

Supplementary material

Estimation of cooking-related carbonaceous aerosol emissions in Senegal

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Figure S1- Portable Emission Monitoring System (PEMS), designed by the Aprovecho Research Centre.



Figure S2- Cookstoves tested in the study. From left to right: three stones (traditional stove), Noflaye Jegg (rocket stove), Jambaar Bois (basic ceramic stove) and Prime Square (gasifier).

Table S1- Comparison of Measured EC and OC EF for fuelwood combustion with previous studies.

Type of Study	Country	Type of fuel	Type of stove	EC EF (g/Kg)	OC EF (g/Kg)	Study
Field UCT and laboratory WBT	Senegal	Wood (species: Cordyla Pinnata ^a and Casuarina Equisetifolia ^b)	Three stones (laboratory WBT) Rocket stove (laboratory WBT) Ceramic improved stove (laboratory WBT) Gasifier (laboratory WBT) Three stones (in-field UCT) Rocket stove (in-field UCT)	^a 1.98±0.17; ^b 0.75±0.20 ^a 3.93±1.20; ^b 1.23±0.20 ^a 2.05±0.16; ^b 0.87±0.23 ^a 1.95±0.52; ^b 0.86±0.18 ^a 1.81±1.22 ^a 3.14±1.51	^b 3.33±0.61 ^b 4.04±1.50 ^a 9.91±1.11; ^b 1.49±0.28 ^a 3.02±2.27 ^a 2.06±1.22	This study
Field UCT	Malawi	Wood	Traditional Ceramic improved stove Forced-draft Philips Forced-draft ACE	2.07±1.24 1.51±0.63 0.81±0.26 1.30±0.69	2.09±0.75 2.43±1.62 0.96±0.12 1.27±0.96	(Wathore et al., 2017)
Laboratory WBT	USA	Wood (species: Douglas fir)	Three stones Rocket stove Gasifier Fan stove	0.88 1.16 0.28 0.06	1.45 0.55 0.82 0.14	(MacCarty et al., 2008)
Field	Honduras	Wood (species: oak and pine)	Traditional woodstove	1.50±0.3	4.00±0.9	(Roden et al., 2006)
Simulated kitchen WBT and in-field WBT and UCT	Mexico	Wood	Open fire simulated kitchen WBT Mud-cement Patsari simulated-kitchen WBT Open fire in-home WBT Mud-cement Patsari in-home WBT Brick Patsari in-home WBT Open fire in-home Mud-cement Patsari in-home Brick Patsari in-home	1.1±0.5 1.0±0.5 1.1±0.1 1.0±0.6 0.8±1.1 0.3±0.1 0.8±0.4 0.1±0.2	2.5±0.4 2.4±0.9 1.8±1.1 2.6±1.2 1.1±1.3 4.4±1.6 2.7±1.1 0.8±0.9	(Johnson et al., 2008)
Field	China	Wood	Improved metal stove without chimney	0.83±0.69	0.62±0.64	(Shen et al., 2012)
Field	China	Wood (17 tree species widely used as biofuel in China)	Improved chimney brick stove	0.91-1.60	2.20-3.60	(Shen et al., 2013)
Laboratory WBT	India	Wood (4 species widely used as biofuel in India)	Traditional stove	0.38-0.62	0.17-4.69	(Venkataraman et al., 2005)
Laboratory Controlled Cooking Test	India	Wood (species: Acacia Nilotica)	Traditional Natural-draft front feed Natural-draft top feed Forced-draft	^c 1.47±0.15 ^c 1.26±0.11 ^c 1.89±0.06 ^c 0.42±0.06	^c 1.47±0.21 ^c 1.05±0.13 ^c 0.84±0.04 ^c 0.84±0.13	(Arora and Jain, 2015)

Table S2- Summary of EC and OC emission factors, EC/OC ratios and total emissions per WBT from the stove-fuel combinations tested in the laboratory

Stove type	Fuel type	EC (g/MJ)	EC (g/kg)	EC (g/L of water)	OC (g/MJ)	OC (g/kg)	OC (g/L of water)	OC/EC	Fuel consumed per WBT	Total BC emitted per WBT	Total OC emitted per WBT
Three stones	Dimb	0.09±0.01	1.98±0.17	0.20±0.01	No data	No data	No data	No data	1.00±0.02	2.00±0.20	No data
	Filao	0.04±0.01	0.75±0.20	0.07±0.02	0.18±0.03	3.33± 0.61	0.29±0.05	4.67±0.85	0.89±0.02	0.67±0.16	2.92±0.46
Jambaar bois	Dimb	0.09±0.01	2.05±0.16	0.19±0.02	No data	No data	No data	No data	0.94±0.10	1.94±0.34	No data
	Filao	0.05±0.01	0.87±0.23	0.08±0.02	0.21±0.08	4.04± 1.50	0.42±0.28	4.61±0.40	0.98±0.29	0.89±0.49	4.22±2.80
Noflaye Jegg	Dimb	0.18±0.06	3.93±1.20	0.36±0.11	No data	No data	No data	No data	0.96±0.06	3.75±1.37	No data
	Filao	0.06±0.01	1.23±0.20	0.19±0.02	No data	No data	No data	No data	1.63±0.12	1.90±0.31	No data
Gasifier	Dimb	0.09±0.02	1.95±0.52	0.27±0.07	0.46±0.05	9.91± 1.11	1.38±0.15	5.40±1.71	0.70±0.02	1.35±0.35	4.55±3.80
	Filao	0.05±0.01	0.86±0.18	0.11±0.02	0.08±0.01	1.49± 0.28	0.20±0.04	1.76±0.24	0.67±0.01	0.57±0.12	0.63±0.48

Table S3–Summary of EC, OC and PM Emission Factors, ratios and total emissions from in-field emission testing for each household included in the study.

HH code	Stove type	Type of meal	Type of wood	Duration cooking session (min)	Total fuel used (kg)	Total food prepared (kg)	fuel used/kg of food	PM (g/MJ)	PM (g/Kg)	EC (g/MJ)	EC (g/Kg)	OC (g/MJ)	OC (g/Kg)	OC/E C	EC/P M	OC/P M
1NJ	Noflaye Jegg	Rice	Dimb	83,7	2,9	5,9	0,5	0,18	3,97	0,10	2,18	0,05	1,04	0,48	0,55	0,26
2NJ	Noflaye Jegg	Rice	Dimb	58,8	2,2	3,1	0,7	0,22	4,72	0,08	1,80	0,08	1,84	1,02	0,38	0,39
3NJ	Noflaye Jegg	Rice	Dimb	110,9	2,1	8,5	0,2	0,19	4,15	0,12	2,61	0,07	1,43	0,55	0,63	0,34
4NJ	Noflaye Jegg	Rice	Dimb	67,1	2,3	5,7	0,4	0,17	3,60	0,08	1,69	0,04	0,91	0,54	0,47	0,25
5NJ	Noflaye Jegg	Sauce	Dimb	104,7	2,1	8,2	0,3	0,23	5,09	0,13	2,78	0,06	1,37	0,49	0,55	0,27
6NJ	Noflaye Jegg	Sauce	Dimb	64,2	1,7	2,2	0,8	0,20	4,37	0,12	2,60	0,06	1,38	0,53	0,59	0,32
7NJ	Noflaye Jegg	Rice	Dimb	82,7	1,8	5,5	0,3	0,19	4,05	0,07	1,57	0,05	1,01	0,64	0,39	0,25
8NJ	Noflaye Jegg	Rice	Dimb	38,0	1,3	0,8	1,6	0,16	3,55	0,08	1,76	0,12	2,67	1,52	0,50	0,75
9NJ	Noflaye Jegg	Rice	Dimb	92,3	1,7	6,0	0,3	0,61	13,12	0,28	6,14	0,19	4,13	0,67	0,47	0,31
10NJ	Noflaye Jegg	Cous-cous	Dimb	157,2	4,5	6,2	0,7	0,11	2,49	0,19	4,04	0,09	1,88	0,46	1,62	0,75
11NJ	Noflaye Jegg	Sauce	Dimb	80,4	2,4	11,2	0,2	0,30	6,43	0,16	3,45	0,08	1,77	0,51	0,54	0,27
12NJ	Noflaye Jegg	Rice	Dimb	80,2	3,1	4,6	0,7	0,34	7,27	0,27	5,90	0,23	5,02	0,85	0,81	0,69
13NJ	Noflaye Jegg	Sauce	Dimb	82,6	2,2	4,0	0,6	0,16	3,38	0,23	5,03	0,15	3,31	0,66	1,49	0,98
14NJ	Noflaye Jegg	Sauce	Dimb	81,4	2,7	2,5	1,1	0,14	2,99	0,10	2,19	0,05	1,05	0,48	0,73	0,35
15NJ	Noflaye Jegg	Rice	Dimb	77,4	2,4	10,7	0,2	0,33	7,10	0,16	3,38	0,09	2,03	0,60	0,48	0,29

1T	Three stones	Rice	Dimb	56,6	5,3	19,0	0,3	0,08	1,72	0,01	0,30	0,04	0,83	2,81	0,17	0,49
2T	Three stones	Sauce	Dimb	79,7	4,6	5,9	0,8	0,24	5,21	0,07	1,44	0,09	1,94	1,35	0,28	0,37
3T	Three stones	Sauce	Dimb	54,1	4,3	10,2	0,4	0,19	4,08	0,05	1,05	0,07	1,57	1,49	0,26	0,38
4T	Three stones	Rice	Dimb	54,1	2,4	3,3	0,7	0,25	5,46	0,05	1,05	0,09	1,95	1,85	0,19	0,36
5T	Three stones	Rice	Dimb	48,2	1,0	2,2	0,4	0,28	6,05	0,09	1,90	0,11	2,41	1,27	0,31	0,40
6T	Three stones	Rice	Dimb	74,2	2,3	2,2	1,0	0,99	21,55	0,21	4,59	0,46	10,05	2,19	0,21	0,47
7T	Three stones	Sauce	Dimb	71,8	1,6	3,8	0,4	0,38	8,20	0,07	1,62	0,11	2,44	1,50	0,20	0,30
8T	Three stones	Sauce	Dimb	96,5	3,6	4,5	0,8	0,20	4,32	0,19	4,19	0,17	3,60	0,86	0,97	0,83
9T	Three stones	Rice	Dimb	48,1	1,4	4,8	0,3	0,26	5,65	0,08	1,72	0,16	3,52	2,05	0,30	0,62
10T	Three stones	Sauce	Dimb	95,6	2,2	4,1	0,5	0,30	6,55	0,08	1,64	0,14	2,96	1,81	0,25	0,45
11T	Three stones	Rice	Dimb	64,3	2,0	3,6	0,5	0,40	8,66	0,04	0,96	0,13	2,73	2,83	0,11	0,31
12T	Three stones	Rice	Dimb	65,8	1,6	8,7	0,2	0,28	6,09	0,08	1,80	0,13	2,77	1,53	0,30	0,45
13T	Three stones	Sauce	Dimb	101,1	4,1	2,1	1,9	0,46	9,96	0,11	2,38	0,21	4,58	1,92	0,24	0,46
14T	Three stones	Cous-cous	Dimb	156,2	5,5	12,2		0,11	2,47	0,03	0,72	0,04	0,94	1,31	0,29	0,38

Table S4- EC EFs and % difference between laboratory and field data sets.

EC EF (g/MJ)					% difference*		
Stove-fuel	WBT			Field test	Cold start	Simmer	Average WBT
	Cold start	Simmer	Average WBT				
Three stone-dimb	0.10±0.01	0.08±0.01	0.09±0.01	0.08±0.06	20%	3.8%	14.5%
Noflaye Jegg-dimb	0.21±0.07	0.15±0.04	0.18±0.06	0.14±0.07	33.3%	4.2%	18%

**differences were not significant ($p > 0.05$)*