Sustainable intensification amongst Ghana's pineapple farmers: the complexity of an innovation determines the effectiveness of its training

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ONLINE APPENDIX

In this online appendix we present an additional figure and some additional tables which, due to space limitations, were omitted from the main text.

Figure A1 provides an overview of the distribution of training providers.

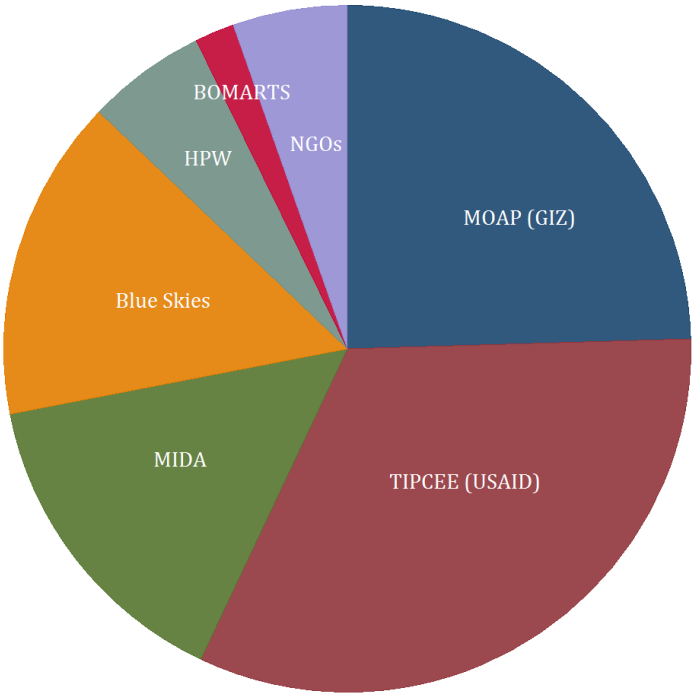

Figure A1. The share of trainings per provider in our sample

Notes: TIPCEE and MOAP are the large programs of USAID and GIZ, respectively. MiDA stands for Millennium Development Authority. Blue Skies, HPW, and Bomarts are private processing companies. NGOs stands for non-governmental organizations.

Tables A1a and A1b are the first stage estimates for table 4 in the main text. Table A1c shows the estimates for the second stage but, in contrast to table 4 in the main text, we also show standard errors that are clustered at the farmer level, for comparison.

Table A1a. Adoption of organic practices first stage organic fertilizers (2SLS)

Spec	(1)	(1)	(2)	(2)	(3)	(3)
dv	Training	Group	Training	Group	Training	Group
n_train	0.651***	0.0987**	0.656***	0.101**	0.655***	0.101***
	(0.0618)	(0.0379)	(0.0599)	(0.0387)	(0.0589)	(0.0384)
n_adopt	-0.0305*	0.767***	-0.0441**	0.766***	-0.0461**	0.768***
	(0.0164)	(0.0120)	(0.0196)	(0.0125)	(0.0191)	(0.0121)
controls	A	A	B	B	C	C
R-sq	0.73	0.77	0.73	0.77	0.74	0.77
Craig Donald F	65.77	2385.34	94.22	2192.19	100.17	2423.42
model	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
N	1990	1990	1990	1990	1990	1990

Notes: The table reports estimated coefficients and standard errors in parentheses. For brevity, only the group level clustered standard errors are reported. Farmer level clustered standard errors can be obtained from the authors upon request. Significance levels are 10% (*), 5% (**), and 1% (***). We control for unobservable differences between the regions and years with fixed effects. The specifications differ by their set of control variables. Set A includes only the lagged adoption of each farmer. Set B also includes rainfall, soil quality, age, education, farm-size, risk preference, and nonfarm income. Set C additionally includes whether the farmer received a credit.

Table A1b. Adoption of organic practices first stage mulching (2SLS)

Spec	(1)	(1)	(2)	(2)	(3)	(3)
dv	Training	Group	Training	Group	Training	Group
n_train	0.775***	0.0224	0.779***	0.0230	0.762***	0.0264
	(0.0253)	(0.0180)	(0.0249)	(0.0169)	(0.0274)	(0.0171)
n_adopt	-0.0468**	0.787***	-0.0520***	0.782***	-0.0488**	0.781***
	(0.0180)	(0.0331)	(0.0193)	(0.0324)	(0.0201)	(0.0320)
controls	A	A	B	B	C	C
R-sq	0.60	0.85	0.61	0.85	0.62	0.86
Craig Donald F	479.64	298.49	493.72	302.22	387.92	
model	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
N	1990	1990	1990	1990	1990	1990

Notes: The table reports estimated coefficients and standard errors in parentheses. For brevity, only the group level clustered standard errors are reported. Farmer level clustered standard errors can be obtained from the authors upon request. Significance levels are 10% (*), 5% (**), and 1% (***). We control for unobservable differences between the regions and years with fixed effects. The specifications differ by their set of control variables. Set A includes only the lagged adoption of each farmer. Set B also includes rainfall, soil quality, age, education, farm-size, risk preference, and nonfarm income. Set C additionally includes whether the farmer received a credit.

Table A1c Adoption of organic practices second stage (2SLS)

Spec	(1)	(2)	(3)	(4)	(5)	(6)
adoption of	Organic fertilizer	Organic fertilizer	Organic fertilizer	Mulch	Mulch	Mulch
training	0.0361**	0.0348**	0.0351**	0.0196	0.0203	0.0177
	(0.00670)	(0.00666)	(0.00667)	(0.0108)	(0.0108)	(0.0112)
	(0.0150)	(0.0146)	(0.0146)	(0.0131)	(0.0132)	(0.0136)
group	0.0374***	0.0373***	0.0373***	0.190***	0.188***	0.188***
	(0.00481)	(0.00493)	(0.00492)	(0.0119)	(0.0122)	(0.0122)
	(0.0134)	(0.0135)	(0.0134)	(0.0203)	(0.0212)	(0.0209)
rain		0.0101*	0.0101*		-0.0129	-0.0131
		(0.00408)	(0.00408)		(0.00956)	(0.00955)
		(0.00605)	(0.00605)		(0.0117)	(0.0117)
farmsize		0.00743**	0.00789**		0.0196**	0.0158*
		(0.00349)	(0.00361)		(0.00812)	(0.00843)
		(0.00513)	(0.00520)		(0.0133)	(0.0131)
risk pref		0.00430	0.00431		-0.0126	-0.0129
		(0.00388)	(0.00388)		(0.00925)	(0.00925)
		(0.00412)	(0.00413)		(0.0128)	(0.0126)
nonfarm		-0.00318	-0.00310		0.00418	0.00315
		(0.00358)	(0.00359)		(0.00814)	(0.00816)
		(0.00315)	(0.00306)		(0.00827)	(0.00838)
credit			-0.00188			0.0151
			(0.00368)			(0.00894)
			(0.00394)			(0.0113)
controls	A	B	C	A	B	C
R-sq	0.79	0.79	0.79	0.50	0.50	0.51
model	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
N	1990	1990	1990	1990	1990	1990

Notes: The table reports estimated coefficients and standard errors in parentheses. The upper parentheses show the standard errors of a random parameter OLS regression, the lower parentheses show standard errors that are clustered at the group level. When the significance differed between the two models, the stars are assigned according to the lower significance. Levels are 10% (*), 5% (**), and 1% (***). We control for unobservable differences between the regions and years with fixed effects. The specifications differ by their set of control variables. Set A includes only the lagged adoption of each farmer. Set B also includes rainfall, soil quality, age, education, farm-size, risk preference, and nonfarm income. Set C additionally includes whether the farmer received a credit.

Tables A2a, A2b and A2c have the same purpose, but for table 5 in the main text.

Table A2a. Adoption of organic practices first stage organic fertilizers (2SLS)

Spec	(1)	(1)	(1)	(2)	(2)	(2)	(3)	(3)	(3)
dv	Training	Group	Contract	Training	Group	Contract	Training	Group	Contract
n_train	0.649***	0.0996***	0.130***	0.655***	0.101***	0.134***	0.654***	0.102***	0.131***
	(0.0220)	(0.0213)	(0.0360)	(0.0213)	(0.0213)	(0.0342)	(0.0213)	(0.0214)	(0.0332)
n_adopt	-0.0288*	0.766***	0.127***	-0.0420**	0.765***	0.142***	-0.0438***	0.767***	0.137***
	(0.0154)	(0.0222)	(0.0326)	(0.0165)	(0.0248)	(0.0339)	(0.0166)	(0.0250)	(0.0339)
distance	0.0329**	-0.0220***	-0.207***	0.0283**	-0.0156**	-0.189***	0.0315**	-0.0179**	-0.180***
	(0.0128)	(0.00578)	(0.0381)	(0.0135)	(0.00700)	(0.0368)	(0.0136)	(0.00735)	(0.0353)
R-sq	0.73	0.77	0.12	0.73	0.77	0.19	0.74	0.77	0.20
F excl.	316.10	444.23	23.16	330.39	341.64	24.12	333.22	336.21	22.79
N	1990	1990	1990	1990	1990	1990	1990	1990	1990

Notes: The table reports estimated coefficients and standard errors in parentheses. For brevity, only the group level clustered standard errors are reported. Farmer level clustered standard errors can be obtained from the authors upon request. Significance levels are 10% (*), 5% (**), and 1% (***). We control for unobservable differences between the regions and years with fixed effects. The specifications differ by their set of control variables. Set A includes only the lagged adoption of each farmer. Set B also includes rainfall, soil quality, age, education, farm-size, risk preference, and nonfarm income. Set C additionally includes whether the farmer received a credit.

Table A2b. Adoption of organic practices first stage mulching (2SLS)

Spec	(1)	(1)	(1)	(2)	(2)	(2)	(3)	(3)	(3)
dv	Training	Group	Contract	Training	Group	Contract	Training	Group	Contract
n_train	0.775***	0.0214*	0.275***	0.778***	0.0219*	0.266***	0.765***	0.0249**	0.256***
	(0.0165)	(0.0116)	(0.0318)	(0.0165)	(0.0116)	(0.0303)	(0.0176)	(0.0118)	(0.0293)
n_adopt	-0.0464***	0.788***	0.158***	-0.0516***	0.783***	0.140***	-0.0490***	0.782***	0.142***
	(0.0136)	(0.0138)	(0.0322)	(0.0141)	(0.0137)	(0.0313)	(0.0138)	(0.0135)	(0.0313)
distance	-0.00757	-0.0181	-0.200***	-0.0152	-0.0217	-0.177***	-0.00827	-0.0233*	-0.172***
	(0.0148)	(0.0132)	(0.0302)	(0.0150)	(0.0135)	(0.0308)	(0.0143)	(0.0136)	(0.0300)
R-sq	0.60	0.85	0.22	0.61	0.86	0.26	0.62	0.86	0.27
F excl.	623.99	863.70	45.53	848.19	1098.69	52.24	717.73	1121.65	51.27
N	1990	1990	1990	1990	1990	1990	1990	1990	1990

Notes: The table reports estimated coefficients and standard errors in parentheses. For brevity, only the group level clustered standard errors are reported. Farmer level clustered standard errors can be obtained from the authors upon request. Significance levels are 10% (*), 5% (**), and 1% (***). We control for unobservable differences between the regions and years with fixed effects. The specifications differ by their set of control variables. Set A includes only the lagged adoption of each farmer. Set B also includes rainfall, soil quality, age, education, farm-size, risk preference, and nonfarm income. Set C additionally includes whether the farmer received a credit.

Table A2c. Adoption of organic practices second stage (2SLS)

Spec adoption of	(1) Organic fertilizers	(2) Organic fertilizers	(3) Organic fertilizers	(4) Mulch	(5) Mulch	(6) Mulch
training	0.0327**	0.0314**	0.0306**	-0.0205	-0.0327	-0.0346
	(0.00733)	(0.00758)	(0.00765)	(0.0223)	(0.0255)	(0.0254)
	(0.0119)	(0.0119)	(0.0119)	(0.0216)	(0.0236)	(0.0234)
group	0.0335**	0.0327*	0.0313*	0.166***	0.157***	0.157***
	(0.00630)	(0.00721)	(0.00730)	(0.0167)	(0.0183)	(0.0186)
	(0.0110)	(0.0121)	(0.0125)	(0.0160)	(0.0172)	(0.0174)
contract	0.0213	0.0217	0.0278	0.111	0.152*	0.152*
	(0.0207)	(0.0240)	(0.0253)	(0.0536)	(0.0653)	(0.0664)
	(0.0172)	(0.0211)	(0.0237)	(0.0510)	(0.0597)	(0.0605)
	(0.0168)	(0.0168)	(0.0168)	(0.0222)	(0.0231)	(0.0232)
	(0.0380)	(0.0379)	(0.0377)	(0.0277)	(0.0289)	(0.0291)
controls	A	B	C	A	B	C
R-sq	0.79	0.79	0.79	0.48	0.46	0.46
N	1990	1990	1990	1990	1990	1990

Notes: The table reports estimated coefficients and standard errors in brackets. The upper brackets show the standard errors of a random parameter OLS regression, the lower brackets show standard errors that are clustered at the group level. When the significance differed between the two models, the stars are assigned according to the lower significance. Levels are 10% (*), 5% (**), and 1% (***). We control for unobservable differences between the regions and years with fixed effects. The specifications differ by their set of control variables. Set A includes only the lagged adoption of each farmer. Set B also includes rainfall, soil quality, age, education, farm-size, risk preference, and nonfarm income. Set C additionally includes whether the farmer received a credit.

Table A3 shows the first stage Craig Donald F-values for table A4 (period specific effects). Tables A4 to A7 are further robustness checks as referred to in the main text.

Table A3. F Values of the excluded instruments

Spec	(1)	(2)	(3)	(4)	(5)	(6)
training 1	221.70	228.43	234.10	15.22	20.09	19.96
training 2	297.04	292.08	293.26	29.94	33.45	33.42
training 3	232.49	256.36	259.27	38.24	43.15	43.13
training 4	254.59	269.60	264.02	63.38	68.88	65.96
training 5	106.25	109.04	109.08	64.42	68.76	65.37
peer 1	9.71	12.65	12.81	48.11	51.07	50.01
peer 2	14.31	19.23	19.30	59.05	62.34	62.35
peer 3	15.18	17.58	17.66	53.39	53.54	53.64
peer 4	12.86	18.34	17.70	54.44	55.01	55.62
peer 5	44.87	68.13	67.28	65.05	65.17	65.39

Table A4. Period specific effects (2SLS)

Spec adoption of	(1) Organic fertilizer	(2) Organic fertilizer	(3) Organic fertilizer	(4) Mulch	(5) Mulch	(6) Mulch
training 09	0.00807	0.00661	0.00670	-0.00587	-0.00588	-0.00546
	(0.0262)	(0.0258)	(0.0259)	(0.0316)	(0.0324)	(0.0322)
training 10	0.0493***	0.0480***	0.0483***	0.0275	0.0293	0.0289
	(0.0157)	(0.0155)	(0.0155)	(0.0280)	(0.0277)	(0.0277)
training 11	0.0384***	0.0363***	0.0366***	0.0290	0.0291	0.0293
	(0.0124)	(0.0119)	(0.0119)	(0.0306)	(0.0315)	(0.0310)
training 12	0.0319*	0.0301*	0.0306*	0.0353	0.0360	0.0313
	(0.0185)	(0.0182)	(0.0183)	(0.0218)	(0.0222)	(0.0229)
training 13	0.0475***	0.0473***	0.0476***	0.00532	0.00546	-0.000384
	(0.0173)	(0.0172)	(0.0172)	(0.0186)	(0.0189)	(0.0198)
peer 09	0.0279*	0.0247	0.0249	0.201***	0.196***	0.195***
	(0.0158)	(0.0153)	(0.0153)	(0.0280)	(0.0277)	(0.0281)
peer 10	0.0323**	0.0308**	0.0306**	0.192***	0.187***	0.189***
	(0.0135)	(0.0141)	(0.0141)	(0.0200)	(0.0197)	(0.0199)
peer 11	0.0289	0.0291	0.0289	0.183***	0.181***	0.182***
	(0.0198)	(0.0197)	(0.0197)	(0.0198)	(0.0203)	(0.0204)
peer 12	0.0258	0.0258	0.0257	0.182***	0.180***	0.180***
	(0.0184)	(0.0182)	(0.0181)	(0.0180)	(0.0185)	(0.0183)
peer 13	0.0526**	0.0532**	0.0535**	0.191***	0.191***	0.193***
	(0.0246)	(0.0245)	(0.0246)	(0.0173)	(0.0178)	(0.0177)
controls	A	B	C	A	B	C
R-sq	0.79	0.79	0.79	0.51	0.51	0.51
N	1990	1990	1990	1990	1990	1990

Notes: The table reports estimated coefficients and standard errors in parentheses. The latter are clustered at the community and year level. Significance levels are 10% (*), 5% (**), and 1% (***). We control for unobservable differences between the regions and years with fixed effects. The specifications differ by their set of control variables. Set A includes only the lagged adoption of each farmer. Set B also includes rainfall, soil quality, age, education, farm-size, risk preference, and nonfarm income. Set C additionally includes whether the farmer received a credit.

Table A5. How much do financial incentives and constraints matter? (2SLS)

Spec	(1)	(2)	(3)	(4)
adoption of	Organic fertilizers	Organic fertilizers	Mulch	Mulch
contract	no	yes	no	yes
training	0.0264***	0.0743***	0.00732	0.0289*
	(0.00835)	(0.0135)	(0.0179)	(0.0149)
group	0.0381***	0.0427***	0.185***	0.192***
	(0.00528)	(0.00987)	(0.0146)	(0.0225)
controls	B	B	B	B
F excl. 1	766.82	132.78	638.87	340.10
F excl. 2	1676.24	838.35	3076.48	546.58
R-sq	.75	.83	.47	.41
N	1425	565	1425	565

Notes: The table reports estimated coefficients and standard errors in parentheses. The latter are clustered at the group level. Significance levels are 10% (*) and 1% (***). We control for unobservable differences between the regions and years with fixed effects.

Table A6. Interdependencies with chemical fertilizer (2SLS)

Spec	(1)	(2)	(3)	(4)	(5)	(6)
adoption of	Organic fertilizer	Organic fertilizer	Organic fertilizer	Mulch	Mulch	Mulch
training	0.0372***	0.0361***	0.0361***	0.00560	0.00284	0.00110
	(0.0123)	(0.0121)	(0.0121)	(0.0238)	(0.0240)	(0.0236)
peer	0.0376***	0.0375***	0.0375***	0.181***	0.175***	0.176***
	(0.0110)	(0.0115)	(0.0115)	(0.0196)	(0.0195)	(0.0197)
chem.fert,	0.00949**	0.00825*	0.00838*	0.0181	0.0168	0.0159
	(0.00429)	(0.00451)	(0.00458)	(0.0161)	(0.0150)	(0.0148)
controls	A	B	C	A	B	C
R-sq	0.79	0.79	0.79	0.51	0.51	0.51
F train	307.48	320.91	321.98	619.30	867.13	755.86
F peer	469.51	493.46	459.84	914.42	1194.59	1211.67
N	1990	1990	1990	1990	1990	1990

Notes: The table reports estimated coefficients and standard errors in parentheses (clustered at the farmers' group). F train is the Craig Donald F value for the excluded instrument for training (the training of indirect neighbors), F peers shows the same for the excluded instrument for peer-learning (the innovation diffusion amongst indirect neighbors). Significance levels are 10% (*), 5% (**), and 1% (***). We control for unobservable differences between the regions and years with fixed effects. The specifications differ by their set of control variables. Set A includes only the lagged adoption of each farmer. Set B also includes rainfall, soil quality, age, education, farm-size, risk preference, and nonfarm income. Set C additionally includes whether the farmer received a credit.

Table A7. Considering training heterogeneity (2SLS)

Spec adoption of	(1) Organic fertilizer	(2) Organic fertilizer	(3) Organic fertilizer	(4) Mulch	(5) Mulch	(6) Mulch
train AEA	0.0167	0.0157	0.0207	-0.0249	-0.0171	-0.0188
	(0.0365)	(0.0360)	(0.0411)	(0.0266)	(0.0280)	(0.0280)
train GIZ	0.0406***	0.0405***	0.0401***	0.0542*	0.0550*	0.0505
	(0.0134)	(0.0131)	(0.0130)	(0.0309)	(0.0316)	(0.0318)
train USAID	0.0257	0.0263	0.0241	-0.0462	-0.0450	-0.0439
	(0.0321)	(0.0323)	(0.0320)	(0.0311)	(0.0309)	(0.0308)
train Blue Skies	0.0375***	0.0373***	0.0374***	0.00404	0.00922	0.00704
	(0.0134)	(0.0134)	(0.0135)	(0.0276)	(0.0282)	(0.0276)
train MIDA	-0.0657*	-0.0639	-0.0665	-0.0174	-0.0201	-0.0157
	(0.0393)	(0.0392)	(0.0408)	(0.0430)	(0.0445)	(0.0449)
peer	0.0423***	0.0407***	0.0412***	0.178***	0.178***	0.179***
	(0.0118)	(0.0120)	(0.0120)	(0.0146)	(0.0149)	(0.0149)
controls	A	B	C	A	B	C
R-sq	0.78	0.78	0.78	0.50	0.50	0.50
F AEA	127.75	99.24	72.39	46.74	35.11	26.18
F GIZ	356.89	299.05	247.08	157.14	160.09	159.95
F USAID	173.79	148.09	146.23	289.41	282.22	272.39
FBlue Skies	97800.26	78128.22	77040.22	6790.79	2127.31	1839.60
F MIDA	227.84	208.18	177.29	78.36	66.35	67.91
F peer	197.58	179.18	180.79	480.10	457.38	457.86
F contract	31.34	33.58	31.56	42.20	37.96	40.56
N	1990	1990	1990	1990	1990	1990

Notes: The table reports estimated coefficients and standard errors in parentheses (clustered at the farmers' group). Significance levels are 10% (*) and 1% (***). We control for unobservable differences between the regions and years with fixed effects. The specifications differ by their set of control variables. Set A includes only lagged adoption and whether the farmer participates in contract farming. Set B also includes rainfall, soil quality, age, education, farm-size, risk preference, and nonfarm income. Set C additionally includes whether the farmer received a credit. AEA denotes extension agents, GIZ is the German development agency, USAID is the US development agency, Blue Skies is the company most active in providing training, and MIDA is the Millennium Development Authority of the UN.