Towards Safer Water: A Comparative Study of Two Types of Household Filters in Venezuela

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PICTURE: LIZ GARCÍA, JACKELINE KABBAS, MAYERLIS BARRETO.

Glossary & Acronyms

List	
Aquatabs	Effervescent chlorine tablets containing sodium dichloroisocyanurate (NaDCC) designed to kill waterborne micro-organisms.
ADRA	Adventist Development and Relief Agency.
CBTs	Aquagenx Compartment Bag Tests that indicate most probable numbers of E. coli and total coliforms simultaneously in 100ml water samples. Aquagenx results span six categories. In this study the “Safe”, “Probably Safe” and “Possibly Safe” categories are sometimes referred to as a ‘Low Risk’. The “Possibly Unsafe”, “Probably Unsafe” and “Unsafe” categories are referred to as the ‘High Risk Range’.
ECFs	Ecofiltro ceramic filters. A gravity fed filtration unit produced from clay, activated charcoal and colloidal silver by Ecofiltro, a social enterprise. Weighing 5.6 kg it includes a 22 litre plastic bucket, and is promoted by the manufacturer as capable of removing bacteria and sediment at a rate of 2 litres/hr over a working life up to 3 years.
mWater Surveyor	An application used to map water sources and sanitation facilities with GPS coordinates or to conduct location specific surveys.
PointOne	Manufactured by Sawyer Products, PointOnes are a compact, gravity fed 0.1 micron absolute hollow fiber membrane filter designed to remove bacteria, protozoa, cysts and microplastics at the rate of 32.8 to 46.5 litres per hour. When used with a bucket, connection pieces, gravity tubing, cleaning plunger and instructions, the manufacturer claims the design allows for aggressive backwashing with a restoration rate of 98% and working life of up to 10 years or 100,000 gallons or 378,000 litres.[1]
POU	Point of Use. Filtration devices used in homes including Ecofiltro ceramic filters and Sawyer PointOnes.
SEM	Scanning Electron Microscope. Microscopy using a beam of electrons that reacts with the atoms in a sample to reveal information about its surface topography and composition, including fouling and damage.
UGAVII	Una Gota de Amor para Venezuela II (UGAV-II). A project to improve the food security, nutrition awareness, access to safe water and hygiene supplies for 5,100 families in the cities of Barquisimeto and Caracas in Venezuela.
WASH	Water Sanitation and Hygiene.
WHO	World Health Organization.

[1]Rating of up to 100,000 gallons advertised on Aquagenx online product pages. Use instructions available at Aquagenx, 2025. “CBT EC+TC Kit: Portable Quality Test Kits for P/A and MPN Test Results.” Available from https://www.aquagenx.com/how-to-use-cbt-ectc/.

Executive Summary

In 2023 and 2024, the Adventist Development and Relief Agency in Venezuela (ADRA/V) distributed 2400 PointOne and 300 Ecofiltro[3] ceramic filters to households in humanitarian projects funded by ADRA International. The distribution of both filter types, accompanied by a comparative study, was a first of its kind activity for ADRA in South America.[4] Using a mixed-method approach, the study utilized data from household surveys, Compartment Bag Tests (CBTs), focus group discussions, physical inspections, scanning electron microscopy (SEM) and interviews with water, sanitation and hygiene (WASH) project staff.[5]

In Phase I of the study, WASH staff recruited 38 PointOne recipient families for household surveys at 3 months, and a further 66 at approximately 12 months. During this period the WASH team conducted physical inspections of PointOnes and acquired input (influent) and output (filtrate) water samples for CBTs. CBTs were completed during the first three months of use (38 households) and at a single point in time after 12 months. Scanning Electron Microscopy (SEM) was used for post-mortem analysis of fouling of 6 PointOnes after three months use and a further 7 PointOnes after 12 months use.

In Phase II of the study, WASH staff recruited 38 Ecofiltro ceramic filter (ECF) recipient households for a similar study. These households participated in household surveys and CBTs 3 and 6 months after distribution using the methods described above. Post-mortem analysis of ECFs using SEM was attempted on 3 ceramic filters, but difficulties in sectioning samples prevented analysis.[6]

> **"In phase one of our study, we used Sawyer PointOne filters; however, in phase two, we experimented with ceramic Ecofiltros. It was fascinating to compare these two types."**
>
> *—Mayerlis Barreto*

Phase I – PointOnes	Phase 2 – ECFs
PointOne performance declined more rapidly than expected. After 12-16 months of use, 56% of filtrate samples subjected to CBTs did not meet the WHO guidelines of zero E. coli per 100ml.[7] Filtrate samples in the Aquagenx 'High Risk Range' increased from 6% after one month, to 23% over 3 months and 39% after 12-16 months.	ECF performance declined less rapidly than expected. After 6 months of use, 18% of filtrate samples did not meet WHO guidelines of zero E. coli per 100ml. Filtrate samples in the Aquagenx 'High Risk Range' increased from 11% after 3 months, to 18% after 6 months.
Satisfaction with PointOnes declined over 12 months with 27% of recipients expressing concern about limitations and 12% no longer recommending distribution. In the 3-month household survey all 38 beneficiaries reported high or very high levels of user satisfaction. A paired samples T-Test comparing satisfaction at 3 months and 12 months revealed a significant statistical difference with lower satisfaction on all measures after one year. However, after 12 months most participants still indicated that they were moderately or highly satisfied with taste (97%), volume (86%), speed of filtration (55%), ease of maintenance (85%) and impact on child health (90%).	Satisfaction with ECFs remained high over 6 months with 100% of recipients recommending distribution to other families. After 6 months most participants indicated that they were moderately or highly satisfied with taste (97%), volume (92%), speed of filtration (92%), ease of maintenance (97%) and impact on child health (95%).

[3] Electron Scanning Microscopy was performed on PointOnes only.

[4] An initial study of PointOne efficacy over 3 months is documented in Brad Watson, Victoria Fray, and Nestor Mogollon, "A Drop of Love: UGAVII 2023 Sawyer PointOne Study," ADRA International, 2024.

[5] SEM analysis was facilitated by professors Daniele Lantagne and Ayse Asatekin, with testing by Ashleigh Herrera at Tufts University.

[6] Ecofiltro samples were sent to Tufts for analysis. However, splitting cross sections for analysis was problematic and therefore discontinued.

[7] Percentages in this executive summary are rounded to the nearest per cent..

Post-mortem analysis of PointOnes confirmed significant fouling at 3 and 12 months of use. High resolution imagery showed both external and internal fouling of hollow membranes that was likely to compromise water quality.	Post-mortem analysis of ECFs was attempted however was not possible due to difficulties in analyzing cross-section samples.
Correct PointOne maintenance was observed for 79% of systems inspected. However, after 12 months, more than half of the original recipient households were either not contactable by ADRA staff or using their filters. This suggests a higher potential rate of filter failure than measured.	Correct ECF maintenance was observed for 79% of systems inspected. All recipient households were still using filters after 6 months.
Most, if not all PointOne recipients are unlikely to replace the filters. A lack of availability and replacement parts in Venezuela, combined with a unit cost in excess of USD $50 when purchased internationally by ADRA, raises serious questions about sustainability.	Some ECF recipients are likely to replace the filters. This is due to high user levels of satisfaction, an apparently longer working life, and availability via local distribution networks. The current replacement cost of the ceramic component is USD $60.
Sharing CBT results and images with PointOne filter recipients is a powerful behaviour change tool, especially when accompanied with SEM images of fouled filters.	In the absence of SEM images for ECFs, the provision of timely, visual CBT results continues to motivate sustained behaviour change.

Recommendations

ADRA/V WASH staff view PointOnes a useful, low-cost POU filtration system when accompanied by high levels of user education, ongoing support of vulnerable households, regular CBT result sharing with beneficiaries and provision of adequate warnings about safe use periods and disposal. Because of rapid declines in filter performance beyond 3 months, ADRA recommends cessation of use for many households by 6 months and close follow-up of users as a protective measure. It is noted that replacement PointOnes are not readily available and internal fouling is invisible to users. Problematically, PointOnes may appear to work faster as membranes tear and lose effectiveness.

Although ECFs are fragile and relatively expensive to replace, ADRA/V WASH staff were pleasantly surprised with their performance over the 6 months they were studied. High levels of user satisfaction, ease of maintenance and the visibility of fouling, combined with strong performance over time, led to the preliminary conclusion that they are a more viable option for use by low-income families in a Venezuelan context. Further research over a period of 12 months is needed to test this conclusion and compare performance to PointOnes.

> **"Although Ecofilters are fragile and relatively expensive to replace, ADRA staff were satisfied with their performance over a six-month period."**
>
> *—Brad Watson*

Context & Literature Review

Hollow membrane water filters (including PointOnes) are increasingly distributed in humanitarian emergencies and community development settings because POU filtration is considered cost-effective and can be easily sourced or rapidly deployed while providing immediate benefits compared to centralized treatment solutions.

Research on the physical performance of PointOnes has been conducted in an increasing number of low and middle-income country settings, with mixed results. A 2015 article published in the Journal of Water, Sanitation and Hygiene for Development by Murray and colleagues, reported on the fouling of PointOnes in Honduras, verified by Scanning Electron Microscope (SEM) analysis of 6 specimens. Notably, water turbidity was high.

> *…six PointOnes were removed from Honduran homes after 23 months of use… we imaged membranes with scanning electron microscopy and characterized surface elemental compositions with spectroscopy. Images and spectroscopy of the used, cleaned membrane revealed a dense, cake fouling layer consisting of inorganic metal oxides, organic material, and biofouling. Burst fibers were visually observed. This PointOne was thus irreversibly fouled and non-functional after <2 years of use. Further research is recommended to determine: impacts of source water quality on PointOne performance, a cleaning regimen to manage fouling, and an appropriate filter lifespan.*[8]

In a follow-up article on the Honduran study, Murray and colleagues found that 1-3 years after receiving the hollow membrane filters, only 30% continued to comply with WHO water quality standards with no detectable E. coli per 100 mL.[9]

A 2019 article published in the same journal by Holding and colleagues, reported on SEM testing of filters collected from South Sudan where water turbidity was also high.

> *773 PointOnes were distributed. For 13 months after distribution, household surveys were completed quarterly, water quality testing was conducted monthly, and post-mortem analysis was completed at study midline to assess acceptability, effectiveness, and membrane fouling, respectively. Recipients found PointOnes acceptable, with high rates of demonstrated correct use (97–100%) and correct backflushing (96–100%). PointOnes effectively reduced thermotolerant coliforms for four months. When surface water use increased, effectiveness dropped, with 38% of filtrate samples contaminated. After backflushing filters with 0.2% chlorine solution, effectiveness improved; however, 5–38% of PointOne filtrate samples remained contaminated over subsequent months. Irreversible fouling was documented during post-mortem analysis.*[10]

Other studies have assessed health outcomes using qualitative methods. A 2021 article published in the journal Tropical Medicine and Health gathered data from 16 villages over 200 days in the Dominican Republic and assessed reported diarrhoea incidence in four settings: home and school; home only; school only; a control group. In this study, Tintle and colleagues found that:

> *Self-reported household prevalence of diarrhea decreased from 25.6 to 9.76% from installation to follow-up (at least 7 days, and up to 200 days post-filter installation)… There was no evidence of a loss of efficacy of filters up to 200 days post-filter installation. Installation of filters in schools was not associated with decreases in diarrhea prevalence in school-aged children or family members.*[11]

A 2019 study involving Give Clean Water, Inc. in partnership with the Fiji Ministry of Health, evaluated PointOnes in 503 households prior to distribution and a second time between 19 and 225 days later (mean = 66 days). The researchers reported:

> *…2-week diarrhea prevalence decreased in households from 17.5% at baseline to 1.8% at follow-up. Also, the 2-week prevalence of severe diarrhea decreased per household from 9.7% at baseline to 0.6% at follow-up. Finally, monthly diarrhea-related medical costs reduced by an average of Fijian (FJ) $3.54 per person, and monthly water expenses reduced by FJ $0.63 per person.*[12]

Other studies have focused on filter maintenance and component longevity. In their paper, *Evaluating filter functionality and user competence after a hollow fiber membrane filter intervention in Liberia,* Alford and colleagues reported surveying 30,154 eligible

[8] Anna Murray et al., "Fouling in hollow fiber membrane microfilters used for household water treatment," Journal of Water, Sanitation and Hygiene for Development 5, no. 2 (2015): 220-228.
[9] Anna Murray et al., "Laboratory efficiency and field effectiveness of hollow fiber membrane microfilters used for household water treatment in Honduras," Journal of Water, Sanitation and Hygiene for Development 7, no.1 (2017): 74-84.
[10] Shannon Holding et al., "Acceptability, effectiveness, and fouling of PointOne membrane filters distributed in South Sudan," Journal of Water, Sanitation and Hygiene for Development 9, no. 2 (2019): 247-257.
[11] Nathan Tintle et al., "Diarrhea prevalence in a randomized, controlled prospective trial of point-of-use water filters in homes and schools in the Dominican Republic," Tropical Medicine and Health 49, no. 1 (2021): 1-14.
[12] Nathan Tintle et al., "Evaluating the efficacy of point-of-use water filtration units in Fiji," Tropical Medicine and Health 47, no. 1 (2019): 1-7.

households, evaluating both the proportion of filters in proper working order at approximately 2 and 8 weeks post-intervention and the proportion of households that could correctly use and properly backwash the filter. Although they saw emerging needs for affordable repairs and replacement of filters, the authors argued:

> *A short-term follow-up supports intervention sustainability in these areas, with the majority (over 95%) of filters functioning properly and the majority of households (over 90%) properly demonstrating filtering and backwashing after 8 weeks.*[13]

An unpublished 2023 ADRA Madagascar pilot study assessed the performance of 0.01 micron hollow fiber filters and a dual bucket system (Société Malgache de Transformation des Plastiques- SMTP) distributed to 400 households in four fokontany (villages) in the rural commune of Ejeda. ADRA's 3-month pilot study recruited 40 households for Aquagenx CBT testing on filtrate (for E. coli and total coliforms) and found the percentage of households consuming water with measurable E. coli levels reduced from 90% to 1% after one month. After approximately 2 months of use, 51% of filters appeared somewhat clean, while 22% were visibly dirty.[14]

By way of comparison, ceramic filters can also be problematic in terms of robustness and longevity. In a follow-up study of a ceramic filter distribution project in Cambodia, Brown and colleagues found that 31% of 500 household recipients who had received filters in the past 4 years, still used their filters regularly.[15]

Taken collectively, the studies above indicate a need for further investigation of hollow membrane filter performance and longevity in diverse settings. SEM studies suggest that safe working life is likely to be compromised (fouling- organic and inorganic, caking and internal tearing) by use of high-turbidity influent, irregular backwashing, compromised maintenance and water sources with high organic and inorganic loading. Complementary field testing for E. coli levels can be readily undertaken with Aquagenx CBTs where other microbial water quality testing resources are not readily available.[16]

[13] Kristin R. Alford et al., "Evaluating filter functionality and user competence after a hollow fiber membrane filter intervention in Liberia," Journal of Water, Sanitation and Hygiene for Development 12, no.12 (2022): 851–861.
[14] Tinotenda Muvuti, Edouard, Raelson, Edino Noelson, and Rudy Andrianaivo, "Effectiveness of Membrane Filtration to Improve Drinking Water Quality: A Field Trial from Rural Southern Madagascar," ADRA International (2023).
[15] Joe Brown, S Proum and Mark Sobsey, "Sustained use of a household-scale water filtration device in rural Cambodia," Journal of Water and Health 7, no. 3 (2009): 404-412.
[16] Christine Stauber, Candace Miller, Britany Cantrell and Kate Kroell, "Evaluation of the Compartment Bag Test for the Detection of Escherichia coli in Water," Journal of Microbiological Method 99, no. 1 (2014): 66-70.

Design & Methodology

Overarching Research Question

Are PointOne and ECFs effective in improving sustainable access to potable water in vulnerable Venezuelan households?

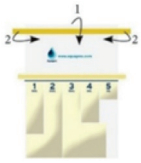
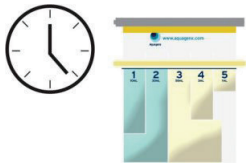
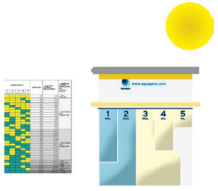
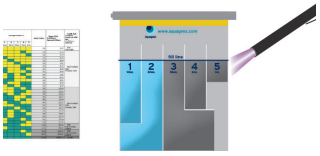
Design

The study design for PointOnes and ECFs incorporated a mixed-method approach utilizing both qualitative and quantitative data. All participants in the study were volunteers and provided informed consent.

Data Set 1—Household surveys. PointOne recipient surveys (n38) were conducted after 3 months of use in August 2023 (n38), then with an expanded group (n66) after 12-16 months use. ECF recipients were surveyed after 6 months use in late 2024 (n38). All face-to-face interviews took place in homes after informed consent was provided. Data was logged in mWater with GPS coordinates for each household and a photo of the home. SPSS was used for statistical Analysis.

Data Set 2—Aquagenex Compartment Bag Tests (CBTs) were conducted by the WASH team for PointOne recipients (n38) for 3 consecutive months after initial distribution, and then again after 12 months (n76) to measure presence of E. coli in influent and filtrate samples. The same process of pre and post filtration was used to with ECF recipients (n38) after 3 and 6 months use.

The process below was followed for testing:

Collect 100 mL Sample	Add Powder Growth Medium	Pour Sample into Compartment Bag	Roll Down Whirl-Pak Seal & Attach Plastic Clip
			
Incubate 20–48 Hours	**Score EC Test Results in Ambient Light**	**Score TC Test Results under UV Light in Dark Environment**	**Decontaminate Sample**
			

ABOVE: TESTING PROCEDURE FROM SAMPLE COLLECTION TO DECONTAMINATION

Samples were then Recorded in the Following Categories:
a. Safe
b. Probably Safe
c. Possibly Safe
d. Possibly Unsafe
e. Probably Unsafe
f. Unsafe

ABOVE: AN IDEAL SERIES OF CBT RESULTS FROM A HOUSEHOLD SHOWING, FROM LEFT TO RIGHT, HIGHLY CONTAMINATED WATER BEFORE FILTRATION (LEFT) AND LOW OR NO E.COLI OR COLIFORM COUNTS AFTER FILTRATION AND AQUTAB USE (MIDDLE AND RIGHT).

All CBT data was logged in mWater with a photo of each CBT result. Additionally, the WASH team randomly sampled an average of 31 PointOne recipient households for concurrent CBTs over 3 months (n93) in one-off testing of PointOne filtrate. The purpose of this was to validate CBT results collected.

For the purpose of analysis, the World Health Organization guideline of zero measurable E. coli per 100ml of filtrate was used. In addition to WHO guidelines, CBT results were split into a 'High Risk Range' ("Unsafe", "Probably Unsafe", "Possibly Unsafe") and 'Low Risk Range' ("Safe", "Probably Safe", "Possibly Safe") using Aquagenx most probable scores.

In instances where influent tested negative for E. coli, results were excluded from analysis on the assumption that influent water was already safe.

Data Set 3—Semi-structured individual interviews (n8) with ADRA WASH staff and field assistants took place 3 months after PointOne distribution and 6 months (n5) after ECF distribution. Each staff member was interviewed using set questions, both in writing and in a follow-up interview.

Data Set 4—Participatory, focus group discussions for 5 PointOne beneficiary groups (n31) and 1 ADRA WASH team group (n6) took place at 3 months. The process was replicated with 2 ECF beneficiary groups at 6 months (n13). ADRA staff were trained to use a participatory, dot-voting method to acquire satisfaction feedback. This was not replicated with PointOne recipients at 12-16 months due to the difficulty of access during elections and pauses in project activity.

Data Set 5—Convenience sampled PointOnes were shipped to Tufts for disassembly, visual inspection, and SEM analysis after 3 months (n6) and 12 months (n7) use. This included a control PointOne used daily by project staff with contaminated water, accompanied by a strict regime of maintenance and backflushing with chlorine.

PICTURE: MAYERLIS BARRETO, LEADER OF THE WASH TEAM, VISITING A POTENTIAL FAMILY.

Study Limitations

The study compares the performance of two types of filters using a mixed-methods approach that was adapted on an ongoing basis to real-world conditions within two humanitarian projects.

Variance in Influent: The study did not gather influent turbidity data using recognized testing procedures and in some cases relied on visual inspections. It was therefore not possible to contextualize filter performance across sites or for seasonal water use.

Conflicts of interest: All data was collected by project staff during the cycle of project activity. For household surveys and focus groups, there was potential for community members to provide more favourable feedback than would be the case where external enumerators were used and participant anonymity guaranteed.

Sample size: Small cohorts of 38 participants were chosen for PointOne and ECF household recipients out of pragmatic respect for the commitments of busy project staff tasked with collecting data. Considering 2400 PointOnes were distributed, the sample size represented 1.6% of recipient households. In the case of Ecolfiltros, it represented 9.5%.

Duration differences: While project staff were successful in following the same PointOne recipients over 3 months, this was not possible over 12 months due to attrition, households moving and changes in project location. ADRA therefore expanded the study to 76 recipients, many of whom had not been surveyed earlier. Further, some surveys and water samples were collected at 16 months due to elections and security concerns. By way of comparison, the ECF study concluded after following the same recipients at 3 and 6 months.

Participant selection: All participants were chosen randomly using preliminary water test results showing high levels of exposure to E. coli. Some subsequent CBTs found zero levels of E. coli in influent samples, necessitating their exclusion, resampling, and consequent reductions in sample sizes.

Storage of filters for SEM: Extensive delays occurred between collection of filters, shipping to Tufts, and post-mortem analysis. In some cases, this led to storage periods of several months.

Ecofiltros

THE ECOFILTRO UNIT CONTAINS A PLASTIC BUCKET WITH A REPLACEABLE CERAMIC INSERT CONTAINING ACTIVATED CARBON.[17]

[17] Images courtesy of EcoFiltro Venezuela, https://ecofiltrovenezuela.com.

Compartment Bag Test Results

2400 PointOnes were distributed by ADRA. CBTs on influent and filtrate were completed in three successive months for the same 38 recipient households. Between 12 and 16 months of PointOne use, 76 household recipients participated in a final round of CBTs. Of these households, 16 were from the group studied in the first three months.

19 of the 76 influent samples were deemed invalid because CBTs found no measurable levels of E. coli prior to filtration. Of the remaining 57 influent samples, 41 (71.92%) were deemed to be 'High Risk' because prior to filtration, they scored results in the "Unsafe", "Probably Unsafe", or "Possibly Unsafe" categories of the Aquagenx rating scale. The remainder (28.07%) were considered 'Low Risk' because they scored results in the "Safe", "Probably Safe", or "Possibly Safe" categories.

As can be seen below, 23.07% of PointOne filtrate samples tested in the 'High Risk Range' after 3 months, increasing to 38.6% by 12-16 months. The percentage of samples not compliant with WHO guidelines of zero E. coli per 100 ml ranged from 40.75% to 43.86%. The results are especially grim when we look at high-risk influent samples after filtration. In this case, 53.65% of PointOnes did not move filtered water into the 'Low Risk Range'. Additionally, up to one-third of PointOne users had stopped filtering by 12 months, leaving the authors of this study to wonder if the real failure rate was much higher.

PointOne results at 3 and 12–16 months:

Month	HHs tested	Filtrate Aquagenx 'Low Risk Range'	Filtrate WHO 'Low Risk Range/Safe' (zero per 100ml)	Comments
3	39 (27 valid)	23.07%	59.25%	CBTs on a control group of 32 households similarly found that 21.87% of filtrate samples were in the Aquagenx high risk categories. In this group, 34.4% did not meet WHO guidelines of zero E. coli per 100 ml.
12+	76 (57 valid)	38.60%	56.14%	After filtration, 38.60% were still in the Aquagenx high risk categories. 56.14% did not meet WHO guidelines of zero E. coli per 100ml.

A total of 300 ECFs were distributed with 38 recipients recruited for influent and filtrate CBTs at 3 and 6 months. 6 of the filtrate samples were deemed invalid in the first round and 10 in the second round because influent showed no measurable E. coli.

ECF results at 3 and 6 months:

Month	HHs tested	Filtrate Aquagenx 'High Risk Range'	Filtrate WHO 'Low Risk Range/Safe' (zero per 100ml)	Comments
3	38 (32 valid)	10%	28.12%	90% of filtrate samples moved from the 'High Risk Range' to the 'Low Risk Range'. 71.88% of filtrate samples were "Safe" according to WHO guidelines.
6	38 (28 valid)	11.11%	17.86%	88.89% of filtrate samples moved from the 'High Risk Range to the 'Low Risk Range'. 82.14% of filtrate samples met WHO guidelines of zero E. coli per 100ml.

Ideally, this study would have compared CBT results over a 12-month period for both PointOnes and ECFs. Nevertheless, the performance difference is substantial at 3 months and based on ECF CBT tests at 6 months, ADRA WASH staff predict that ECFs will continue to outperform PointOnes when used in households with low socio-economic status and low levels of hygiene. Despite this unanimous view, there is a case for PointOnes to be used for beneficiaries who are motivated to clean them regularly. According to the WASH coordinator, *"I still maintain that the Sawyer filter is a good filter, has a good system and can be effective...for more than a year, but it depends completely on good care, so for these families in vulnerable situations and with little knowledge and poor hygiene habits, they are not a good option to guarantee safe water."*

ADRA WASH staff have concluded that PointOne performance in field conditions is compromised by irregular backflushing, inadequate use of chlorine, backflushing using contaminated water and insufficient cleaning of components. The invisibility of internal fouling also hinders motivation to maintain PointOnes. This is not to refute the proficiency of PointOnes in optimal conditions. In the words of one team member, *"...after further analysis and discussions with the team, the conclusion is not that the filter is ineffective, but rather that user interaction is determining the results obtained."* By contrast, ECFs are easy to inspect, clean and maintain over time.

Household Survey Results

A household survey for PointOne recipients was successfully completed after 3 months of use (n38), then between 12 and 16 months (n66). The same survey was completed with ECF recipients (n38) 6 months after distribution.

The most consistent themes arising from comments in the household survey for PointOne recipients after 3 months use was improvements in family health (n21) and taste (n9). A selection of comments can be seen below, and were largely repeated after 12 months.

Comments from PointOne recipients after 3 months use:

"Before in the family there were many stomach diseases... the diseases have decreased. In addition, now the water before drinking looks transparent after filtering because it comes from the very dirty pipe."

"Water consumption has increased since the taste is pleasant."

"Good changes because now the taste of the water is much better and now the water is much clearer."

"Thanks to the filter I consume treated water and my family has not gotten sick anymore."

An increased level of user concern about PointOnes after 12 months use can be seen in the comments below, although the recipients continued to identify positive benefits on health, taste, and expenditure. This was surprising given water test results that indicated more than 55% of filtrate did not meet WHO standards, and half of 'High Risk Range' influent samples remained in the 'High Risk Range' after filtration. We speculate that continued enthusiasm about the impact of PointOnes after 12 months is a legacy of positive experiences in the first 6 months of use, a desire to affirm ADRA staff, and perceptions that most filters were making some sort of positive difference even when not working properly. This conflict between high levels of perceived effectiveness (revealed in surveys) and low levels of actual microbiological safety (indicated by CBTs) indicates a positive bias that is likely to be harmful to users.

PICTURE: BARQUISIMETO TEAM CONDUCTING HOME VISITS

Comments from PointOne recipients after 12 months of use:

Would you recommend the filters to others?	What good or bad changes have occurred?
"Yes. For a short time yes."	*"The family hardly gets sick from diarrhea or stomach pains."*
"Yes. It doesn't last long but can be used."	*"The water is very pure and we don't have stomach pains."*
"No. Because it doesn't last as long as it should."	*"Good changes. The quality of the water is better, children do not get sick and it is easier to have clean water."*
"Yes. While it is in it's optimal state."	*"Good changes because before I had to boil a lot of water and used a lot of gas. Now I can save water. And our stomachs don't hurt as much anymore."*
"Yes. Because it is an easy way to improve the quality of water in the house."	*"Good changes. Now we spend less money buying filtered water. We can do it at home and it is easier to consume more water daily."*

A paired samples T-Test comparing satisfaction with the PointOnes at 3-months vs 12-months revealed a significant statistical difference with significantly lower satisfaction on all measures after one year. However, most participants still indicated that they were moderately or highly satisfied with Taste (97%), Impact on child health (90.3%), Volume (86.4%), Ease of maintenance (84.6%) and Speed of filtration (54.6%). These high rates of satisfaction were surprising given a precipitous decline in filter performance. Anecdotally, project staff consider that most PointOne users believe that *"something is better than nothing" and "Even if it is not working properly, at least is it doing some good."*

A comparison of key data from the PointOne and ECF household surveys can be found below. Notably, median age of participants, status as heads of the home, gender, number of family members, children under five, and rates of correct filter maintenance were similar. However, ECF users were more likely to use piped water (94.7% vs 64.6%)[18] and filter less than 20 litres of water daily (63.2% vs 23.8%). They were also more satisfied with the speed of filtration, ease of maintenance, and were therefore more likely to recommend them to others. Direct comparison is problematic given that the PointOne survey was conducted at 12 months, while the ECF survey was at 6 months. Nevertheless, this is provided below.

PointOne and ECF Household Survey Data

	PointOne Household Survey 12–16 months	ECF Household Survey 6 months
Mean age	43	39
Heads of home	95%	97%
Gender	95.5% Female	94.7% Female
Members per HH	5.6	6.3
Children U5 per HH	1.4	1.3
Drinking water sources	Piped water 64.6% Trucked water 30.8% Surface water, wells 1.5% Tapstand 3.1%	Piped Water 94.7% Trucked Water 2.6% Surface Water 2.6%
Time spent daily treating water	0–30 mins day 40% 30–60 mins day 21.5% 1 hr p/w 21.5% 2 hrs day 1.5 3 hrs day 12.3 6 hrs 3.1	0–30 mins day 31.6% 30–60 mins day 31.6% 1 hr p/w 36.8%
Estimated Litres p/d	0–19 23.8% 20–39 46% 40–59 12.7% 60–79 9.5% 80+ 7.9%	0–19 63.2% 20–39 21.1% 40–59 10.5% 60–79 5.3% 80+ 0%
Correct filter use	78.79%	79%
Satisfaction	Medium High & High	Medium High & High
Taste	97%	97.4%
Volume	86.4%	92.1%
Speed	54.6%	92.1%
Ease of maintenance	84.6%	97.4%
Family health/Child Health	90.3%	94.7%
Recommend to others	88%	100%

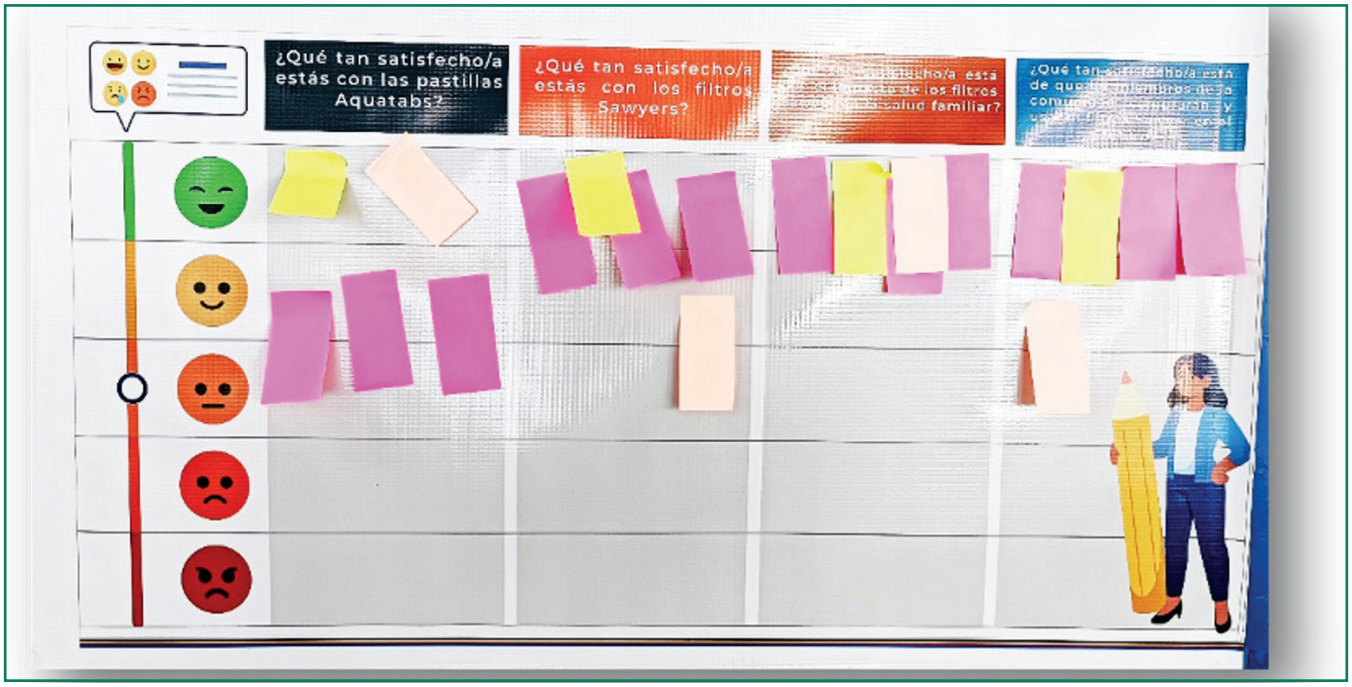
[18] According to project staff, trucked water accessed by households was from municipal water sources and therefore generally of the same quality as piped water.

Focus Group Results

Participatory focus groups for PointOne and ECF recipients were a highlight of the investigation, and participants enjoyed the activity while providing highly useful feedback. Focus groups for PointOne participants were completed at 3 months only with follow-up not possible due to election-related lockdowns and travel restrictions. Focus groups for ECF participants were conducted at 6 months.

Four key areas were chosen for discussion, feedback and voting. A comparison of the questions can be seen below:

PointOne Categories for Voting	ECF Categories for Voting
How satisfied are you with Aquatabs?	*How satisfied are you with Ecofiltros?*
How satisfied are you with Sawyer filters?	*How satisfied are you with the impact of Ecofilltros on family health?*
How satisfied are you with the impact of Sawyer filters on family health?	*How satisfied are you that community members will buy and use Ecofiltros in the future?*
How satisfied are you that community members will buy and use Sawyer filters in the future?	*How satisfied are you with the training and knowledge provided by ADRA?*



PICTURE: FOCUS GROUP ACTIVITY IN CARACAS

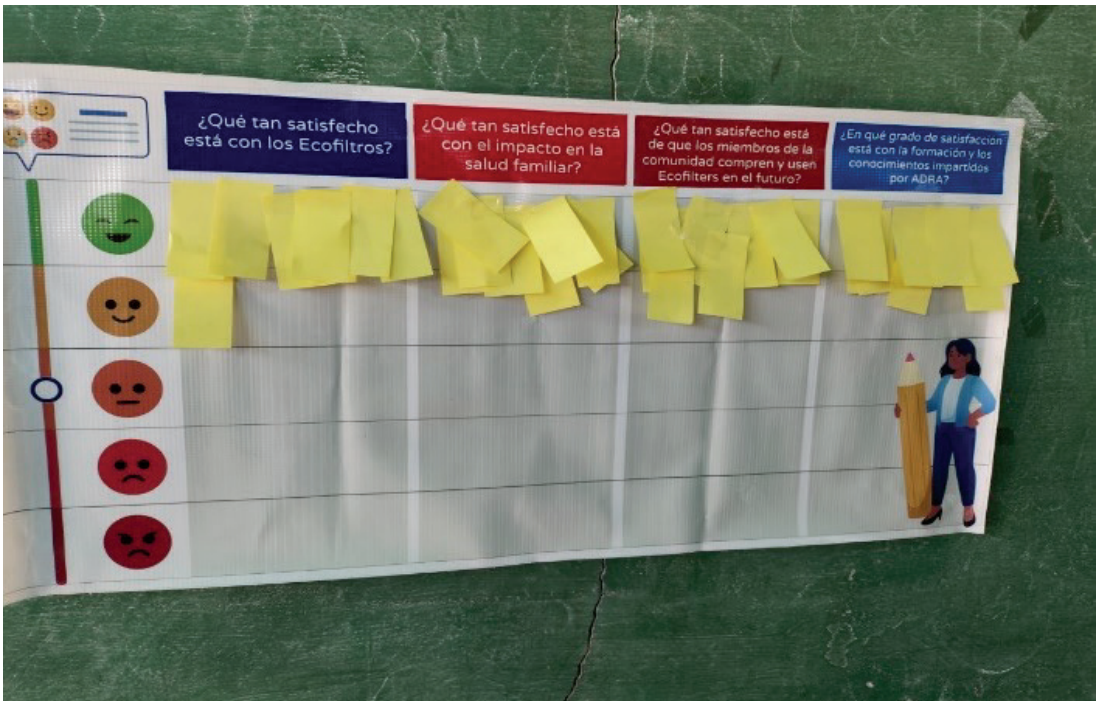
FOCUS
GROUP RESULTS

Sample comments made by PointOne recipients in Barquisimeto after 3 months of use:

Feedback
"Overall, we find the filter to be excellent."
"Before going through the filter, the water is cloudy and acquires an unpleasant green color and a bad smell."
"Before having the filter, we tried to filter the water with a cloth, but there was always residue in the buckets."
"Before having the filter, children used to get sick more, but now it happens less often."
"Cases of diarrhea and vomiting among young people are less frequent since we have the filter."
"The taste of the water after filtering is much nicer compared to tablets, which have a strong chlorine taste."
"We prefer to use the filter instead of boiling the water, since the latter method leaves residue, unlike the filter."
"The filter gets clogged with dirt, but backwashing solves this problem and improves water quality."
"We are concerned that replacing the filter every 6 months could be costly and make it less safe, so that is a concern."

PICTURE: MAYERLIS BARRETO, LEADER OF THE WASH TEAM, UNPACKING AN ECOFILTER BEFORE DISTRIBUTION.

LABORATORY TESTING RESULTS



PICTURE: FOCUS GROUP ACTIVITY IN LARA

Sample comments made by recipients of ECFs in Lara:

Feedback
"The filtration time of the Ecofiltro is much faster than the Sawyer filter."
"The water is filtered very quickly; the whole filtering unit takes about 30 minutes. After that we fill it up again, take out the jugs and put the water in the refrigerator."
"I had both the Ecofiltro and the Sawyer filter and I prefer the Ecofiltro, the Sawyer's washing process is very slow and complicated; the Ecofiltro filters faster and its cleaning is simpler, I don't need to use Aquatabs."
"I feel that the filter is educating us, because we were used to drinking water even from puddles, but now that we have the Ecofiltro the girls are asking when they are given water and they ask if it is filtered or not."
"It would be easier for the families if they could pay in installments, so it would be easier for them to have access, it is feasible."
"Very grateful to the volunteer who was in charge of me, because he was a very attentive volunteer, he went to my house to supervise the Ecofiltro and taught me how to clean it, he told me that I had to use a sponge just for that and without soap or chlorine."

Laboratory Testing Results

In 2025, 159 families received Ecofiltros. 10% (n16) of these were subjected to bacteriological testing of influent and filtrate using a Potatech+ portable water quality laboratory manufactured by Palintest. Featuring a complete set of digital instruments in a portable carry case, the kit contained an incubator, turbimter, pH sensor, and conductivity sensor with capacity to test for thermotolerant/fecal coliforms and total coliforms. Unlike prior testing of PointOnes and Ecofiltros, ADRA did not use CBTs for this phase of project activity. However, it did test water used by households prior to filter distribution (baseline) and on two other occasions at approximately 3 and 5 months.

Much to the delight of project staff, testing of 16 Ecofiltros between four and five months of use recorded coliforms in 14 of 16 (87.5%). Of those that tested positive, 100% tested negative after filtration. This was consistent with data collected at mid-term and led ADRA WASH staff to conclude that *"Ecofiltros are effective in removing coliforms from household water after more than three months use."*

Sem Results

SEM Analysis of Sawyer PointOnes

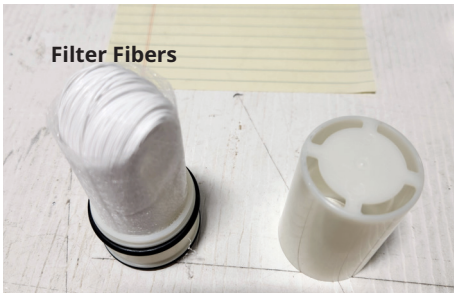
A total of 25 PointOnes were collected for Scanning Electron Microscopy (SEM) analysis and mailed to Tufts University.[19] Testing was undertaken by a Ph.D. student, Ms. Ashleigh Herrera, advised by Professor Ayse Asatekin in the Department of Chemical and Biological Engineering. Of these samples, six had been continuously used by project beneficiaries for a period of 3–4 months and six for 8-9 months. An additional 12 were used for 12 months. To enable comparison, a control filter was used and meticulously maintained for 12 months by ADRA staff. Participating households were voluntary, and each received a new, replacement filter at time of collection.

Using an identical process, PointOnes were collected after influent and filtrate CBT tests. Each filter was drained at point of collection and stored in the ADRA Venezuela office until shipped. When received at Tufts, the filters were stored in a refrigerator until testing. Each filter was disassembled by twisting the black capsule open, removing the white plastic coating, and cutting the top part of the casing to expose the membrane fibres for preliminary visual assessment. The initial assessment entailed photography of the feed side (water/influent intake) for obvious fouling in the form of dark discolouration, or presence of spots and biofilm either on membrane surfaces or between the fibres and fabric.

PHOTO: ADRA STAFF COLLECTING WATER SAMPLES IN THE FIELD.

The filter opening process of an unused sample can be seen below:

Filter Opening—New Filter



- Black Capsule was twisted open.
- The white plastic casing around the fibers was removed.
- The top part of the casing was cut off right above the potting the expose fibers. The thin non-woven fabric that held the fibers together was also removed.
- Note: water goes from outside the fibers to inside.

Visual inspections of PointOnes provided initial insights into surface membrane fouling. Given the use periods spanning 3 and 12 months, exterior fouling was expected to some extent. This can be seen in Sample 6 below, taken from a household in Barquisemeto after approximately 3 months use.

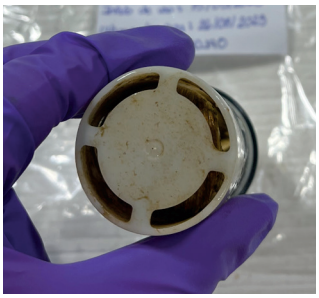
[19] Filters were chosen using convenience sampling.

SEM
RESULTS

Sample 6—Barquisimeto, Carorita





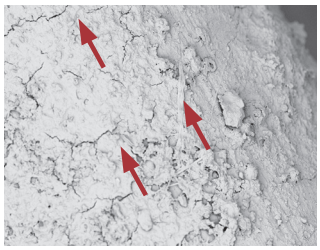
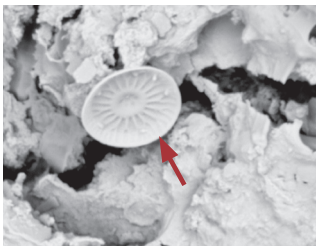
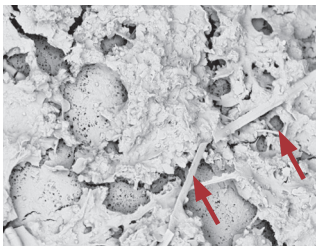
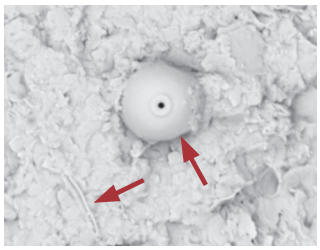


- Large amount of fouling, not only covering the fibers but filling space between fibers and fabric.
- Patchiness implying biofilm formation.

Phenom Pure Desktop Scanning Electron Microscope

After visual inspection, imaging was performed using a Phenom Pure G2 Desktop SEM.[20] Select fibres from each sample were removed from each PointOne, and three fibres attached horizontally to the SEM sample holder to image the outer (feed side) surface of the fibre sample. In non-scientific terms, this was like laying three pipes on the ground side-by-side and photographing their exterior surface in high resolution up to 19,000x. Images of the external fibres can be seen below, revealing a predominance of organic material with some inorganic crystals, algal diamatoms and unique structures.

Sample 6–Barquisimeto, Carorita-Outside

**THICK BIOFILM COVERING THE MEMBRANE.
MANY DIFFERENT ORGANISMS VISIBLE, INCLUDING ALGAL DIATOMS AND ASSEMBLIES, ROUND AND FILAMENTOUS STRUCTURES, HELD TOGETHER BY LIKELY MOSTLY ORGANIC MATTER AND POSSIBLY SOME INORGANIC CRYSTALS.**

Another set of fibres were immersed in liquid nitrogen and freeze-fractured to provide clean cross-sectional samples, which were mounted on a 90 degree sample holder vertically. In lay terms, this was equivalent to breaking the pipes in two, and photographing the side-profile and interior to see what was happening in the strata. Generally speaking, the presence of significant fouling internally indicates that microorganisms, organic materials, and/or particles penetrated the outer selective layer of the fiber and made their way inside. Therefore, fouling and especially microorganisms that are visible on the inside of the membrane is a predictor compromised filtration efficacy. It is worth noting that SEM imaging samples only a few fibres in small sections. It is possible for filters to be compromised (e.g. broken fibers, holes) even without visible fouling in SEM. However, if microorganisms are visible on the inside of the fiber, this means the filtrate likely contains microorganisms that both pass through the filter and grow on the inside of fibers.

[20] Further information can be found at https://www.atascientific.com.au/products/phenom-pure-desktop-scanning-electron-microscope/.

SEM
RESULTS

Findings for SEM Analysis of PointOnes Used for 3–4 months

Sample 1, from Caracas, showed fouling that was less severe than the other PointOnes. Notably, “The fouling appears to arise mostly from organic material in water, adhering to the porous material throughout.”

Sample 2, from Caracas, showed a significant amount of brown deposits on the outside of the fibres “…consistent with extensive organic fouling that led to pore narrowing throughout the thickness of the filter. It was noted that “…when organic fouling is throughout the fiber, it is extremely difficult (or impossible) to remove thoroughly by a water backwash.”

Sample 3 from Caracas “…showed black patches under visual inspection. SEM showed a patchy, thick biofilm. Pores were visible where the film peeled off, indicating the main mode of fouling was the accumulation and adhesion of microorganisms, possibly already in communities or clumps, onto the outside of fibers.”

Samples 4–6 from Barquisimeto were relatively similar in the extent and cause of fouling. All showed black patches and extensive biofilm covering the outside of the fibers. The biofilm contained many different microorganisms, including bacteria and algae, embedded in a matrix that is likely organic but may contain inorganic particles also. This implies the biofilm has been growing on these surfaces for quite a while, with the large amount of algae possibly arising from an algal bloom or similar phenomenon in the water supply.

Additionally, in samples 5 and 6, there was evidence of defects in the membrane that allowed the permeation of microorganisms under the outside, selective layer of the membrane. This implies that the filters lost their ability to remove microorganisms. Further, the visible growth inside the filter module indicates the filter may instead serve as a reservoir for microorganisms that further contaminate the water that passes through it.

Taken together, post-mortem analysis of PointOne filters used for 3-4 months showed evidence of serious fouling of 5 of the 6 specimens with a very significant presence of microorganisms in samples for Barquisimeto. This aligned with the predictions of ADRA staff who speculated that education levels were lower there, water sources were more likely to be contaminated, and rates of filter maintenance were lower.

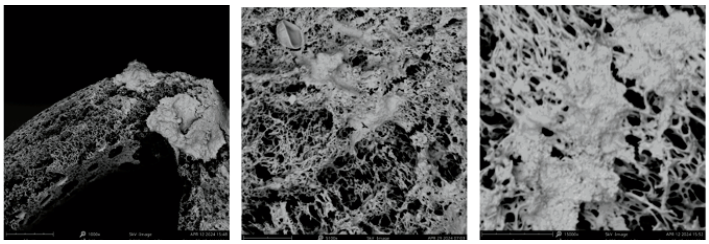
WATER SAMPLE COLLECTION FOR TESTING.

SEM
RESULTS

Findings for SEM Analysis of PointOnes used in Caracas for 8-9 months

ADRA collected 6 PointOnes from households in Caracas. However, CBTs indicated that only one filter met the inclusion criteria of 'unsafe range' influent ("unsafe", "probably unsafe" or "possibly unsafe") at time of collection. Each of the other samples was below this threshold. Despite this, 4 of the 6 samples showed significant fouling.

Sample No.	Water Source	Estimate of litres filtered	Influent CBT–pre filtration	Filtrate CBT–post filtration	Findings
1	Tap	5400	9.6 Possibly Safe	0 Safe	Some fouling on the surface, but pores still visible. Algal assemblies on surface.
2	Tap	2700	0 Safe	0 Safe	Some fouling, but not heavily fouled.
3	Tap	8100	0 Safe	0 Safe	Thick fouling layer with various microorganisms embedded. Microorganisms embedded in the inner structure of the membrane (potential defects allowing access to the inside of membrane).
4	Tap	8100	>100 Unsafe	4.7 Possibly Safe	Dense coating of foulant layer and many microorganisms visible. No visible fouling inside fiber sampled.
5	Tap	2700	0 Safe	1.5 Probably Safe	Highly fouled with organics, microorganisms, and inorganic crystals. Extensive fouling inside the fiber, indicating integrity compromised. Microorganisms growing inside fiber.
6	Tap	2700	1.5 Probably Safe	0 Safe	Thick coating layer with microorganisms, but also visible pores—patchy fouling.



EXTENSIVE FOULING INSIDE FIBER, INDICATING COMPROMISED. MICROORGANISMS GROWING INSIDE FIBER.

The WASH team initially expected to exclude all the SEM results above, based on the CBT data, which suggested that 5 of the 6 filters were using influent in the "safe", "probably safe", or "possibly safe" range. It was a surprise, therefore, to see that filter 4 (with an estimated throughput of 8100 litres) was functioning remarkably well despite "unsafe" levels of E. coli in influent and dense exterior fouling on membranes. On the other hand, filter 5 (with an estimated throughput of 2700 litres) was extensively fouled inside the fibre, and filtration worsened water quality.

This round of testing provided three salient reminders. Firstly, that PointOnes using relatively safe water, as indicated by CBT results that measure the presence of bacteria, can still be significantly fouled over 8-9 months for a variety of reasons, including irregular backwashing and periodic differences in water quality over time. The foulants observed included organic materials, small particles, as well as algal assemblies. While these contaminants would not be detected by CBT tests, they can all contribute to fouling that would impact the operation of the filter. Secondly, that significant fouling does not necessarily result in unsafe filtrate, at least in terms of bacterial contamination. Thirdly, that most probable E. coli results arising from single point in time CBT tests do not necessarily predict levels of PointOne fouling.

Findings for SEM Analysis of PointOnes used for 12 months in Barquisemeto

ADRA collected 6 PointOnes from households in Barquisemeto after 12 months of use. CBTs indicated that all influent samples at time of collection were 'unsafe.' In some filters, cross-sections showed fouling/microorganisms embedded all the way inside the fiber, indicating likely loss of effectiveness. Even on filters with less fouling, there were many microorganisms of many sizes that looked like bacteria, algal assemblies including diatoms, and what seemed to be pieces of other organisms, all embedded in probable organic deposits.

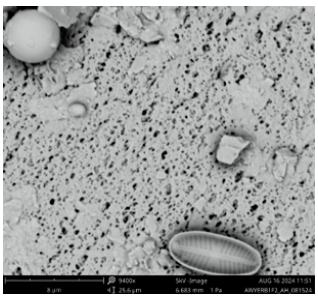
SEM
RESULTS

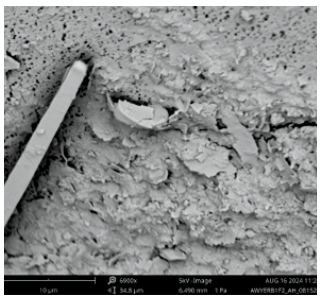
Findings for SEM Analysis of PointOnes used for 12 months in Caracas

Various degrees of fouling were observed in samples used for 12 months, with “Lots of different microorganisms deposited on the fibers, some more than others.” It was noted that in some cases (see samples 5 and 6 below) “Fouling doesn’t necessarily mean loss of efficacy,” possibly because less water is filtered over time. In others (see sample 4), declining filter performance seems not to be linked to the volume of water filtered.

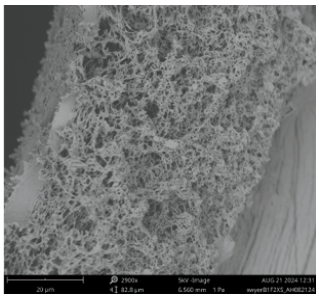
The standout for ADRA is sample 7. Utilizing the same water as other households, the PointOne was used daily in the ADRA office with backwashing and maintenance strictly according to user guidelines. As can be seen below, this filter was still working efficiently after 12 months with excellent CBT results and little visible fouling. This suggested to the ADRA WASH team that PointOne efficacy in Caracas, using piped water, was more to do with user behaviour and maintenance than the filter itself. This supports findings in prior studies that filter performance in laboratory conditions tends to be better than in real-world conditions.

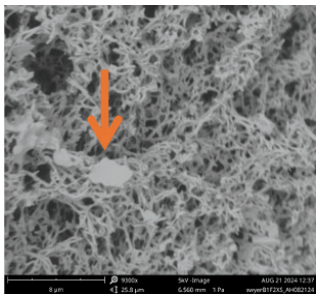
Batch 1 Filter 2





- Less visible fouling
- SEM shows lots of microorganisms on the surface, but still some visible pores
- Cross-section is not fouled extensively, but some bacteria seem to have penetrated into the middle part





SEM RESULTS

Sample No.	Water Source	Estimate of litres filtered	Influent CBT–pre filtration	Filtrate CBT–post filtration	Findings
1	Pipe	1500	>100	48.3	Some visible fouling. A broad range of micro-organisms visible in SEM, along with patchy organic fouling. Cross-section shows foulants penetrated well inside the membrane due to defects, possibly microorganisms populating some pores.
2	Pipe	9000	1	3.4	Some visible fouling. SEM shows patchy fouling that is thin overall. Some algae/microorganisms visible. Cross-section looks clear of organic fouling; very thin layer on top. It is worth noting the family specified they used a fabric to pre-filter the water before the water was fed to the Sawyer filter. This is likely why limited fouling was observed, especially in comparison with other filters that were used for even shorter periods.
3	Pipe	10000	48.3	48.3	Some visible fouling. SEM shows patchy fouling: Some thick layers of organics, as well as areas with microorganisms along with visible pores. Cross-section shows organic fouling that partially penetrates through the outer layer.
4	Pipe	1500	48.3	48.3	Visible fouling. Thick, dense fouling layer with embedded micro-organisms and algal assemblies. Fouling layer visible on the inner surface, possibly indicating biofilm growing on the filtrate side. Organic deposits inside membrane. In agreement with CBT results showing no E. coli removal.
5	Pipe	3000	>100	4.7	Dark, extensive visible fouling. SEM shows thick, dense fouling layer cracked and peeled in many places. Microorganisms in layer. No visible fouling inside pores in this specific set of samples.
6	Pipe	1500	48.3	1.2	Dark, thick visible fouling. Thick, dense fouling layer, lots of microorganisms in layer but smaller. Layer outside fibers visible in cross-section, but inside the pores look clean.
7 Office	Pipe	–	>100	0	Little visible fouling. Some patches of fouling, but most surface pores visible; some but fewer and smaller microorganisms. Cross-section looks clear. This filter worked perfectly using a maintenance regime supervised by office staff at ADRA headquarters.

ADRA Wash Team Observations

Feedback
Studying PointOne and Ecofiltro ceramic filter performance was both challenging and transformative for members of the WASH team. In the words of one member, "There were days when left at 7 am, arrived back at the office by 4 pm and we were still there at 10 pm. It was tough, but an incredible experience. We have learned so much. I was hooked and really loved it." Another said, *"The research was very difficult. It was challenging, visiting houses, going high up hills, carrying everything. People opened their doors to us. It was beautiful to see the impact of following up on the results of the CBT tests."* For program leaders, it confirmed that *"The best method of training is door-to-door visits."*
The ADRA team concluded that a model of training trainers and equipping household support volunteers for regular visitation to individual households was key to effective filter use for both PointOnes and ECFs. Replicated across both projects, support consisted of training volunteers who were responsible for a minimum of one monthly visit to 9–10 families. Across both types of filter, *"We used the same process of selection, distribution, training, and household visits…Volunteers did up to two visits to homes per month—we didn't want to bother them too much. Each visit was 10–20 minutes."* Staff concluded, *"The process is working very well. We go to the homes and ask them how are you going? Is the filter working? Are you cleaning it regularly? If they have a problem, we say OK, let's see. Let's look at the pamphlet."* Using CBTs, visual inspections, and sharing results was time-intensive and costly; however led staff to the view that *"…the quality of the training provided to families on the use and maintenance of filters has a direct relationship with the effectiveness of their use. The better and more complete the training, the smaller the margin of error in the use of filters."*
A transformative part of home visitation was sharing CBT results directly with families. Impactful for volunteers and ADRA staff, it had significant education and motivation value. According to a WASH assistant, *"When we saw the filter results, it was like wow, this is what people are really consuming. When the people saw the results with their own eyes, they became really aware and motivated to change their behaviours."* Another said, *"…it was beautiful to learn more- to see the results… of testing, before and after."* In some cases, fear became a motivating factor because *"…some got a bit afraid, especially the ones with small children."* Such was the power of images, including SEM pictures, that one staff member recommended sharing pictures and results before distribution, suggesting, *"Instructing and teaching them visually…is essential."*
Although they were unanimous in the view that both types of filters improve family health, save time for women, increase water consumption, reduce medical costs, and improve flavour, the WASH team also expressed concerns over sustainability when many families have a monthly income of less than $100 USD. With similar replacement costs of $50–60 USD for both PointOnes and ECFs, the economic reality is that *"Although some families may be willing to invest in replacement filters due to the health benefits, many will depend on external support as they prioritize food or medical expenses."* For many families, water is secondary need to food. *"Asking them to spend $60–90 will be difficult because every day they are trying to find more food to eat."*
One of the most interesting claims made by field staff was about suitability of PointOnes and ECFs for different socio-economic groups. One said, *"I believe that for both low-educated and more educated families, the Ecofiltro would be the best option, as it is easier to handle and maintain"* there were more nuanced views. Most agreed with the view that, *"For low-income families with low levels of education, Ecofiltros are better due to their ease of use and maintenance, as well as not requiring additional tools. More educated families can easily adapt to systems like Sawer PointOnes, which are effective but require greater care and technical understanding."* While ECFs are fragile and easily broken,[21] they are, in the opinion of ADRA, *"… easy to install, has suppliers in Venezuela, and does not take up much space."* Further, *"…they have many advantages in terms of durability, easy cleaning, porosity and fast filtration… families have stated that they keep water clean and cold in areas where it is very hot."*
While the WASH team tended to recommend ECFs over PointOnes for low-income households with lower levels of hygiene, this was with some caution and accompanied by the observation that *"…the most useful thing would be to monitor these Ecofiltros for a longer period of time... How do the Ecofiltros act after 1 year of constant use?"*

"There were days when we left at 7 in the morning, returned to the office at 4 in the afternoon, and were still there at 10 at night. It was tough, but an incredible experience."

—Mayerlis Barreto

[21] WASH staff estimate a breakage rate of 5 per cent in the first year of use, including during shipping, distribution and home use.

Discussion & Reflections

ADRA Venezuela's provision of 2400 Sawyer PointOne filters and 700 ECFs in Venezuela, with a commitment to stringent monitoring and evaluation, has had a profound effect on its understanding of the efficacy and sustainability of in-home, point-of-use water filtration systems in disadvantaged households. The mixed-methods approach used has demonstrated significant improvements in water quality in the short term, consistent with international studies.

Project beneficiaries and WASH team members unanimously agree that PointOnes and ECFs are acceptable to community members, effective in reducing measurable levels of E. coli, and beneficial to family health. This can be seen in the comments below:

> **"The Sawyer Filters are really positive for Venezuelan families, mainly because of how practical they can be to improve water quality, since in Caracas the water that arrives through pipes is of very poor quality; Most commonly you will find that this pipe water is yellow and brown; Now, when passed through the filter it is really transparent and the difference is very evident."**
>
> **"The Ecofiltro has several good things. First, it is very easy to clean, which is a great help for families because it does not take up much time from their daily tasks. They don't have to spend a lot of effort and time to keep it clean. Second, the Ecofiltro uses activated carbon to clean the water. This is very important because it greatly improves the flavor. In Lara, many families complained about the bad taste of the water they received. It was a common problem. But now, with the Ecofiltro, the water tastes much better. Families notice a big difference and that is why they now drink more water. Additionally, they feel safer taking it because they know it is cleaner and tastes better."**

In the absence of rigorous, multi-year studies comparing PointOnes and ECFs, estimation of safe use periods for the benefit of users in fragile contexts is difficult to establish. The studies mentioned earlier in this report suggest that in humanitarian or developing country contexts with very low water quality (high turbidity, with organic matter and inorganic matter), safe use of hollow membrane filters is likely to be less than 6 months because of irreversible fouling, caking, and internal tearing of membranes. SEM analysis of high-use filters used between 3 and 12 months revealed significant organic and non-organic fouling, echoing concerns in other international studies about durability and safety in real-world conditions. An ongoing tension to consider in future projects is balancing beneficiary enthusiasm with uncertain safe use periods, a lack of transparency for users about PointOne lifespan, and apparent decline filtrate due to irregular or improper maintenance.

Extension of the PointOne study found that by 12–16 months, approximately 55% of tested PointOnes were likely to be unsafe according to WHO guidelines and were failing to reduce samples from the 'High Risk Range' to a 'Low Risk Range'.[22] ADRA's initial recommendation that PointOne recipients cease using these filters at 6 months remains valid unless families have willingness and capacity to maintain them properly. Further, ADRA suggests that distribution of PointOnes in Venezuela should be a short-term intervention, with a replacement strategy for low-income families. Ongoing use should be associated with very high levels of user education (including provision of CBT results and SEM images), periodic water testing, and household savings plans to assist with replacement.

ECFs are, in ADRA's experience, more fragile than PointOnes. In the words of ADRA's WASH Coordinator:

> **"One of the biggest concerns we have with the Ecofiltro is that the filter unit is very fragile. This weakness becomes even more notable due to its considerable size and a little weight (although it is not much). From the moment it is taken out of the factory until it is installed in the house, great care must be taken so that it does not fall or break. Once the filter is in the house, care must be maintained; for example, cleaning it can be complicated, since it must be handled very carefully so as not to damage it. Additionally, if there are children in the house, there is a risk that, while playing or running, they may collide with the filter and it may fall, which could result in a breakage."**

[22] The two broad ranges are based on aggregation of 6 Aquagenx categories "Unsafe", "Probably Unsafe", "Possibly Unsafe", "Possibly Safe", "Probably Safe" and "Safe" into two ranges.

While PointOnes are much more robust, and replacement costs are similar to ECFs, they are not readily available in Venezuela, internal fouling is invisible, and backwashing with chlorine requires a frequency and habitual pattern of cleaning that does not seem to be sustainable for many families. ECFs are, in ADRA's experience, more viable because *"First, it is very easy to clean, which is a great help. for families because it does not take up much time from their daily tasks. Second, the Ecofiltro uses activated carbon to clean the water. This is very important because it greatly improves the flavor."* Pleasingly for project staff, *"From the beginning, families understood how it works and how they should clean it regularly. This is crucial because if a product is complicated to use or clean, people tend to stop doing it, which can affect its performance in the long term. In this case, simplicity was a key factor for success."*

Overall, ADRA's research in Venezuela suggests that while PointOne hollow membrane filters are relatively cheap, easily distributed, and effective in purifying water for three months, replacement of the filter body and parts is problematic due to supply chain issues, and performance declines rapidly by three–six months. Provision of CBT and SEM images increases user awareness and can be a powerful education tool for users.

PHOTO: FIELD TEAM AT WORK.

BIBLIOGRAPHY

Alford, Kristin R, Katherine D. Rosendale, Abdul Hafiz Koroma, Stacy L. DeRuiter, Randall Pruim, Jason E. VanHorn, Matthew Bone, Jared Deighton, Adam DenHaan, Jamison Koeman, Sadie Kornoelie, Blerta Lika, Abigain Stratton, Lydia Walls, and Nathan Wang. "Evaluating filter functionality and user competence after a hollow fiber membrane filter intervention in Liberia," *Journal of Water, Sanitation and Hygiene for Development 12*, no.12 (2022): 851–861. https://doi.org/10.2166/washdev.2022.075.

Aquagenx. 2013. "Aquagenx CBT EC+TC (Compartment bag Test) Most probable Number (MPN) Kit Instructions for Use: Drinking Water." Available from https://www.aquagenx.com/wp-content/uploads/2022/05/MPN-CB (accessed 29/05/2022).

Aquagenx, 2025. "CBT EC+TC Kit: Portable Quality Test Kits for P/A and MPN Test Results." Available from https://www.aquagenx.com/how-to-use-cbt-ectc/ (accessed 01/07/2025).

Aquagenx. 2025. "Shop Products." Available from https://www.sawyer.com/category/water-filtration (accessed 01/07/2025).

Brown, Joe, S Proum and Mark Sobsey. "Sustained use of a household-scale water filtration device in rural Cambodia," J*ournal of Water and Health 7*, no. 3 (2009): 404-412. https://doi.org/10.2166/wh.2009.085.

Muvuti, Tinotenda, Raelson Edouard, Edino Noelson, and Rudy Andrianaivo, "Effectiveness of Membrane Filtration to Improve Drinking Water Quality: A Field Trial from Rural Southern Madagascar," ADRA International (2023).

Holding, Shannon, Ilin Sadeghi, Trevor White, Anna Murray, James Ray, III, Ayse Asatekin and Daniele Lantagne. "Acceptability, effectiveness, and fouling of PointOne membrane filters distributed in South Sudan," *Journal of Water, Sanitation and Hygiene for Development 9*, no. 2 (2019): 247-257. https://doi.org/10.2166/washdev.2019.040.

Murray, Anna, Mario Goeb, Barbara Stewart, Catherine Hopper, Jamin Peck, Carolyn Meub, Ayse Asatekin and Daniele Lantagne. "Fouling in hollow fiber membrane microfilters used for household water treatment," *Journal of Water, Sanitation and Hygiene for Development 5*, no. 2 (2015): 220-228. https://doi.org/10.2166/washdev.2015.206.

Murray, Anna, Barbara Stewart, Catherine Hopper, Ellen Tobin, Jimmy Rivera, Henry Mut-Tracy, Patrick Stewart, Cordelia Stewart, Claire Tobin, Mario Goeb, Carolyn Meub and Daniele Lantagne. "Laboratory efficiency and field effectiveness of hollow fiber membrane microfilters used for household water treatment in Honduras," *Journal of Water, Sanitation and Hygiene for Development 7*, no.1 (2017): 74-84. https://doi.org/10.2166/washdev.2017.156.

Stauber, Christine, Candace Miller, Britany Cantrell and Kate Kroell. "Evaluation of the Compartment Bag Test for the Detection of Escherichia coli in Water," *Journal of Microbiological Method 99*, no. 1 (2014): 66-70. https://doi.org/10.1016/j.mimet.2014.02.008.

Tintle, Nathan, Adam Heynan, Kristin Van De Griend, Rachel Ulrich, Matthew Ojo, Emma Boven, Sarah Brokus, Randall Wade and Aaron A. Best. "Evaluating the efficacy of point-of-use water filtration units in Fiji," Tropical Medicine and Health 47, no. 1 (2019): 1-7. https://doi.org/10.1186/s41182-019-0175-4.

Tintle, Nathan, Kristin Van De Griend, Rachel Ulrich, Randall D. Wade, Tena M. Barr, Emma Boven, Carolyn E.A. Cooper, Olivia Couch, Lauren Eekhoff, Benjamin Fry, Grace K. Goszkowicz, Maya A. Hecksel, Adam Heynen, Jade A. Laughlin, Sydney M. Les, Taylor R. Lombard, B. Daniel Munson, Jonas M. Peterson, Eric Schumann, Daniel J. Settecerri, Jacob E. Spry, Matthew J. Summerfield, Meghana Sunder, Daniel R. Wade, Caden G. Zonnefeld, Sarah A. Brokus, Francesco S. Moen, Adam D. Slater, Jonathan W. Peterson, Michael J. Pikaart, Brent P. Krueger and Aaron A. Best. "Diarrhea prevalence in a randomized, controlled prospective trial of point-of-use water filters in homes and schools in the Dominican Republic," Tropical Medicine and Health 49, no. 1 (2021): 1-14. https://doi.org/10.1186/s41182-020-00291-y.

Watson, B, Victoria Fray, and Nestor Mogollon. "A Drop of Love: UGAVII 2023 Sawyer PointOne Study," *ADRA International*, 2024.