Payang	557	Tampuon
		Seung	568	Tampuon
	Lumpat	Sam Kha	403	Khlmer/ Lao
		Sre Chrouk	690	Lao
		Kamphlenh	468	Kreung
	Kon Mom	Phoum I	539	Khmer
		Phoum II	429	Khmer
	Oyadav	Des	125	Jarai
SEM	Vuen Sai	Ban Pong	1,086	Lao
		Kachon	345	Tampuon
		Tiem Leu	582	Khmer
		Ka Lan	2,105	Khmer
		Pak Nam	1,081	Jara
		Koh Peak	1,067	Lao

7. Implementation of Social Entrepreneur Model in Target Villages

Objectives:

- Test the feasibility of the SEM approach in selected villages from a sustainability and community ownership perspective
- Determine the community health and uptake impacts of the SEM approach for household safe water provision
- Create a replicable approach with documentation for scalability to other contexts/ villages through future projects.

8. Agreed Activities

The below details the main project components/ activities of the Cambodia dimension of the project:

- Project Baseline/ End-line Surveys
- Clinca Distribution
- Provision of village level health education in collaboration with relevant Village Health Support Group members
- Establishment of 6 Social Entrepreneur Model (SEM) Villages
- Regular scheduled collection of relevant health data from the target Health Centers and the Provincial Health Department / Operational District level
- Regular scheduled collection of health data from the village level in collaboration with relevant Village Health Support Group (VHSG) members.

9. Outputs/ Deliverables

The project outputs are as follows:

1. Interim Report detailing the implementation of the project: activities, survey narrative summaries, review of attainment of project objectives/ results
2. Results of baseline survey and baseline data
3. Results of agreed end-line survey and ex-post data results
4. Final Report detailing the implementation of the project: activities, survey narrative summaries, review of attainment of project objectives/ results. The Final Report will also include statistical analysis of data findings and comparative analysis vis-a-vis equivalent interventions in the field; and any additional observations/ information resulting from the Project
5. Two short videos illustrating the project.

In addition, the Service Provider will provide the Client with the following deliverables:

1. Memorandum of Understanding between the IPHA and the Provincial Department of Rural Development and a Letter of Assistance from the Provincial Health Department.
2. SEM project case studies of the different beneficiary sub-groups/ Project Arms
3. Project Assessment Memorandum by PDRD and/ or PHD on project results and recommendations *(if feasible)*.

10. Reporting Schedule

Report Type	Report Due Date
Interim Report	December 31st, 2012
Final Report	January 27th, 2013

For more information see the detailed project Term of Reference, Activities Work-Plan, and Project Narrative documents attached to the Sub-contractors Agreement with Kaihatsu Management Consulting.

ANNEX 3: Baseline Survey Form

District:	XXXXXXXXXX	Household Head:	XXXXXXXXXXX
Village:	XXXXXXXXXXX	Respondent:	XXXXXXXXXXX

Survey No.:
XX-XX-XXX

X XX

Age of Respondent.. XX

Gender of Respondent.. MALE ○ FEMALE ○

[1] How much combined income does your household make on average every month ...... XXX,XXX,XXX

[2] How many motorbikes are owned by members of your household including you.......................... XX

[3] (**SUVERYOR**) What type of roofing does the house have? ....

Thatch	Iron	Corrugated Steel	Wood	Other: ___________
○	○	○	○	○

[4] Does your household have a separate farm that your household members work on? XX

NO ○ YES ○

[4A] How many days did at least 1 family member sleep at the farm in the last week? ....

SURVEYOR: Read this notice to the respondent word for word.

"In the following questions I will be asking some questions about cases of diarrhea in your household. Before I begin, it is important that I let you know what I mean by the word "diarrhea". For this survey we are using the WHO standard meaning of diarrhea, which is 3 or more loose or watery stools in a 24 hour period.

So, when I ask if someone has had diarrhea I mean:

"Has someone had 3 or more loose or watery stools in a 24 hour period."

While the use of the word may have a slightly different meaning in everyday use, for the questions I am about to ask please try and remember that diarrhea will mean 3 or more loose or water stools in a 24 hour period.

If you have any questions about this definition please ask me now."

[6] How many people live permanently in your house/household? XX

[1A] "How many times have members of your household gone to the district Health Center in the last week due to diarrhea?" XX

[7] How many people older than 17 years live permanently in your house/household? XX

[7A] Of those people, who...

	.... currently has diarrhea (12hr)	..... has had diarrhea within the last 3 days
Person 1	◯	◯
Person 2	◯	◯
Person 3	◯	◯
Person 4	◯	◯
Person 5	◯	◯
Person 6	◯	◯
Person 7	◯	◯
Person 8	◯	◯
Person 9	◯	◯

[7B] What is the highest level of education out of these members?

None	Lower Primary	Upper Primary	Lower Secondary	Upper Secondary	Secondary Certificate	Beyond Secondary
0	1 2 3	4 5 6	7 8 9	10 11 12	12 Cert.	12 <
◯	◯	◯	◯	◯	◯	◯

[8] How many people younger than 18 years live permanently in your house/household? XX

[8A] Of those people, who...

	.... currently has diarrhea (12hr)	..... has had diarrhea within the last 3 days
Person 1	◯	◯
Person 2	◯	◯
Person 3	◯	◯
Person 4	◯	◯
Person 5	◯	◯
Person 6	◯	◯
Person 7	◯	◯
Person 8	◯	◯
Person 9	◯	◯

XX-XX-XXX

[9] How many people younger than 6 years live permanently in your house/household? .... | XX |

[9A] Of those people, who...

	.... currently has diarrhea (12hr)	..... has had diarrhea within the last 3 days
Person 1	◯	◯
Person 2	◯	◯
Person 3	◯	◯
Person 4	◯	◯
Person 5	◯	◯
Person 6	◯	◯
Person 7	◯	◯
Person 8	◯	◯
Person 9	◯	◯

[10] Where does your household primarily get its drinking water?

Well	River	Natural Spring	Bottled Water	Local Stream	Other: ____________
◯	◯	◯	◯	◯	◯

[10A] When you cannot get water from that source, where does household get its water?

Well	River	Natural Spring	Bottled Water	Local Stream	Other: ____________
◯	◯	◯	◯	◯	◯

[11] What type of container does your household primarily use to store drinking water at your house?

Gourd	Plastic Bucket	Clay Jar/Cistern	Metal Can/Bucket	Pond/Pool	Other: ____________	Container Size (Liter):
◯	◯	◯	◯	◯	◯	XX

[12] Do you have a toilet at your house?... ....

NO	YES
◯	◯

[13] Do you own any other clean water producing devises or chemicals?

(check all that apply)

Chlorine	Ceramic Filter	Bio-sand Filter	Life-Straw	Charcoal Filter	Other: ____________
◯	◯	◯	◯	◯	◯

END OF SURVEY

XX-XX-XXX

ANNEX 4: Endline Survey Form

District:	XXXXXXXXXX	Household Head:	XXXXXXXXXXX	**Survey No.:** XX-XX-XXX
Village:	XXXXXXXXXXX	Respondent:	XXXXXXXXXXX	X XX

Age of Respondent…………………………………………………………………………………………………… XX

Gender of Respondent……………………………………………………………………………………… MALE ○ FEMALE ○

[1] How much combined income does your household make on average every month …… XXX,XXX,XXX

[2] How many motorbikes are owned by members of your household including you……………………… XX

[3] (**SUVERYOR**) What type of roofing does the house have? ……………………………………………………

Thatch	Iron	Corrugated Steel	Other: ___________________________
○	○	○	○

[4] Does your household have a separate farm that your household members work on? . NO ○ YES ○

[4A] How many days did at least 1 family member sleep at the farm in the last week? ……………………………………………………………………… XX

SURVEYOR: Read this notice to the respondent word for word.

"In the following questions I will be asking some questions about cases of diarrhea in your household. Before I begin, it is important that I let you know what I mean by the word "diarrhea". For this survey we are using the WHO standard meaning of diarrhea, which is 3 or more loose or watery stools in a 24 hour period.

So, when I ask if someone has had diarrhea I mean:

> *"Has someone had 3 or more loose or watery stools in a 24 hour period."*

While the use of the word may have a slightly different meaning in everyday use, for the questions I am about to ask please try and remember that diarrhea will mean 3 or more loose or water stools in a 24 hour period.

If you have any questions about this definition please ask me now."

[6] How many people live permanently in your house/household? XX

[6A] “How many times have members of your household gone to the district Health Center in the last week due to diarrhea?” XX

[7] How many people older than 17 years live permanently in your house/household? XX

[7A] Of those people, who...

	.... currently has diarrhea (12hr)	..... has had diarrhea within the last 3 days
Person 1	◯	◯
Person 2	◯	◯
Person 3	◯	◯
Person 4	◯	◯
Person 5	◯	◯
Person 6	◯	◯
Person 7	◯	◯
Person 8	◯	◯
Person 9	◯	◯

[7B] What is the highest level of education out of these members?

None	Lower Primary	Upper Primary	Lower Secondary	Upper Secondary	Secondary Certificate	Beyond Secondary
0	1 2 3	4 5 6	7 8 9	10 11 12	12 Cert.	12 <
◯	◯	◯	◯	◯	◯	◯

[8] How many people younger than 18 years live permanently in your house/household? XX

[8A] Of those people, who...

	.... currently has diarrhea (12hr)	..... has had diarrhea within the last 3 days
Person 1	◯	◯
Person 2	◯	◯
Person 3	◯	◯
Person 4	◯	◯
Person 5	◯	◯
Person 6	◯	◯
Person 7	◯	◯
Person 8	◯	◯
Person 9	◯	◯

XX-XX-XXX

[9] How many people younger than 6 years live permanently in your house/household? XX

[9A] Of those people, who...

	.... currently has diarrhea (12hr)	..... has had diarrhea within the last 3 days
Person 1	○	○
Person 2	○	○
Person 3	○	○
Person 4	○	○
Person 5	○	○
Person 6	○	○
Person 7	○	○
Person 8	○	○
Person 9	○	○

[10] Where does your household primarily get its drinking water?

Well	River	Natural Spring	Bottled Water	Local Stream	Other: ____________
○	○	○	○	○	○

[10A] When you cannot get water from that source, where does household get its water?

Well	River	Natural Spring	Bottled Water	Local Stream	Other: ____________
○	○	○	○	○	○

[11] What type of container does your household primarily use to store drinking water at your house?

Gourd	Plastic Bucket	Clay Jar/Cistern	Metal Can/Bucket	Pond/Pool	Other: ____________	Container Size (Liter):
○	○	○	○	○	○	XX

[12] Do you have a toilet at your house?... ....

NO	YES
○	○

[13] Do you own any other clean water producing devises or chemicals?

(check all that apply)

Chlorine	Ceramic Filter	Bio-sand Filter	Life-Straw	Charcoal Filter	Other: ____________
○	○	○	○	○	○

XX-XX-XXX

[14] **Surveyor:** Ask the respondent if they have any clean water products and have them show you [DO NOT HAVE THEM BRING IT TO YOU!!].

Did you see Clinca at the household?.. NO ○ YES ○

IF "YES".....

[14A] Surveyor: Was the Clinca being used in water when you saw it?.................... NO ○ YES ○

END OF SURVEY

ANNEX 5: Memorandum of Understanding (PDRD)

អនុស្សរណៈនៃការយោគយល់ រវាង អង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច

នឹង មន្ទីរអភិវឌ្ឍន៍ ជនបទខេត្ត រតនគិរី

សំរាប់គំរោងទឹកស្អាត (Clinca205) និង ការវាយតំលៃការប្រើប្រាស់ទឹកនៅតាមសហគមន៍

ជនបទខេត្តរតនគិរី។

១ អនុស្សរណៈនៃការយោគយល់ រវាង អង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច និង មន្ទីរអភិវឌ្ឍន៍ជនបទខេត្តរតនគិរី ទាក់ទងទៅនិងការអនុវត្តន៍សកម្មភាពវាយតំលៃការប្រើប្រាស់ទឹក នៅតាមសហគមន៍ជនបទខេត្តរតនគិរី ដោយប្រើផលិតផលសំអាតទឹក(Clinca205) ដោយគ្មានសារធាតុគីមី ដែលបានផលិតនិងប្រើប្រាស់នៅប្រទេសជប៉ុន និង គំរោងដែលផ្តួចផ្តើមជាផ្លូវការ ដោយគំរោងជំនួយអភិវឌ្ឍន៍នៃក្រសួងការបរទេសរបស់រាជរដ្ឋាភិបាលជប៉ុនដែលនឹងចាប់ផ្តើមអនុវត្តន៍ក្នុងខេត្តរតនគិរី ចាប់ពីថ្ងៃទី ០៣ **ខែ ធ្នូ ឆ្នាំ២០១២** នឹងបញ្ចប់នៅថ្ងៃទី៣១ **ខែមេសា ឆ្នាំ២០១៣។** អនុស្សរណៈនៃការយោគយល់គ្នានេះនិងចូលជាធរមានចាប់ពីពេលថ្ងៃដែលចុះហត្ថលេខាដោយភាគីទាំងពីរ។

២ អង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច បានទទួលកញ្ចប់ថវិការ ដើម្បីអនុវត្តសកសម្មភាពដូចខាងក្រោម ដែលបានអធិប្បាយនៅក្នុងឯកសារលំអិតរបស់គំរោង និង កិច្ចសន្យាដែលបានអនុម័តដោយអ្នកទទួលជំនួយផ្ទាល់។

ក, អនុវត្តការស្រាវជ្រាវទិន្នន័យបឋម ពាក់កណ្តាលគំរោង និងចុងបញ្ចប់គំរោង។

ខ, ចែកចាយផលិតផលសំអាតទឹក (Clinca205) នៅតាមភូមិគោលដៅ។

គ, បណ្តុះបណ្តាល និងដឹកនាំក្រុមស្ម័គ្រចិត្ត និងផ្តល់សំភារះអប់រំសុខភាពសំរាប់សកម្មភាព អប់រំនៅតាមភូមិ គោលដៅ សំរាប់រយះពេល ០២ខែដំបូងនៃគំរោង។

ឃ, ប្រមូលទិន្នន័យសុខភាពនៅតាមភូមិនិងមណ្ឌលសុខភាព តាមរយះក្រុម ទ្រទ្រង់សុខភាពភូមិ មណ្ឌលសុខភាព និង ប្រភពផ្សេងៗ ។

ង, អនុវត្តការងាររដ្ឋបាលនានា និងរៀបចំឯកសារគំរោង សំរាប់គំរោងជំនួយអភិវឌ្ឍន៍ឆ្នាំបន្ទាប់ របស់ស្ថានទូត ជប៉ុនប្រចាំប្រទេសកម្ពុជា។

៣, ក្នុងការ អនុវត្តសកម្មភាព អង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច យល់ព្រមសហការជាមួយ មន្ទីរអភិវឌ្ឍន៍ជនបទខេត្តរតនគិរី ក្នុងការងារអភិវឌ្ឍន៍ជនបទដូចខាងក្រោមៈ

ក, មន្ទីរអភិវឌ្ឍន៍ជនបទខេត្តរតនគិរី និងផ្តល់នូវការគាំទ្រ ដល់អង្គការសកម្មភាពសុខភាព **ជនជាតិដើមភាគតិចក្នុងការអនុវត្តសកម្មភាពគំរោងតាមរយះជាការផ្តល់គោលការណ៍ណែនាំនឹងការត្រួតពិនិត្យរយះពេលនៃគំរោង។**

ខ, មន្ទីរអភិវឌ្ឍន៍ជនបទខេត្តរតនគិរីនិង ផ្តល់ឲ អង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច នូវព័ត៌មានអំពីអណ្តូងទឹក និងគំរោងទឹកស្អាតនានា ដែលមាននៅក្នុងភូមិគោលដៅគំរោងក៏ដូចជាទិន្នន័យ អំពីគុណភាពទឹក និងការប្រើប្រាស់នៅក្នុងតំបន់ភូមិគោលដៅគំរោង។

គ, មន្ទីរអភិវឌ្ឍន៍ជនបទខេត្តរតនគិរី និងផ្តល់ឲ អង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច នូវការណែនាំអំពីការ រៀបចំគំរោងសំរាប់ស្នើសុំជំនួយអភិវឌ្ឍន៍សំរាប់ឆ្នាំបន្ទាប់ពីរាជរដ្ឋាភិបាលជប៉ុន បូករួមទាំងការចូលរួមរបស់ មន្ទីរអភិវឌ្ឍន៍ជនបទជាដៃគូគំរោងផងដែរ។

៤, កញ្ចប់ថវិការក្នុងការអនុវត្តសកម្មភាព ដូចមានចែងនៅក្នុងថាខ័ណ្ឌ (៣ ,ក និង ខ)ត្រូវអនុវត្តសកម្មភាពគ្រប់គ្រងគំរោងនៃមន្ទីរអភិវឌ្ឍន៍ជនបទខេត្ត រឺមន្ត្រីជំនាញដោយទទួលបានថវិការ **១២៥** អាមេរិកក្នុងមួយខែ សរុបចំនួន **៥០០$** សំរាប់រយ:ពេល ០៤ ខែដែលនឹងត្រូវផ្តល់ជូនដោយអង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច។

៥, ការទទួលខុសត្រូវក្នុងការសរសេររបាយការណ៍ ទៅអ្នកទទួលជំនួយផ្ទាល់ទាក់ទងទៅនឹង សកម្មភាពគំរោងជាការទទួលខុសត្រូវរបស់អង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច។

៦, ក្នុងករណីមានបញ្ហា ការខ្វែងគំនិតគ្នា រឺ ការត្អូញត្អែរណាមួយកើតឡើងនៅក្នុងគំឡុងពេលអនុវត្ត អនុសារ:នេះដោយភាគីទាំង ៣ មន្ទីរអភិវឌ្ឍន៍ជនបទខេត្ត និង អង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច ហើយ(ប្រសិនបើមានការចាំបាច់ឲមានការចូលរួមពីភាគីទី៣)នឹងត្រូវពិនិត្យមើលនិងកែប្រែកិច្ចសន្យានេះ។

៧, អនុសារណៈនេះ នឹងត្រូវពិនិត្យមើលដោយ អង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច និងមន្ទីរអភិវឌ្ឍន៍ជនបទខេត្តរតនគិរីនៅថ្ងៃទី **៣១ ខែ មេសាឆ្នាំ២០១៣** ហើយអាចនឹងអស់សុពលភាពលុះត្រាណាតែមានការយល់ព្រមពីភាគីទាំងសងខាង។

ហត្ថលេខាអង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិចតំណាង ដោយនាយកអង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច

ឈ្មោះ ...IPHA ...ស្រីត...... ហត្ថលេខា ...[signature]...... ថ្ងៃទី ...12/12/12....

ហត្ថលេខា មន្ទីរអភិវឌ្ឍន៍ជនបទខេត្ត តំណាងដោយ ប្រធានមន្ទីរអភិវឌ្ឍន៍ជនបទខេត្ត

ឈ្មោះ.............................. ហត្ថលេខា ...[signature]...... ថ្ងៃទី ...17.12.2012

លេញ - ចឺន

ANNEX 6: Letter of Support (PHD)

លិខិតសុំការអនុញ្ញាតពីមន្ទីរសុខាភិបាលរតនគិរី

សំរាប់គំរោងទឹកស្អាត (Clinca205) និង ការវាយតំលៃការប្រើប្រាស់ទឹកនៅតាមសហគមន៍

ជនបទខេត្តរតនគិរី។

១ យោងលើកាពិភាក្សារវាងក្រុមប្រឹក្សាភិបាល និងការ ចុះនុសារណៈនៃការយោគយល់រវាងអង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច និងមន្ទីរអភិវឌ្ឍន៍ជនបទខេត្តរតនគិរី ទាក់ទងទៅនិងការអនុវត្តន៍សកម្មភាពវាយតំលៃការប្រើប្រាស់ទឹក នៅតាមសហគមន៍ជនបទខេត្តរតនគិរី ក្រោមគំនិតផ្តួចផ្តើមជាផ្លូវការដោយគំរោងជំនួយអភិវឌ្ឍន៍នៃក្រសួងការបរទេសរបស់រាជរដ្ឋាភិបាលជប៉ុនដែលនឹងចាប់ផ្តើមអនុវត្តន៍ក្នុងខេត្ត រតនគិរី ចាប់ពីថ្ងៃទី **០៣ ខែ ធ្នូ ឆ្នាំ២០១២** នឹងបញ្ចប់នៅថ្ងៃទី**៣០ ខែមេសា ឆ្នាំ២០១៣។**

២ អង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច បានទទួលកញ្ចប់ថវិការ ដើម្បីអនុវត្តសកសម្មភាពដូចខាងក្រោម ដែលបានអធិប្បាយនៅក្នុងឯកសារលំអិតរបស់គំរោងនិងកិច្ចសន្យាដែលបានអនុម័តដោយអ្នកទទួលជំនួយផ្ទាល់។

ក, អនុវត្តការស្រាវជ្រាវទិន្នន័យបឋម ពាក់កណ្តាលគំរោង និងចុងបញ្ចប់គំរោង។

ខ, បណ្តុះបណ្តាល និងដឹកនាំក្រុមស្ម័គ្រចិត្ត និងផ្តល់សំភារះអប់រំសុខភាពសំរាប់សកម្មភាពអប់រំ នៅតាមភូមិ គោលដៅ សំរាប់រយះពេល ០២ខែដំបូងនៃគំរោង។

គ, ប្រមូលទិន្នន័យសុខភាពនៅតាមភូមិនិងមណ្ឌលសុខភាព តាមរយះក្រុមទ្រទ្រង់សុខភាពភូមិ មណ្ឌលសុខភាព និង ប្រភពផ្សេងៗ ។

៣, ក្នុងការ អនុវត្តសកម្មភាពអង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច ព្រមព្រៀងសហាការជាមួយ មន្ទីរសុខាភិបាលខេត្តរតនគិរី ក្នុងសកម្មភាពដូចខាងក្រោមះ

ក, មន្ទីរសុខាភិបាលខេត្តរតនគិរី និងផ្តល់នូវការគាំទ្រដល់អង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិចក្នុងការប្រមូលទិន្នន័យសុខភាពនៅតាមភូមិគោលដៅនិងមណ្ឌលសុខភាពដែលស្ថិតក្រោមការគ្រប់គ្រងរដ្ឋបាលរបស់មន្ទីរសុខាភិបាលខេត្ត។

ខ, មន្ទីរសុខាភិបាលខេត្តរតនគិរី នឹងផ្តល់ឲអង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិចនូវទិន្នន័យសុខភាពអំពីជម្ងឺរាគនិងជម្ងឺដែលបង្ករដោយទឹកពីពេលកន្លងមកនិងក្នុងកំលុងពេលនៃការអនុវត្តគំរោង។

គ, មន្ទីរសុខាភិបាលខេត្តរតនគិរី និងផ្តល់ឲ អង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច នូវគោលការណ៏ណែនាំនិងការគាំទ្រជាផ្លូវការក្នុងការអនុវត្តសកម្មភាពអប់រំសុខភាពនិងការចូលរួមរបស់ក្រុមទ្រទ្រង់សុខភាពភូមិក្នុងការប្រមូលទិន្នន័យនិងការអប់រំសុខភាពនៅតាមភូមិគោលដៅ។

៤, កញ្ចប់ថវិកាក្នុងការអនុវត្តសកម្មភាពដូចមានចែងនៅក្នុងកថាខ័ណ្ឌ (៣ ,ក និង ខនិងគ)ដែលនឹងត្រូវអនុវត្ដោយមន្ទីរសុខាភិបាលខេត្ត រីមន្ត្រីជំនាញនឹងទទួលបានថវិកាចំនួន **១០០**អាមេរិកក្នុងមួយខែ សរុបចំនួន **៨០០$** សំរាប់រយះពេល ០៨ ខែដែលនឹងត្រូវផ្តល់ដោយអង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច។

៥, ការទទួលខុសត្រូវក្នុងការសរសេររបាយកាណ៌ ទៅធអ្នកទទួលជំនួយផ្ទាល់ទាក់ទងទៅនឹង សកម្មភាពគំរោងជាការទទួលខុសត្រូវរបស់អង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច។

៦, ក្នុងករណីមានបញ្ហាការខ្វែងគំនិតគ្នារឺការត្អូញត្អែរណាមួយកើតឡើងក្នុងកំឡុងពេលនៃការអនុវត្តអនុសាណៈនេះដោយភាគីទី៣ មន្ទីរសុខាភិបាលខេត្តរតនគិរីនិងអង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច (ប្រសិនបើមានការចាំបាច់ធមានការចូលរួមពីភាគីទី៣)ត្រូវពិនិត្យមើលនិងកែប្រែកិច្ចសន្យានេះរួមគ្នា។

៧, លិខិតសុំការអនុញ្ញាតនេះ នឹងត្រូវពិនិត្យមើលឡើងវិញដោយ អង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិច និងមន្ទីរសុខាភិបាលខេត្តរតនគិរីនៅថ្ងៃទី **៣០ ខែ មេសាឆ្នាំ២០១៣** ហើយអាចនឹងអស់សុពលភាពលុះត្រាណាតែមានការយល់ព្រមពីភាគីទាំងសងខាង។

ហត្ថលេខាអង្គការសកម្មភាពសុខភាពជនជាតិដើមភាគតិចតំណាងដោយនាយកអង្គការសកម្មភាពសុភាពជនជាតិដើមភាគតិច

IPHA RTK

ឈ្មោះ.................................ហត្ថលេខា.......................................ថ្ងៃទី 25-12-12

ហត្ថលេខា មន្ទីរសុខាភិបាលខេត្តរតនគិរីតំណាងដោយៈ នាយកមន្ទីរសុខាភិបាលខេត្ត

ឈ្មោះ.................................ហត្ថលេខា.......................................ថ្ងៃទី 25-12-2012