SUPPLEMENTARY MATERIALS

Proxies for agro-ecological and economic drivers

Table S1 presents site-level proxy variables representing agro-ecological and economic drivers as well as farming systems across the study sites. For agro-ecological drivers, Highland Systems (Bubureka, Volcanic and Congo Nile Crest) have altitudes exceeding 2,000 m above sea level and steeply sloped landscapes with over 30% of land with slope of > 25% compared to Savanna and Plateau regions (Eastern Savanna, Eastern and Central Plateaus). Still the proportion of areas with steep slope varies considerably between Cell 1 and Cell 2 across the Highland Systems with the latter reporting higher proportions than the former. Population density per site excluding the areas under natural forests and woodlots varies greatly from 32 persons /km in Kirebe (A1) of Eastern Savanna to 1,043 persons/km in Kaganza (F1), with a general trend of higher population density at over 400 persons/km in Highland Systems (C, D, F), as well as in Central plateau (E).

In contrast to those for agro-ecological drivers, the proxy variables for economic drivers, in terms of accesses to main markets and tarmac roads, presented less clear geographical patterns with a significant variability between sites within a land use system. Farming system proxy variables whose higher mean scores, especially >1.0 indicate commercial cultivation of particular crops, presented clear geographic patterns, but also variations between Cell 1 and Cell 2. Irish potatoes, climbing beans and wheat were grown more commercially in Highland systems than Savanna and Plateau systems. Irish potatoes were more commercially grown in D Volcanic Highland (1.71-1.80) and C Bubureka Highland (1.45-1.56), while the same applied to climbing bean in C Bubureka Highland (1.10-1.24) and wheat in F Congo-Nile Crest (0.82 – 1.11) with Cell 1 having higher scores than Cell 2. In contrast, bush beans, cassava, banana were more commercially grown in Savanna and Plateau systems, while rice was more specific to A2 Gakirage (0.82) where an irrigation scheme was present for years. Maize was grown as more than subsistence crop (>1.0) across relatively wider land use systems except D Volcanic Highland. On the other hand, livestock farming was more implemented commercially for cash income (>1.3) in Cell 1 than Cell 2 in specific land use systems, such as F1 Kaganza (1.46 against 0.9 of F2 Kagano), E1 Kiruhura (1.33 against 1.03 of E2 Buhimba) and B1 Murama (1.32 against 0.69 of B2 Batima).

Table S1 Site-level proxy variables representing agro-ecological drivers, economic drivers and farming systems

	A.Eastern Savanna		B.Eastern Plateau		C.Bubureka Highlands		D.Volcanic Highlands		E.Central Plateau		F.Congo-Nile Crest	
	A1	A2	B1	B2	C1	C2	D1	D2	E1	E2	F1	F2
	Kirebe	Gakirage	Batima	Murama	Ruhanga	Gacundura	Cyamabuye	Arusha	Kiruhura	Buhimba	Kaganza	Kagano
Agro ecological drivers												
Altitude (m above sea level)	1458	1412	1377	1412	2184	2164	2461	2748	1676	1699	2123	2423
Relief (% of land with slope of >25%)	20	0	14	9	35	60	50	75	10	8	32	65
Mean annual Rainfall (mm)	925	887	887	937	1165	1181	1546	1745	1170	1166	1419	1622
Proportion of very fertile soil (%)	48	47	50	58	52	22	56	75	33	48	0	11
Total area (ha)	12889	1619	2211	2170	1238	891	761	1233	1416	820	477	5335
Prop. of area under natural forests & woodlands (%)	0	1	5	3	5	2	12	8	33	14	31	82
Pop. density excl. natural forests and woodlots (pp/km)	32	336	444	250	445	574	768	455	586	633	1043	548
Economic drivers												
Distance to main market (km)	8.90	6.26	2.50	5.91	6.18	4.26	5.19	13.60	5.03	6.34	2.67	9.26
Travel time to main market (min)	153.84	97.72	37.65	74.55	77.76	69.41	63.20	150.79	72.35	71.25	43.75	95.53
Distance to tarmac road d (km)	6.69	8.15	5.84	4.81	14.12	5.71	2.73	7.03	1.06	.74	1.04	1.51
Travel time to Tarmac road (min)	102.92	98.47	73.18	57.41	200.88	63.00	30.14	80.91	12.80	8.91	15.50	16.51
Distance to main market (km)	8.90	6.26	2.50	5.91	6.18	4.26	5.19	13.60	5.03	6.34	2.67	9.26
Farming system indicators mean scores*												
Irish potato	.22	.13	.06	.07	1.56	1.45	1.80	1.71	.52	.55	.86	1.10
Wheat	.00	.03	.03	.02	.24	.40	.08	.11	.12	.06	1.11	.82
Climbing beans	.24	.05	.14	.17	1.24	1.10	.76	.16	.72	.61	1.07	.69
Bush beans	1.10	1.13	1.20	1.29	.20	.45	.02	.02	1.18	1.21	.79	.77
Cassava	.73	.54	0.97	1.37	.00	.00	.00	.00	1.19	.79	.18	.08

Rice	.05	.82	.00	.05	.00	.05	.00	.00	.48	.64	.00	.05
Banana	.20	.31	0.34	1.07	.00	.15	.00	.04	.97	.97	.46	.10
Maize	1.49	1.54	1.31	1.22	1.36	1.20	.42	.13	1.19	1.24	1.04	1.13
Sweet potato	.49	.69	.63	.63	.84	.95	.04	.04	.87	.79	1.21	.56
Livestock	.34	.10	0.69	1.32	.92	1.00	.80	1.04	1.33	1.03	1.46	.90
Napier grass	.12	.38	.43	.61	.52	.55	.16	.00	.52	.55	.64	.54

(note)* each farmer was asked for each crop type to score 0 if not cultivating at all, 1 if cultivating for subsistence only, and 2 if cultivating for sale, thus higher the mean score, a particular crop is more grown as commercial crop in a particular site

Proxies for enabling conditions

Table S2 presents site-level proxy variables representing enabling conditions, which include accesses to services, tenure conditions and community profiles. The proportion of households having access to or participating in saving group ranged widely from 0.23 in Gakirage (A2) to 0.57 in Kaganza (F1), while easy accessibility of cell-level administrative office availability in neighbourhood ranged between 0.03 in Kirebe (A1) and Kagano (F2) to 0.22-0.23 in Ruhanga (C1) and Gacundura (C2). In contrast, easy accessibility of cell agronomist office (agriculture extension office) was higher in Volcanic (0.82-0.88) and Bubureka (0.78-0.79) Highlands than the other systems.

For plot profiles, mean plot size was relatively larger in Eastern Savanna (A) and Eastern Plateau (B), and smaller in Central Plateau (C) and Congo-Nile Crest (E), while there were large discrepancies between Cell 1 and Cell 2 (Cell 2 > Cell 1) in Bubureka (C) and Volcanic (D) Highlands. Plot fragmentation was more severe in Bubureka Highland (C1 Ruhanga 0.60 > C2 Gacundura 0.51) and Congo-Nile Crest (F1 Kaganza 0.53 > F2 Kagano 0.42) followed by Central Plateau (E1 Kiruhura 0.45 > E2 Buhumiba 0.41). Eastern Savanna (A) and B Eastern Plateau (B), especially A1 Kirebe which was only settled after the end of the 1994 genocide, presented relatively low ownership of plots with indications of occupations of some public land by residents, in contrast to Bubureka Highlands (C) where 99% of the plots were owned by farmers. Bubureka Highland (C) in turn reported higher proportion of plots accessed by farmers was located in steel slopes of > 25%, followed by Congo-Nile Crest (F) and Volcanic Highland (D) in contrast to very low proportions of plots in such locations in Eastern Savanna (A), Eastern Plateau (B) and Central Plateau (E).

For community profiles, Kirebe (A1), Gakirage (A2) and Arusha (D2) reported higher proportion of households with experience of recent migration or resettlement in their sites. Mean head education level ranged from 0.97 in Kagano (F2) to 1.49 in Murama (B2), without other significantly observable inter-system, inter-site patterns. Mean transport asset values showed great divergence across sites, due to outliers or a few individuals who owned motorcycles, cars and trucks concentrated in specific sites such as Kaganza (F1), Batima (B1), Murama (B2), and lesser extent, Kirebe (A1) and A2 Gakirage (A2), while the majority of the surveyed households in the six land use systems reported only to own bicycles. Off-farm remittance income regularly received from families and relatives living outside also followed a less clear patterns.

Table S2 Site-level proxy variables representing enabling conditions

	A.Eastern Savanna		B.Eastern Plateau		C.Bubureka Highlands		D.Volcanic Highlands		E.Central Plateau		F.Congo-Nile Crest	
	A1	A2	B1	B2	C1	C2	D1	D2	E1	E2	F1	F2
	Kirebe	Gakirage	Batima	Murama	Ruhanga	Gacundura	Cyamabuye	Arusha	Kiruhura	Buhimba	Kaganza	Kagano
Service access*												
Saving group participle	0.37	0.23	0.34	0.39	0.4	0.35	0.36	0.38	0.55	0.44	0.57	0.44
Cell office availability	0.03	0.06	0.11	0.1	0.22	0.23	0.13	0.11	0.04	0.12	0.04	0.03
Agronom office availability	0.51	0.46	0.57	0.54	0.79	0.78	0.88	0.82	0.48	0.5	0.43	0.46
Plot profiles												
Mean plot size (ha)	1.24	0.85	1.02	0.89	0.59	1	0.43	0.76	0.53	0.39	0.46	0.42
Mean plot fragmentation index**	0.17	0.29	0.39	0.38	0.6	0.51	0.38	0.15	0.45	0.41	0.53	0.42
Mean % plots owned	0.64	0.75	0.84	0.89	0.99	0.99	0.96	0.93	0.87	0.9	0.89	0.96
Mean % plots on sloped land	0.1	0.01	0	0	0.46	0.62	0.23	0.32	0.12	0.08	0.35	0.5
Community profiles												
Migration experience (% households)	0.82	0.53	0.26	0.23	0.12	0.05	0.09	0.57	0.17	0.3	0.19	0.13
Mean head education level*	1.1	1.33	1.32	1.49	1.26	1.26	1.27	1.23	1.27	1.07	1.22	0.97
Mean transport asset values (RWF)	42,683	34,615	481,429	403,659	4,000	12,500	6,000	1,111	11,194	8,824	641,071	5,128
Off-farm remittance income (RWF)	-	1,231	5,000	7,317	-	600	2,400	8,956	3,970	588	17,571	7,949

(note) * service access is 1 if having access, and 0 if having no access. Mean figures presented indicates proportion of surveyed households having accesses to these services

** Plot fragmentation index was calculated by using Simpson Index (SI), determined by the number of plots and the plot size distribution. This index is located within the range of 0 to 1. A higher SI value corresponds with a higher degree of land fragmentation.

*** education level is 0 if no formal education, 1-3 if completed primary, secondary and post-secondary educations