

Appendix tables

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for the paper entitled

Cost assessment of robotic technology in maize farming and related logistics

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Table A1: Route composition of the machine cooperation

Route ID	Number of fields	Number of field access points	Route size in ha	Average field size in ha	Route length in km	Return route to farm in km
LaFarm1	5.0	3.0	23.5	4.7	14.5	15.0
LaFarm2	4.0	4.0	13.3	3.3	17.0	25.2
WKFarm1	2.0	1.0	20.4	10.2	0.0	0.0
WKFarm2	3.0	1.0	16.8	5.6	0.0	0.0
WKFarm3	3.0	2.0	15.7	5.2	4.0	10.0
WKFarm4	7.0	1.0	23.4	3.3	6.0	47.6
WKFarm5	2.0	2.0	22.0	11.0	3.4	6.2
WKFarm6	3.0	3.0	20.4	6.8	7.0	16.4
WKFarm7	5.0	2.0	19.0	3.8	3.6	10.5
WKFarm8	6.0	3.0	21.6	3.6	8.3	42.0
WKFarm9	7.0	5.0	22.9	3.3	25.0	105.3
WKFarm10	6.0	5.0	21.0	3.5	26.4	99.6
WKFarm11	5.0	3.0	19.4	3.9	21.5	70.8
WKFarm12	3.0	3.0	18.6	6.2	17.8	44.2
Mean	4.4	2.7	19.9	5.3	11.0	35.2
SD	1.7	1.3	3.0	2.5	9.2	35.1

Table A2: Structure of working times in scenario 1 (Sc1), including the total working time (TWT), field work time (FWT), logistic time (LT), transport time (TT), loading time (LoT), return transport time to farm (RTTFa), and farm working time (FaWT) in h/ha

Route ID	Scenario 1 (Sc1)					Scenario 2 (Sc2)			
	TWT	FWT	LT	TT	LoT	TWT	LT	RTTFa	FaWT
LaFarm1	0.79	0.70	0.09	0.05	0.04	0.81	0.11	0.02	0.68
LaFarm2	0.92	0.75	0.17	0.06	0.11	0.95	0.20	0.03	0.72
WKFarm1	0.63	0.63	0.00	0.00	0.00	0.63	0.00	0.00	0.63
WKFarm2	0.73	0.73	0.00	0.00	0.00	0.73	0.00	0.00	0.73
WKFarm3	0.69	0.64	0.05	0.01	0.04	0.71	0.07	0.02	0.62
WKFarm4	0.83	0.81	0.02	0.01	0.01	0.87	0.06	0.04	0.77
WKFarm5	0.72	0.68	0.04	0.01	0.03	0.73	0.05	0.01	0.67
WKFarm6	0.72	0.65	0.07	0.02	0.05	0.74	0.09	0.02	0.63
WKFarm7	0.78	0.73	0.05	0.01	0.04	0.80	0.07	0.02	0.71
WKFarm8	0.78	0.70	0.08	0.03	0.05	0.83	0.13	0.05	0.65
WKFarm9	0.85	0.72	0.13	0.05	0.08	0.95	0.23	0.10	0.62
WKFarm10	0.85	0.73	0.12	0.04	0.08	0.94	0.21	0.09	0.64
WKFarm11	0.77	0.68	0.09	0.04	0.05	0.85	0.17	0.08	0.60
WKFarm12	0.74	0.65	0.09	0.03	0.06	0.79	0.14	0.05	0.60
Mean	0.77	0.70	0.07	0.03	0.05	0.81	0.11	0.04	0.66
SD	0.07	0.05	0.05	0.02	0.03	0.10	0.08	0.03	0.05

Table A3: Cost components in scenario 1 (Sc1), comprising total costs (TC), field work costs (FWC), and logistic costs (LC), differentiated by field robot and tractor operation in €/ha

Route ID	Field robot: power harrowing			Tractor: power harrowing			Field robot: sowing			Tractor: sowing			Field robot: inter-row hoeing			Tractor: inter-row hoeing		
	TC	FWC	LC	TC	FWC	LC	TC	FWC	LC	TC	FWC	LC	TC	FWC	LC	TC	FWC	LC
LaFarm1	74.03	63.34	10.69	51.84	49.96	1.88	66.81	56.11	10.69	44.62	42.73	1.88	61.97	51.28	10.69	39.78	37.90	1.88
LaFarm2	88.16	67.86	20.30	55.91	53.52	2.38	80.42	60.12	20.30	48.17	45.79	2.38	75.24	54.94	20.30	42.99	40.61	2.38
WKFarm1	57.30	57.00	0.30	44.96	44.96	0.00	50.80	50.50	0.30	38.46	38.46	0.00	46.45	46.15	0.30	34.11	34.11	0.00
WKFarm2	66.39	66.05	0.34	52.10	52.10	0.00	58.86	58.52	0.34	44.56	44.56	0.00	53.82	53.48	0.34	39.52	39.52	0.00
WKFarm3	64.03	57.91	6.12	46.08	45.67	0.41	57.42	51.31	6.12	39.48	39.07	0.41	53.00	46.88	6.12	35.06	34.65	0.41
WKFarm4	75.96	73.29	2.67	58.21	57.81	0.41	67.60	64.93	2.67	49.86	49.45	0.41	62.01	59.34	2.67	44.26	43.85	0.41
WKFarm5	66.38	61.53	4.86	48.91	48.53	0.38	59.37	54.51	4.86	41.90	41.51	0.38	54.67	49.82	4.86	37.20	36.82	0.38
WKFarm6	67.12	58.81	8.31	47.16	46.39	0.78	60.42	52.11	8.31	40.46	39.68	0.78	55.93	47.62	8.31	35.97	35.19	0.78
WKFarm7	72.09	66.05	6.04	52.49	52.10	0.39	64.56	58.52	6.04	44.96	44.56	0.39	59.52	53.48	6.04	39.91	39.52	0.39
WKFarm8	72.74	63.34	9.40	51.09	49.96	1.13	65.52	56.11	9.40	43.87	42.73	1.13	60.68	51.28	9.40	39.03	37.90	1.13
WKFarm9	80.43	65.15	15.28	53.38	51.38	1.99	73.00	57.72	15.28	45.95	43.95	1.99	68.02	52.75	15.28	40.97	38.98	1.99
WKFarm10	80.30	66.05	14.24	53.78	52.10	1.68	72.76	58.52	14.24	46.25	44.56	1.68	67.72	53.48	14.24	41.21	39.52	1.68
WKFarm11	72.41	61.53	10.88	50.18	48.53	1.65	65.40	54.51	10.88	43.16	41.51	1.65	60.70	49.82	10.88	38.46	36.82	1.65
WKFarm12	69.65	58.81	10.83	47.65	46.39	1.26	62.94	52.11	10.83	40.95	39.68	1.26	58.45	47.62	10.83	36.46	35.19	1.26
Mean	71.93	63.34	8.59	50.98	49.96	1.03	64.71	56.11	8.59	43.76	42.73	1.03	59.87	51.28	8.59	38.92	37.90	1.03
SD	7.81	4.49	5.74	3.78	3.54	0.79	7.47	3.98	5.74	3.28	3.03	0.79	7.25	3.63	5.74	2.94	2.69	0.79

Table A4: Machinery costs (MC), diesel costs (DC), and labour costs (LaC) incurred during field work in scenario 1 (Sc1) in €/ha

Route ID	Machine costs (MC)				Diesel costs (DC)			Labour costs (LaC)			
	Field robot	Tractor: 55 kW	Power harrow	Maize planter	Inter-row hoe	Power harrowing	Sowing	Inter-row hoeing	Power harrowing	Sowing	Inter-row hoeing
LaFarm1	22.72	9.33	9.63	11.48	8.10	15.94	6.87	5.42	15.05	15.05	15.05
LaFarm2	24.34	10.00	10.32	12.30	8.68	17.08	7.36	5.80	16.13	16.13	16.13
WKFarm1	20.44	8.40	8.67	10.34	7.29	14.35	6.18	4.87	13.55	13.55	13.55
WKFarm2	23.69	9.73	10.05	11.98	8.44	16.62	7.16	5.65	15.70	15.70	15.70
WKFarm3	20.77	8.53	8.81	10.50	7.40	14.57	6.28	4.95	13.76	13.76	13.76
WKFarm4	26.29	10.80	11.15	13.29	9.37	18.44	7.94	6.27	17.42	17.42	17.42
WKFarm5	22.07	9.07	9.36	11.16	7.87	15.48	6.67	5.26	14.62	14.62	14.62
WKFarm6	21.09	8.67	8.95	10.66	7.52	14.80	6.38	5.03	13.98	13.98	13.98
WKFarm7	23.69	9.73	10.05	11.98	8.44	16.62	7.16	5.65	15.70	15.70	15.70
WKFarm8	22.72	9.33	9.63	11.48	8.10	15.94	6.87	5.42	15.05	15.05	15.05
WKFarm9	23.37	9.60	9.91	11.81	8.33	16.39	7.06	5.57	15.48	15.48	15.48
WKFarm10	23.69	9.73	10.05	11.98	8.44	16.62	7.16	5.65	15.70	15.70	15.70
WKFarm11	22.07	9.07	9.36	11.16	7.87	15.48	6.67	5.26	14.62	14.62	14.62
WKFarm12	21.09	8.67	8.95	10.66	7.52	14.80	6.38	5.03	13.98	13.98	13.98
Mean	22.72	9.33	9.63	11.48	8.10	15.94	6.87	5.42	15.05	15.05	15.05
SD	1.61	0.66	0.68	0.81	0.57	1.13	0.49	0.38	1.07	1.07	1.07

Table A5: Machinery costs (MC), diesel costs (DC), and labour costs (LaC) incurred during logistics in scenario 1 (Sc1) in €/ha

Route ID	Machine costs (MC)			Diesel costs (DC)		Labour costs (LaC)	
	Tractor: 121 kW	Tractor: 55 kW	Low-loader	Tractor: 121 kW	Tractor: 55 kW	Tractor: 121 kW	Tractor: 55 kW
LaFarm1	2.04	0.67	6.22	0.44	0.14	1.99	1.08
LaFarm2	3.85	0.80	11.73	0.97	0.29	3.76	1.29
WKFarm1	0.07	0.00	0.12	0.05	0.00	0.07	0.00
WKFarm2	0.08	0.00	0.12	0.06	0.00	0.08	0.00
WKFarm3	1.19	0.13	3.62	0.15	0.06	1.16	0.22
WKFarm4	0.50	0.13	1.52	0.16	0.06	0.49	0.22
WKFarm5	0.94	0.13	2.87	0.12	0.04	0.92	0.22
WKFarm6	1.61	0.27	4.90	0.23	0.08	1.57	0.43
WKFarm7	1.17	0.13	3.58	0.15	0.04	1.15	0.22
WKFarm8	1.82	0.40	5.56	0.23	0.09	1.78	0.65
WKFarm9	2.92	0.67	8.91	0.60	0.25	2.85	1.08
WKFarm10	2.71	0.53	8.25	0.64	0.29	2.64	0.86
WKFarm11	2.05	0.53	6.26	0.57	0.25	2.00	0.86
WKFarm12	2.05	0.40	6.27	0.50	0.22	2.01	0.65
Mean	1.64	0.34	4.99	0.35	0.13	1.60	0.55
SD	1.08	0.27	3.33	0.28	0.11	1.06	0.43

Table A6: Costs and benefits in scenario 2 (Sc2), comprising total costs (TC), field work costs (FWC), logistic costs (LC), benefit of automation (BA), net costs of automation (NC), and net benefit of automation (NB) for the field robot operation in €/ha

Route ID	Field robot: power harrowing						Field robot: sowing						Field robot: inter-row hoeing					
	TC	FWC	LC	BA	NC	NB	TC	FWC	LC	BA	NC	NB	TC	FWC	LC	BA	NC	NB
LaFarm1	59.99	48.29	11.70	14.62	45.37	6.47	52.77	41.06	11.70	14.62	38.15	6.47	47.93	36.23	11.70	14.62	33.31	6.47
LaFarm2	74.14	51.74	22.41	15.39	58.75	-2.84	66.40	44.00	22.41	15.39	51.01	-2.84	61.22	38.82	22.41	15.39	45.83	-2.84
WKFarm1	43.76	43.46	0.30	13.47	30.29	14.68	37.26	36.96	0.30	13.47	23.78	14.68	32.91	32.61	0.30	13.47	19.43	14.68
WKFarm2	50.70	50.36	0.34	15.70	35.00	17.10	43.16	42.82	0.34	15.70	27.47	17.10	38.12	37.78	0.34	15.70	22.43	17.10
WKFarm3	51.15	44.15	7.00	13.39	37.76	8.32	44.55	37.55	7.00	13.39	31.16	8.32	40.13	33.12	7.00	13.39	26.73	8.32
WKFarm4	60.75	55.88	4.87	16.56	44.19	14.02	52.39	47.52	4.87	16.56	35.83	14.02	46.80	41.92	4.87	16.56	30.24	14.02
WKFarm5	52.22	46.91	5.32	14.42	37.80	11.11	45.21	39.89	5.32	14.42	30.78	11.11	40.51	35.20	5.32	14.42	26.09	11.11
WKFarm6	54.12	44.84	9.28	13.59	40.53	6.64	47.41	38.13	9.28	13.59	33.82	6.64	42.92	33.64	9.28	13.59	29.33	6.64
WKFarm7	57.29	50.36	6.93	15.32	41.97	10.52	49.76	42.82	6.93	15.32	34.44	10.52	44.71	37.78	6.93	15.32	29.40	10.52
WKFarm8	59.98	48.29	11.69	14.05	45.93	5.16	52.76	41.06	11.69	14.05	38.70	5.16	47.92	36.23	11.69	14.05	33.87	5.16
WKFarm9	70.53	49.67	20.86	13.25	57.28	-3.91	63.10	42.24	20.86	13.25	49.85	-3.91	58.12	37.27	20.86	13.25	44.88	-3.91
WKFarm10	69.75	50.36	19.39	13.69	56.06	-2.28	62.22	42.82	19.39	13.69	48.53	-2.28	57.18	37.78	19.39	13.69	43.49	-2.28
WKFarm11	62.09	46.91	15.18	12.91	49.18	1.00	55.07	39.89	15.18	12.91	42.16	1.00	50.38	35.20	15.18	12.91	37.46	1.00
WKFarm12	58.40	44.84	13.56	12.90	45.50	2.15	51.69	38.13	13.56	12.90	38.80	2.15	47.20	33.64	13.56	12.90	34.31	2.15
Mean	58.92	48.29	10.63	14.23	44.69	6.29	51.70	41.06	10.63	14.23	37.46	6.29	46.86	36.23	10.63	14.23	32.63	6.29
SD	8.45	3.42	7.09	1.14	8.46	6.79	8.17	2.91	7.09	1.14	8.24	6.79	8.00	2.57	7.09	1.14	8.10	6.79