

HOUSEHOLD DEMAND FOR SAFELY MANAGED SANITATION:

A case study of two rural communes in Cambodia.

James Harper, Lien Pham, Phalla Chem, IV Bunthoeun, Kim Hor

List of Acronyms

ADP	Alternating dual-pit latrine
CHOBA	Community Hygiene Output-Based Aid, an EMW development project
DORD	Department of Rural Development
DRHC	Department of Rural Healthcare
EMWF	East Meets West Foundation
FS	Fecal sludge
FSM	Fecal sludge management
NGO	Non-governmental organization
PDRD	Provincial Department of Rural Development
MRD	Ministry of Rural Development

1. Introduction

Fecal sludge management (FSM), is required to achieve safely managed sanitation but has been difficult to achieve in rural Cambodia due to the high cost, low availability, and technical difficulty of performing safe pit emptying with trained personnel in areas of low population densities.¹

Single-pit latrine (Figure 1), requires trained FSM service providers who use specific equipment and proper safety techniques to prevent the release of pathogenic fecal sludge into the environment; this process is typically required in rural areas where single-pit latrines are common.² However, difficulties in maintaining such services in rural areas make single-pit latrines difficult to maintain over the long term, lead to frequent self-emptying (households emptying their own pits without proper equipment or safety techniques). Further, liquid waste typically leaches into the surrounding ground. The lack of sustainable FSM and environmental issues associated with single pit latrines highlight the need for alternative methods to manage FS.³

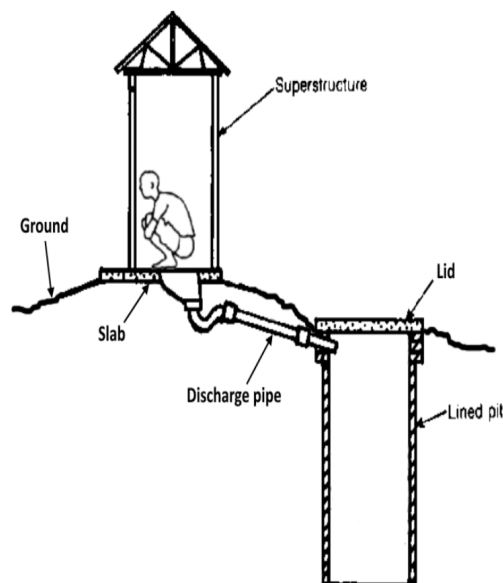


Figure 1: Schematic drawings of an offset single-pit latrine.

¹ Kong, M.; Bartell, J. Behavioral Drivers of Fecal Sludge Management in Rural Cambodia: A Qualitative Study (Technical Report). WaterSHED 2018

² EAWAG. Compendium of Sanitation Systems and Technologies, 2nd Edition. 2014.

³ Strande, L.; Brdjanovic, D. Faecal Sludge Management: Systems Approach for Implementation and Operation; IWA Publishing, 2014.

Eliminating the need for trained pit-emptying services, alternative latrine designs have been developed and constructed at wide scales in the rural areas of various countries, including India, Cambodia and Bangladesh.⁴ In Southeast Asia, the most prevalent of these alternative latrine designs is the alternating dual-pit latrine (ADP; Figure 2).⁵ Although more expensive than single-pit latrines due to their increased material costs, time to construct, and increased design complexity, ADPs provide on-site treatment of stored FS and also increased FS storage capacity.⁶ To achieve on-site treatment, the operation of an ADP is somewhat complex but manageable given proper training: when one pit fills, the latrine is connected to the second pit, and the first is sealed, allowing pathogens in the first pit to degrade over time via storage treatment as the second pit is used;⁷ when the second pit fills, the household empties the first with much lower health risks due to a reduced number of pathogens, the second pit is sealed, the latrine is connected to the first pit again, and the process repeats.

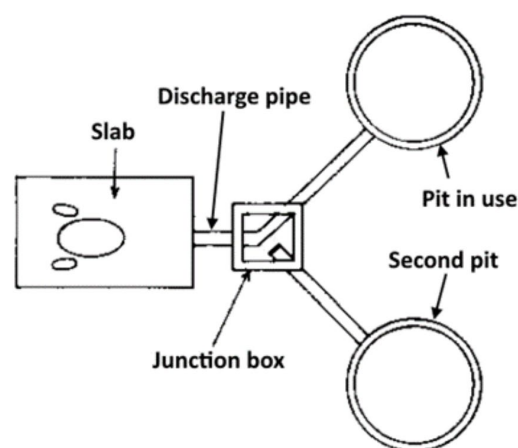


Figure 2: Schematic drawing of an alternating dual-pit latrine (top view).

In rural Cambodia, East Meets West, iDE and other development organizations have been installing ADPs in recent years,⁷ and household familiarity with and demand for ADPs have been increasing markedly as awareness for ADPs spreads.⁸ For example, 28% of households with single-pit latrines purchased an ADP during a sanitation marketing campaign in Svay Rieng province in 2018,⁹ and strong interest in ADPs was found in

⁴ iDE Cambodia. Addressing Fecal Sludge Management in Rural Locations. 2020.

⁵ Ibid

⁶ Strande, L. & Brdjanovic, D. Faecal Sludge Management: Systems Approach for Implementation and Operation; IWA Publishing, 2014.

⁷ iDE Cambodia. Addressing Fecal Sludge Management in Rural Locations. 2020.

⁸ iDE Cambodia. Addressing Fecal Sludge Management in Rural Locations. 2020.

⁹ iDE Cambodia. Technical Guidelines on Twin Pit Pour Flush Latrine. 2017.

⁹ Harper, J.; iDE Cambodia. When Rural Latrine Pits Fill: Characterizing Household Choices and Encouraging Safe Fecal Sludge Management, 2019.

Kampot province in 2019.¹⁰ However, specific household perceptions of, experiences with, and demand for ADPs remain poorly characterized. This study investigated how rural households in two villages in Kampong Trabek district, Prey Veng province, Cambodia, have experienced, perceive and demand different aspects of FSM, particularly ADPs. The results of this study are intended to inform future FSM product and service development, and ultimately improve rural FSM safety and public health.

2. Methods

The study employed surveys and field measurements and was conducted in collaboration with government officials. The study was conducted in one year comprising four field visits every 3 months. Various stakeholders, including five households, eleven local and provincial government officials, and masons that construct and maintain rural latrines, were also interviewed about related topics to describe how they perceive FSM and ADPs. Pit sludge depths are also measured at each household during each field visit to investigate how demand for ADPs is affected by pit sludge depths and the anecdotally reported worry of households about their existing single pit filling. While this study primarily sought to characterize the experiences and perceptions of rural Cambodian households regarding FSM, the study also involved short workshops to educate rural households about the importance of safe FSM, including ADPs and on-site treatment.

Five households were visited four times (once each in March, June, September and December 2020) to 1) measure pit sludge depths at each household in each season during one contiguous year and considered changes in sludge depth with other measured factors; 2) administer a baseline survey followed by three follow-up surveys to track changes in perceptions of FSM and ADPs due to EMWF educational workshops, households' experiences that occurred during the study, and other factors; and 3) to reduce respondent fatigue while still describing household experiences with and perceptions of FSM and ADPs in sufficient detail.

All surveys were conducted in-person, and EMWF managers and the authors reviewed the data collected for accuracy and completeness. All responses were recorded by hand on paper, and all household members signed consent forms that grant EMWF rights to reproduce photos and video of all household members.

¹⁰ SNV. Beyond the Finish Line in Cambodia: Sustainable Sanitation and Hygiene for All (SSH4A Phase III): Faecal Sludge Management (FSM) Research Report. 2019

2.1 Methods

Four household questionnaires were developed for the four field visits. The first household questionnaire asked households about various aspects of FSM, including the household's experiences, perceptions, and expectations related to FSM; details about latrine construction, design, use, functionality and associated household expectations; and demographics. This first household questionnaire provided a baseline, on which to develop the questions for the next three questionnaires. The second household questionnaire asked households more detailed questions about their expectations, concerns, intentions and topics of considered when thinking about FSM; social norms about sanitation in their community; and perceptions about the cost of FSM. Specifically, households were asked about their intentions to upgrade their single-pit latrines to alternating dual-pit latrines. The third household questionnaire built upon the previous two surveys by asking households specifically about problems with their latrines, the availability and their perceptions of trained FSM service providers in their community, and factors that affect how they make decisions about FSM, including the effects of culture and seasonality on FSM at their household. The construction of an ADP upgrade at one household was also observed and documented during the third field visit. Last, the fourth household questionnaire asked households about their experiences with and perceptions of on-site FSM treatment and ADPs in particular; and what they learned from this study series. Pit sludge depths within each household's pit were measured during each field visit.

In addition to the household questionnaires, two questionnaires for stakeholders were developed, one for the March field visit and one for the December field visit. The first stakeholder questionnaire was used to interview five government officials about rural FSM and characterized their knowledge of and experience with rural FSM, including single- and dual-pit latrines and perceptions about FSM of households where they work. The second stakeholder questionnaire was used to interview six government officials and one mason about rural on-site FS treatment, particularly ADPs.

2.2 Educational Workshops

Short workshops were conducted during the second and third field visits by the EMWF team at each household. These workshops taught households about the importance of on-site FS treatment; the design and functionality of ADPs, including using transfer boxes; and the cost of emptying services and upgrading to an ADP with comparisons to single-pit latrines. EMWF also provided large ADP banners to the officials from the provincial Department of Rural Development (PDRD) and the Kampong Trabaek District Office of Rural Development

(DORD), and the masons that participated in the study to expand awareness about these topics to more households in the study region. Also, based on their responses to the questionnaires during each field visit, households were presented with specific recommendations about how to improve FSM safety at their households.

Additionally, stakeholders, primarily PDRD staff members and masons, attended an online workshop about FSM and the design, importance and use of ADPs that was run by EMWF in June and September 2020. Field demonstrations of an ADP, including their design, construction and use, were performed in Pursat and Kratie provinces on 9-10 and 11-12 June 2020, respectively. All participants in the online workshops, the PDRD officials and other local authorities were invited to the two field demonstrations.

2.3 Sampling

Households were selected based on the following criteria: 1) built their latrines more than five years ago; 2) had more than five household members; 3) were ID Poor, a metric of poverty defined by the Cambodian National Government's Identification of Poor Households (ID Poor) Program that considers a household's assets, health, education, income and debt;¹¹ and 4) participated in EMWF's first Community Hygiene Output-Based Aid (CHOBA1) program in 2015. Two of the five households were also selected because they experienced seasonal flooding, while the others did not.

The Kampong Trabek District of Rural Development (DoRD) helped to identify eligible households that met these sampling criteria. All households were located in the villages of Dang Tong and Chhvaing in the communes of Prasath and Pratheat, Kampong Trabek district, Prey Veng province, Cambodia, and were approved by MRD-DRHC and Prey Veng province's PDRD for inclusion in this study. Prey Veng province was selected due to its similarities in primary industry (rice farming), sanitation infrastructure (single-pit latrines with few or no trained FSM services), social norms regarding sanitation (self-empty without treatment is common), and other factors compared to other rural areas within Prey Veng and across other Cambodian provinces.¹² During EMWF's CHOBA1 program, Prey Veng province's rural latrine coverage (the percentage of households with access to a latrine) increased from 30% in 2012 to 70% in 2015; similar marked increases in latrine coverage in other Cambodian provinces have been reported.¹³

¹¹ Ministry of Rural Development, Kingdom of Cambodia. Identification of Poor Households (IDPoor) Programme <https://mop.idpoor.gov.kh/> (accessed May 22, 2020).

¹² (Mensah, Y. M.; Chen, H.-Y. Global Clustering of Countries by Culture – An Extension of the GLOBE Study; SSRN Scholarly Paper ID 2189904; Social Science Research Network: Rochester, NY, 2013. <https://doi.org/10.2139/ssrn.2189904>.

¹³ East Meets West. CHOBA WASH Project Completion Report. 2016.

Table 1 summarizes the demographics of the five households, which were similar to others in their community. Table 2 summarizes the stakeholders' role and the government agency, and the mason that constructed and repaired latrines in the study's communities.

Household ID	IDPoor Status	# Members						Village	Commune	Years Using Latrine
		Total	Males	Females	>18 yrs	2-17 yrs	<2 yrs			
HH1	1	5	2	3	4	1	0	Dang Tong	Prasath	6
HH2	1	7	3	4	6	0	1	Dang Tong	Prasath	6
HH3	2	5	1	4	3	2	0	Dang Tong	Prasath	6
HH4	2	8	6	2	7	0	1	Chhvaing	Pratheath	6
HH5	2	9	5	4	7	2	0	Chhvaing	Pratheath	6
	Total	34	17	17	27	5	2			

Table 1. Demographics of interviewed households.

Title	Organization	Gender	Month Interviewed in 2020
PDRD Official	Prey Veng Provincial Government	F	Mar
2 nd Deputy Chief	Prasath Commune Government	F	
1 st Deputy Chief	Pratheath Commune Government	F	
Chief of Mason	Kansom Art Commune Government	M	
DORD WASH Official	Kampong Trabek District Government	M	Mar & Dec
Deputy Director	Department of Rural Healthcare (DRHC), Ministry of Rural Development (MRD), National Cambodian Government	M	Dec
Officer	Office of Rural Healthcare, Prey Veng PDRD	M	
CC Member	Prasath Commune	M	
1 st Deputy Chief of CC	Pratheath Commune	F	
Village Chief	Dang Tong Village	M	
Mason	Private business in Kampong Trabek District	M	

Table 2. Job titles, organizations and genders of interviewed stakeholders with month interviewed.

3. Results and Discussion

3.1 Survey with households

3.1.1 Problems with single pit latrines.

Four households reported difficulty flushing their latrines in the wet season because their pits were full of rainwater. This problem was directly observed in three households during the third field visit in September, which coincides with the peak of the wet season in Prey Veng province. These households also reported bad smells from their latrine pits in the wet season.

Flooding also prevented access to and use of one household's latrine in the wet season; this was directly observed in September. Flooding typically occurs at this household from early September to late November. While their latrine was flooded, household members used a relative's latrine that is approximately 70 meters away. In December, another household worried about a flushing problem developing during the next rainy season and thus planned to upgrade to an ADP as soon as possible.

With their single-pit latrines, all five households foresaw challenges with emptying their pits due to foul odors and disgust (e.g., touching FS); emptying being too physically demanding; a lack of FSM service availability in their community; and having no proper disposal locations for FS. These future challenges motivated the households to seek easier, safer, and more effective methods of managing their FS.

All households believed that their communities understand the importance of sanitation and safe FSM, and generally favor installing a new pit to manage FS safely. When thinking about emptying their pit, households tend to worry about their neighbors smelling foul odors from their FS, contaminating bodies of water with FS, spreading disease, and hurting the environment, and preferred to empty their pits in the months that they are most financially secure. Households also reported considering all of the following topics to be relevant to how they make decisions about sanitation at their households: religious beliefs, traditions in their community, opinions of their village chief, opinions of politicians, advertisements about sanitation, social media, and cost.

Three out of five households responded that emptying was too expensive, and that it was difficult to find someone to perform such work. When their pits fill up, no household plans to start using a neighbor's latrine due to the shame of using a neighbor's latrine; although using a relative's latrine was acceptable. Also, no household intended to resume open defecation

when their pit fills up because they understand the importance of sanitation and want to keep their community's environment clean and healthy.

3.1.2 Knowledge about FSM

Knowledge about how to empty a pit was lacking: two households could describe how a household could empty their own pit using a bucket and shovel (self-empty), and burying the emptied FS nearby; and one household mentioned hiring a vacuum truck service. Two households mentioned using clothing that prevented contact with FS when emptying a pit, and households generally but incorrectly agreed that only gloves were needed to empty a pit safely. When maintaining a latrine, safety was important to all households, and complete emptying and cost were important to approximately half of the households.

Households learned a lot about sanitation and hygiene during this study series. All five households learned how to maintain good personal hygiene, such as washing hands with soap; how to properly use a latrine and manage problems with a latrine; the importance of having a latrine; and about the design of an ADP, how to use it, and its advantages. They also learned that fecal sludge can be used as compost for agriculture after leaving it within a capped pit for 2 years. The households also learned that using a properly functioning latrine, particularly an ADP, presents a good example for future generations to follow.

WASH-related workshops had a strong effect on how the households and their communities perceived and made decisions about sanitation. Four of five households had attended many of these workshops provided by either the government or non-governmental organizations (NGOs) and had shared what they had learned at those workshops with others. All households reported that since learning about WASH, neighbors use their latrines more, wash their hands with soap more, and typically drink safe water more. All households believe that latrines have improved the health of their household and community, reduced health costs, and improved their community's environment by eliminating FS and its associated smells.

Awareness of on-site FS treatment and its benefits was common. All five households had heard of on-site FS treatment and believed that on-site treatment supports good health within their household and good environmental health around their household. Killing *meruk* (the Khmer word for "germs"), or removing pathogens, was valued by all households, which knew the advantages of making pit emptying safer by using a specific method to kill *meruk* in the FS stored within their pits. Households were also all interested in upgrading their single-

pit latrine to an ADP because they could then treat their FS at their households, would no longer worry about a pit filling up, and would not have to find a pit-emptying service provider. All households were happy with the simple technique of emptying an ADP and using one pit while keeping the other capped for two years. They were also happy that the emptied sludge could then be used as compost for agriculture.

The installation and operation of an ADP were demonstrated to all households in September during the third study. Households also reported learning about ADPs' design, advantages and function during a large banner presentation at each household during the third study.

3.1.3 Upgrade to ADP Latrines

Households' desire to upgrade to ADP were found to vary markedly between each field visit. At the beginning of the study, four of five households expressed a strong desire to upgrade to an ADP to keep their single pit from filling and allow for easy and effective on-site FS treatment. However, no households planned to upgrade within the next year due to the relatively high cost of upgrading to an ADP, which required installing a new pit and associated piping. One household cited having few household members (and thus a slow pit fill rate) as justification keeping their single pit.

By June, four households had changed their minds about ADPs: two committed to upgrading to ADPs by August (two months away) because their pits were nearly full; another committed to the same by the end of 2020 because their pit was not quite full; and another decided not to upgrade to an ADP anytime soon but intended to when the family had more money in the distant future. These decisions were made after discussing the household's options and the importance and advantages of ADPs with the EMWF team.

By September, two households more had again changed their minds about ADPs. One household unfortunately had to pay unexpected healthcare costs related to their daughter's serious illness and could not upgrade their pit as planned; however, they still hoped to upgrade their pit by December. The other household spent their available money on agricultural products for wet rice farming and believed that they would not be able to upgrade to an ADP anytime soon. However, with last-minute generous support from their children, they were able to upgrade their latrine to an ADP in September; this process is documented in the next section.

Households were generally willing to pay 100,000 Riels for emptying due to the difficulty in finding someone to empty pits within or near their communities, and 150,000 Riels for upgrading due to the advantages of on-site treatment provided by an ADP. However, one household was more comfortable paying between 50,000 and 100,000 Riels for upgrading to an ADP. Households tended to favor upgrading because 1) they could save money over time compared to pit emptying; 2) it can be difficult to find local labor to empty pits in their communities; 3) they were unsure if the 100,000 Riels that they were willing to pay would satisfy pit emptiers; 4) desludging pumps are not commonly available in their communities; and 5) no proper disposal area for FS is available in their communities. Three households also mentioned that upgrading to an ADP requires a one-time expense that provides a functional system for many years and also eliminates their worry about a pit filling up. Thus, households viewed upgrading their latrines to ADPs as the best option for FSM, particularly on-site FS treatment. These households were not interested in alternative payment plans and preferred to pay in one simple payment for either emptying or upgrading to ADP.

One of the five households that had planned to upgrade to an ADP had the upgrade performed in September when EMWF was on-site. The household decided to upgrade their pit because 1) their pit was full; 2) it was difficult to flush; 3) it was difficult to find a pit-emptying service provider to empty their pit; and 4) they were unable to access their latrine in the wet season. They also thought that upgrading was a good option despite its high cost.

After the household and mason agreed on a price of 150,000 Riels for the upgrade, the mason and his team began by removing the existing slab pan, chamber box, back wall, and door, and then dug a new pit 0.80 m deep and 0.60 m away from the old pit. Two concrete rings (0.50 m high, 0.80 m inner diameter) were then placed in the new pit, and the chamber box was then cleaned with water. The upgrade required two hours, and the EMWF team recorded the upgrade on video (available upon request). All household members reported feeling satisfied with the upgrade and cost, and were also relieved to no longer have to worry about unsafe sludge emptying, which they experienced 12 days prior to their ADP upgrade (discussed above).

After using their ADP for three months, the household reported feeling pleased with their choice to upgrade their latrine. Most critically, all household members no longer worried about their pit filling up, a strong concern they noted prior to upgrading. The household appreciated the simplicity of the ADP's design because it can treat pathogenic sludge, making it safe to empty, using a relatively simple technique (i.e., storage treatment⁸). The household's members plan to discuss the design of their ADP, its advantages, and how to

operate it with their neighbors, and expect that more households in their community will upgrade their existing single-pit latrines to ADPs in the near future.

3.2 Survey with stakeholders

The five government officials that were surveyed in the first visit generally lacked knowledge of and experience with rural sanitation. Three of five defined FSM accurately and had been involved in activities related to sanitation and hand-washing, but none had observed or participated in the opening of a pit lid to check sludge depths.

All officials were excited by ADPs after learning that they provide on-site FS treatment and mitigate the households' concerns about pits filling. They noted that rural households would enjoy not worrying about their pits filling but would dislike the increased cost and space requirements of ADPs. The officials also indicated that rural households' current lack of awareness and acceptance of ADPs will likely pose challenges to constructing ADPs in this region of Cambodia.

In the fourth visit, six government officials and one mason were asked about on-site FS treatment and their opinions about the effectiveness and design of this study series. They all reported that this study and its results were valuable and helpful to rural households, specifically regarding FSM and on-site FS treatment. They believed that villagers now have a better understanding of sanitation, including the importance of safe FSM and how to use an ADP.

These stakeholders also reported learning a lot about sanitation from this study, including the following topics: how to open pits to check sludge levels during both wet and dry seasons; how to facilitate and enable a community to upgrade their single-pit latrine to an ADP voluntarily; how on-site FS treatment works and what is required to perform on-site treatment; and that no pit-emptying service is needed after upgrading to an ADP, which saves households money. Some were encouraged by their learning and attended the online FSM training and field study visit in Pursat and Kratie provinces in June 2020. One representative from MRD-DRHC also attended an FSM training in India that was funded by UNICEF.

The stakeholders surveyed at the end of this study were able to define the term "FSM" and recall most of the important functions and general importance of ADPs, and how they compare to single-pit latrines, including their ease of emptying, being able to use FS as

fertilizer, how to switch between pits when one pit fills, and how ADPs reduce sanitation costs over time compared to emptying pits.

Unfortunately, the term “on-site treatment” remained incorrectly understood by all interviewees, who used the following phrases to describe on-site treatment: “keeping human faeces in one place within a pit”, “no open defecation”, “do not let the faeces out of pit”, and “a double-pit latrine”. However, they did consider on-site treatment important for many reasons, including preventing infection, reducing smell, reducing harm to the environment, and saving rural households money.

ADPs were strongly preferred by all stakeholders compared to single-pit latrines. When asked what type of latrine they would build, they stated that they would build an ADP because it lasts longer than a single-pit latrine even though it costs more; does not need to be emptied by a trained professional to be emptied safe; and the household would not have to worry about a pit filling up anymore. They believed that their communities would prefer an ADP to a single-pit latrine because ADPs provide more beneficial functions, advantages and last longer, despite costing more.

4. Conclusions and the ways forward

Safely managed sanitation is critical to public and environmental health but has been difficult to achieve in rural areas due to difficulties in providing safe and affordable pit-emptying services. An alternative to pit emptying is on-site treatment, which can be achieved using ADPs that allow rural households to manage their own FS on-site safely. The results of this study highlight the demand for ADPs in two rural Cambodian communities and the need to promulgate the design of ADPs to local government officials and masons that build and repair latrines in the study region and likely across rural Cambodia.

As part of a highly integrated and interactive community based on trust and connection, rural Cambodian households tend to promulgate new information to their neighbors with excitement. In this study, for example, the household that upgraded their latrine to an ADP was excited to discuss their ADP, its design, advantages and operation with neighbors. This interactivity among rural households presents a pathway to disseminate awareness about ADPs and encourage rural households to

upgrade their latrines when needed, as noted in other studies. Campaigns targeting ADP adoption in rural Cambodia should consider this interactivity among rural households when promoting ADPs, and the effectiveness of neighbor-to-neighbor communication should be formally evaluated.

The decisions of households when designing, purchasing, maintaining and upgrading their latrines were also strongly influenced by the opinions of village chiefs and masons, and the examples of neighbors. Although this fact of rural Cambodian society may initially appear to present a barrier to promulgating and encouraging a new sanitation product like the ADP to be purchased and used as designed, we recommend taking advantage of this interactivity between rural households and their communities by targeting behavior change campaigns and marketing of ADPs towards local government officials and masons that construct and maintain latrines. This pathway towards safely managed sanitation will not only improve adoption of ADPs in rural Cambodia but also build the local capacity of change agents about safely managed sanitation in rural Cambodian communities.

Households' consistent use of latrines, their continued functionality and evidence of adequate maintenance indicate strong behavioral adoption of latrine use and the household's continued interest in using their latrines in the future. While evident latrine adoption is indeed a step towards safely managed sanitation, the lack of a path forward to continue safely managing these households' FS highlights the urgent sanitation problem that must be solved in rural Cambodia. ADPs have been shown to be an effective path forward towards safely managed sanitation;¹⁴ however, the behavioral inertia of upgrading a relatively recently built (within the last 6 years in this study) single-pit latrine to an ADP and the relatively high associated costs pose strong barriers to households adopting ADPs. The frequently changing plans and opinions about ADPs of the households in this study are also evidence of this phenomenon.

¹⁴ Hussain, F.; Clasen, T.; Akter, S.; Bawel, V.; Luby, S. P.; Leontsini, E.; Unicomb, L.; Barua, M. K.; Thomas, B.; Winch, P. J. Advantages and Limitations for Users of Double Pit Pour-Flush Latrines: A Qualitative Study in Rural Bangladesh. *Bmc Public Health* 2017, 17, 515. <https://doi.org/10.1186/s12889-017-4412-7>.

Future studies of household FSM in rural Cambodia should interview more households (at least 30) in different regions (at least 2 districts) to provide more comprehensive and useful results. For example, a specific month could not be identified as when households felt most financially stable in this study; a larger sample size would likely allow such a month to be identified. Questionnaires should also be developed with and reviewed by MRD-DRHC, and translated into Khmer to ensure that local priorities are addressed, and that locals can understand the questions easily, respectively. While households were excited that FS treated on-site with an ADP could be used as fertilizer safely, future research should build upon past research and investigate the real-world adoption of FS-based fertilizers in rural Cambodia and the viability of businesses that collect and sell FS-based fertilizers.¹⁵ Future surveys should also be pilot-tested to ensure ease of understanding and improve response quality. Most of these suggestions for future research were echoed by some of the government officials interviewed in December.

Based on the results of this study, we recommend that the design, testing, marketing and construction of ADPs across rural Cambodia be accelerated because on-site treatment is likely the best path forward to achieving safe rural FSM in Cambodia. Awareness among latrine installers and associated training must be improved, focusing on the high-quality design and construction of ADPs, including accurate costs of materials and labor to install an ADP and to upgrade an existing single-pit latrine to an ADP, including suggested margins. We estimate that upgrading to an ADP should cost between 150,000 and 200,000 Riel based on a latrine's location, distance, and other factors; this price should be negotiated and agreed to by the mason and household prior to construction. A finalized high-quality ADP design and demonstration ADP systems in various rural communities should also be used and shared with interested parties, including all levels of government, development practitioners and masons.

Masons should be encouraged to consider the effects of site selection when constructing a new latrine or upgrading a single-pit latrine to an ADP. Flooding can be present only in specific areas of a given property; thus, latrines should be placed

¹⁵ iDE Cambodia. Waste Management Pilot Project, End of Project Report. 2011.

on areas of high ground when possible. Brief but detailed consideration of this topic can mitigate latrine disfunction during the wet season and improve rural FSM safety.

The rural sanitation sector of Cambodia has made marked strides towards safely managed sanitation in recent decades. Focusing on installing ADPs across the country will likely allow safe FSM to be achieved more quickly than via other pathways, such as increasing access to and the quality of trained rural pit-emptying services. By coordinating and collaborating directly with local, district, provincial and national leaders as well as masons and development organizations, effective and wide-spread implementation of ADPs can be achieved to improve rural FSM safety across Cambodia.