Research Article

Understanding on-site sanitation in rural Fiji: where definitions of sanitation back-ends differ

Supplementary Information

Table S1: Steps performed during community-wide sanitation safety planning (SSP) [1].

Step	Description

Step 1: Preparation for SSP	• Assemble team
	   o Community leader
	   o Community health worker / health committee
	   o Water safety committee members
	   o Key residents.

Step 2: Describe sanitation systems	• After being guided by WISH Fiji team, community-wide on-site sanitation data were gathered from community official records about the types of back-ends. The following information were collected during the SSP:
	   o Types and number of sanitations back-ends (septic system, tank, and pit latrine)
	   o Number of shared latrines
	   o What happens when back-ends become full

Step 3: Identify and assess hazards	• Community education regarding back-end type safety.
Step 4: Develop and implement incremental improvement plan	• Develop action plans by identifying opportunities to replace or repair unsafe sanitation systems.
Step 5: Monitor control measures and verify performance	• Monitoring of sanitation systems by community to ensure safe sanitation.
Step 6: Develop supporting programmes and review plans	• Cyclic review to be conducted every 12 months.

Table S2: Treatment assessment criteria for sanitation back-end.

Back-end type	Treating / Not treating
Category 1- Septic system	Treating
Category 2 – Tank (perforated and bottom open plastic or metal tank)	Not treating
Category 3 –Not visible tank	Not treating
Category 4 – Pit latrine	Not treating
Not photographed[*]	Treating / Not treating

[*] Both treating and not treating are listed as the back-end category is unknown.

Table S3: Community level back-end categorisation by household according to results from the sanitation survey, observation, and sanitation safety planning (SSP).

Catchment	Community†	Sanitation survey and observation 29 communities 311 households										Community-wide sanitation safety planning 29 communities 1502 households			
		Surveyed households	Surveyed population	Sanitation survey (‡) Cat 1: Septic system	Sanitation survey (‡) Cat 4: Pit latrine	Sanitation observation (*) Cat 1: Septic system	Cat 2: Tank	Cat 3: Not visible tank	Cat 4: Pit latrine	Not photographed	Reported septic system in survey compared to observation§	Total households	Total population *	Sanitation Safety Planning (SSP) (*) Sewer system / Cat 1: Septic system / Cat 2 and 3: Tank / Cat 4: Pit latrine
Bureta	Community E1	8	36	8				5 (63%)		3 (38%)	5 - 8 ↑	49	256	Cat1: 5 (10%); Cat2&3: 44 (90%)
	Community E2	10	46	9 (90%)	1 (10%)		1 (10%)	7 (70%)		2 (20%)	7 - 9 ↑	43	230	Cat2&3: 23 (53%); Cat4: 18 (42%)
	Community E3	7	40	7			1 (14%)	5 (71%)		1 (14%)	6 - 7 ↑	47	101	Cat1: 2 (4%); Cat2&3: 28 (60%); Cat4: 13 (28%)
	Community E4	6	21	5 (83%)	1 (17%)	3 (50%)		3 (50%)			2 ↑	24	101	Cat2&3: 24
	Community E5	11	42	11		2 (18%)	1 (9%)	6 (55%)		2 (18%)	7 - 9 ↑	78	273	Cat1: 7 (9%); Cat2&3: 57 (73%)
	Community E6	6	26	4 (67%)	2 (33%)			5 (83%)	1 (17%)		4 ↑	16	53	Cat1: 2 (13%); Cat2&3: 6 (38%); Cat4: 4 (25%)
	Community E7	7	44	6 (86%)	1 (14%)	1 (14%)		3 (43%)		3 (43%)	2 - 5 ↑	41	154	Cat1: 1 (2%); Cat2&3: 38 (93%); Cat4: 2 (5%)
		55	**255**	**50 (91%)**	**5 (9%)**	**6 (11%)**	**3 (5%)**	**34 (62%)**	**1 (2%)**	**11 (20%)**	**33 - 44 ↑ (60% - 80%)**	**298**	**1168**	Cat1: **17 (6%)**; Cat2&3: **220 (74%)**; Cat4: **37 (12%)**
Dama	Community D1	6	22	3 (50%)	3 (50%)			3 (50%)	3 (50%)		3 ↑	29	133	Cat1: 8 (28%); Cat2&3: 15 (52%)

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† Communities are coded for anonymity purpose.

‡ Percentage of households.

§ The lower range is calculated assuming from the missing observation data that all not photographed back-ends are Cat 1 (septic system). The higher range is based on assuming all not photographed back-ends are category 2 (tank), category 3 (visible tank) or category 4 (pit latrine).

	Community D2	10	75	10		4 (40%)	1 (10%)	5 (50%)			6 ↑	29	146		11 (38%)	7 (24%)	1 (3%)
	Community D3	10	48	6 (60%)	4 (40%)	4 (40%)		2 (20%)	4 (40%)		2 ↑	79	317		40 (51%)	27 (34%)	
	Community D4	23	142	15 (65%)	8 (35%)	8 (35%)	1 (4%)	5 (22%)	8 (35%)	1 (4%)	6 - 7 ↑	145	675		37 (26%)	50 (34%)	58 (40%)
	Community D5	6	33	5 (83%)	1 (17%)		1 (17%)	4 (66%)	1 (17%)		5 ↑	27	120		5 (19%)	10 (37%)	12 (44%)
	Community D6	10	66		10				10			36	198		2 (6%)	25 (69%)	1 (3%)
		65	**386**	**39 (60%)**	**26 (40%)**	**16 (25%)**	**3 (5%)**	**19 (29%)**	**26 (40%)**	**1 (2%)**	**22 - 23 (34% - 35%) ↑**	**345**	**1589**		**103 (30%)**	**134 (39%)**	**72 (21%)**
Dawasamu	Community A1	16	128	14 (88%)	2 (13%)		1 (6%)	12 (75%)	2 (13%)	1 (6%)	13 - 14 ↑	75	349		5 (7%)	66 (88%)	4 (5%)
	Community A2	10	34	10		3 (30%)		2 (20%)		5 (50%)	2 - 7 ↑	30	171			30	
	Community A3	10	47	2 (20%)	8 (80%)		1 (10%)		8 (80%)	1 (10%)	1 - 2 ↑	30	125		2 (7%)	11 (37%)	
	Community A4	10	85	9 (90%)	1 (10%)	3 (30%)		4 (40%)	1 (10%)	2 (20%)	4 - 6 ↑	35	132		13 (37%)	3 (9%)	6 (17%)
	Community A5	10	64	8 (80%)	2 (20%)	1 (10%)	2 (20%)	5 (50%)	1 (10%)	1 (10%)	6 - 7 ↑	27	155		21 (78%)	2 (7%)	3 (11%)
		56	**358**	**43 (77%)**	**13 (23%)**	**7 (13%)**	**4 (7%)**	**23 (41%)**	**12 (21%)**	**10 (18%)**	**26 - 36 (46% - 64%) ↑**	**197**	**932**		**41 (21%)**	**112 (57%)**	**24 (12%)**
Upper Navua	Community C1	11	40	11			2 (18%)	8 (73%)		1 (9%)	10 - 11 ↑	57	243			51 (89%)	6 (11%)
	Community C2	10	46	7 (70%)	3 (30%)	1 (10%)	1 (10%)	8 (80%)			6 ↑	55	240		33 (60%)	22 (40%)	
	Community C3	14	65	9 (64%)	5 (36%)	1 (7%)		9 (64%)	1 (7%)	3 (21%)	5 - 8 ↑						
	Community C4	13	63	10 (77%)	3 (23%)	3 (23%)		10 (77%)			7 ↑	70	337		4 (6%)	4 (6%)	63 (90%)

** Community population recorded in year 2020.

	Community C5	17	83	13 (76%)	4 (24%)	1 (6%)		14 (82%)		2 (12%)	10 - 12 ↑	92	326		37 (40%)	55 (60%)	
		65	297	50 (77%)	15 (23%)	6 (9%)	3 (5%)	49 (75%)	1 (2%)	6 (9%)	38 - 44 ↑ (58% - 68%)	274	1146		74 (27%)	132 (48%)	69 (25%)
Waibula	Community B1	10	45	9 (90%)	1 (10%)	3 (30%)		2 (20%)		5 (50%)	1 - 6 ↑	102	326		10 (10%)	92 (90%)	
	Community B3	10	44	6 (60%)	4 (40%)		1 (10%)	5 (50%)	4 (40%)		6 ↑	30	142		14 (47%)	16 (53%)	
	Community B2	18	98	17 (94%)	1 (6%)	2 (11%)	4 (22%)	8 (44%)	1 (6%)	3 (17%)	12 - 15 ↑	97	495		31 (32%)	42 (43%)	19 (20%)
	Community B4	10	46	10			2 (20%)	7 (70%)		1 (10%)	7 - 8 ↑	62	327	18 (29%)	16 (26%)	28 (45%)	
	Community B5	10	53	7 (70%)	3 (30%)		1 (10%)	6 (60%)	3 (30%)		7 ↑	16	78			2 (13%)	14 (88%)
	Community B6	12	59	9 (75%)	3 (25%)			8 (67%)	1 (8%)	3 (25%)	6 - 9 ↑	81	308		6 (7%)	22 (27%)	48 (59%)
		70	345	58 (83%)	12 (17%)	7 (10%)	6 (9%)	36 (51%)	9 (13%)	12 (17%)	40 - 52 ↑ (57% - 74%)	388	1676	18 (5%)	77 (20%)	202 (52%)	81 (21%)
All Catchment		311	1641	240 (77%)	71 (23%)	42 (14%)	19 (6%)	161 (52%)	49 (16%)	40 (13%)	161 - 198 ↑ (51% - 64%)	1502	6511	18 (1%)	312 (21%)	800 (53%)	283 (19%)

Table S4: Statistical analysis comparing soil *E. coli* concentration of back-end types.

Catchment	Latrine back-end soil *E. coli* CFU/g soil																Mann Whitney U test comparing cat 1 to other categories[††]
	Cat 1: Septic system				Cat 2: Tank				Cat 3: Not visible tank				Cat 4: Pit latrine				p value
	n	Mean	Min	Max	n	Mean	Min	Max	n	Mean	Min	Max	n	Mean	Min	Max	
Bureta	2	8.5×10^3	6.8×10^3	1.0×10^4					9	1.9×10^4	0	8.5×10^4	1				0.485

[††] Tank, not visible tank and pit latrine categories were combined into single category for the statistical test.

Dama	3	7.1×10^3	8.4×10^2	1.6×10^4					4	9.0×10^3	2.2×10^3	1.7×10^4	11	3.8×10^4	2.0×10^2	3.1×10^5	0.813
Dawasamu	1				2	2.9×10^4	0	5.8×10^4	8	2.2×10^3	4.0×10^2	6.2×10^3	6	2.5×10^2	0	1.0×10^3	0.296
Upper Navua	2	2.5×10^4	1.3×10^4	3.8×10^4					15	1.5×10^4	0	4.1×10^4					0.263
Waibula					3	1.7×10^4	3.6×10^3	3.3×10^4	13	2.7×10^3	0	1.3×10^4					
5 Catchments	8	1.1×10^4	0	3.8×10^4	5	2.2×10^4	0	5.8×10^4	**49**	9.7×10^3	**0**	8.5×10^4	23	1.8×10^4	3.1×10^5		**0.216**

Table S5: Criteria for estimating sanitation coverage according to Sustainable Development Goal [2].

SDG sanitation service level		Front-end slab		Front-end category		Back-end treatment		Back-end emptying		No emptying	Sharing status	
		Yes	No	Improved	Unimproved	Treating	Not treating	Safe	Unsafe		Private	Shared
Safely managed	Flush (cistern or pour) to septic with safe or no emptying and not shared (private)	▣	□	▣	□	▣	□	▣	□	▣	▣	□
	Flush (cistern or pour) to tank, not visible tank and pit with safe emptying and not shared (private)	▣	□	▣	□	□	▣	▣	□	□	▣	□
	Hole type (dry pit) with slab with safe emptying and not shared (private)	▣	□	▣	□	□	▣	▣	□	□	▣	□

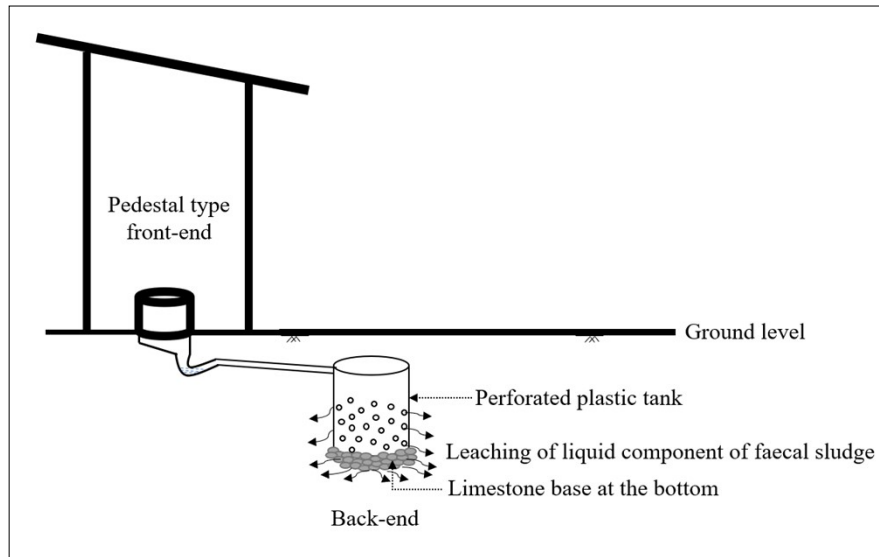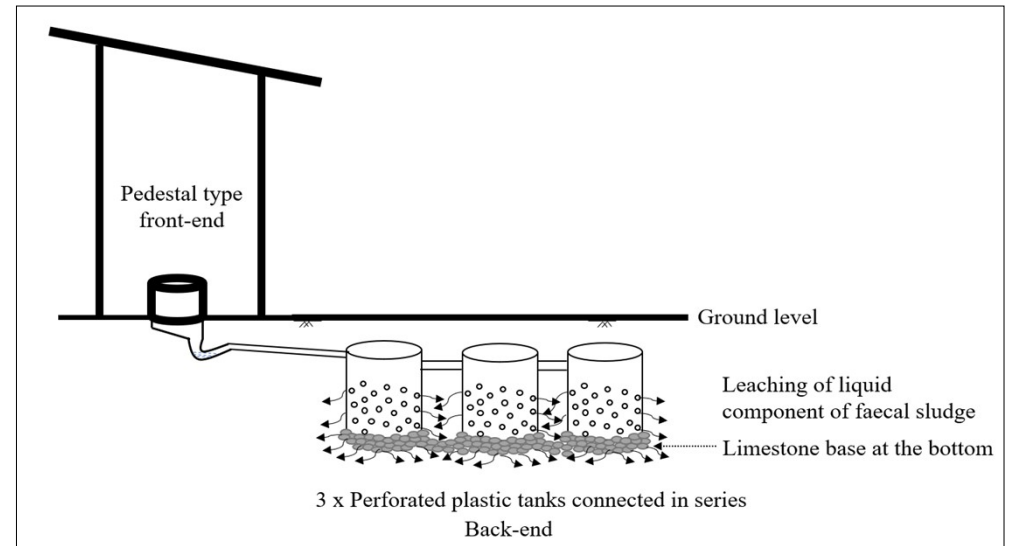| Type											
Basic Flush (cistern or pour) to tank, not visible tank or pit, hole (dry pit) type with slab and not shared (private) with other households	▣	□	▣	□	□	▣	□	▣	▣	▣	□
Limited Flush (cistern or pour) to septic, tank, not visible tank, pit, or hole (dry pit) type with slab and shared between two or more households	▣	□	▣	□	▣	▣	□	▣	▣	□	▣
Unimproved Hole (dry pit) without slab and shared or not shared (private)	□	▣	□	▣	□	▣	□	▣	▣	▣	▣
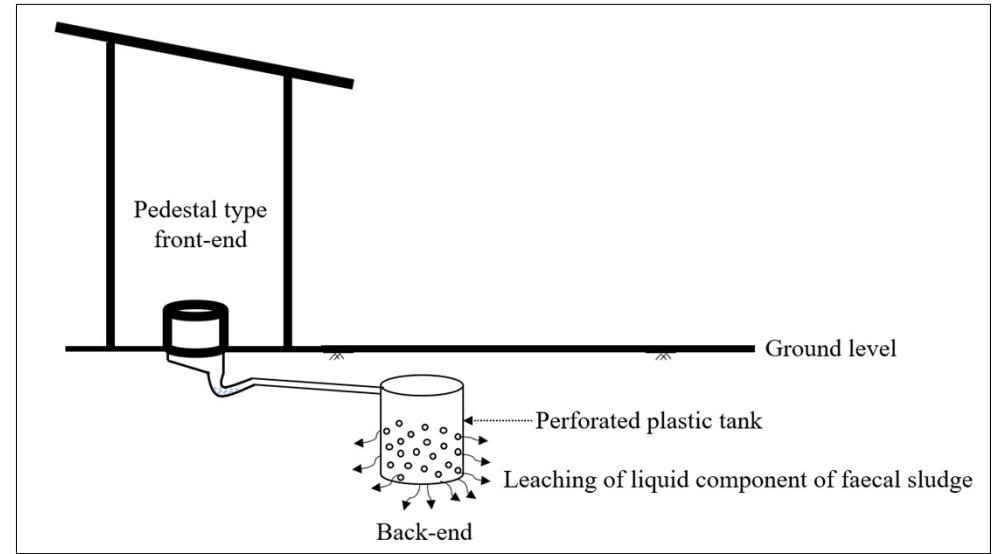
Figure S1: Common types of tank type back-ends in rural communities of Fiji. (a) Construction photograph from Upper Navua catchment where tank type back-end was being placed. (b) Perforated tank type back-ends to allow the liquid component of faecal sludge to leach through the soil layers. (c) Limestones base used to slower the process of the liquid leaching. (d) multiple tanks connected in series to cater for larger household sizes.

Reference

1. WHO, Sanitation safety planning: manual for safe use and disposal of wastewater, greywater and excreta, 2016.
2. UNICEF and WHO, Core questions on drinking water, sanitation and hygiene for household surveys: 2018 update, 2018.