Possibilities of using decision support systems for agriculture in areas with high agrarian fragmentation

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Table 1. Characteristics of the surveyed farms

Area	Number of farms [GUS, 2020]	Production mainly (including exclusively) for own use	Farm structure by size [%]				
			up to 1 ha inclusive	1 - 5 ha	5 - 10 ha	10 - 15 ha	15 ha and more
Poland	1 316 759	15.70	1.87	50.15	21.95	9.91	16.12
Małopolskie voivodeship	126 172	33.93	2.54	78.37	13.24	2.79	3.06
Podkarpackie voivodeship	114 182	39.03	2.30	76.86	13.75	2.96	4.14
Farms surveyed	389	*10.54	x	62.98	20.05	7.20	9.77

Source: **GUS (2020) and own study.

* Production exclusively for own use; **https://stat.gov.pl/

Table 2. Digital technologies used in the surveyed farms – the total group and groups of farms by size [% of responses]

Types of digital technologies	Use of digital technologies in the surveyed household groups [percentage of answers given by respondents]				
	Total	≤2.7 ha	>2.7ha≤4ha	>4ha≤7.8ha	>7.8ha
Decision support applications	18.77	2.83	8.60	12.77	52.08
Plant disease recognition applications	26.22	5.66	15.05	26.60	59.38
Cloud-based farm management systems	7.97	1.89	1.08	1.06	28.13
Precision farming systems	0.26	0.00	0.00	0.00	1.04
Real-time data collection sensors	4.88	0.00	0.00	1.06	18.75
Animal production automation systems	9.25	0.00	0.00	5.32	32.29
Drones monitor the current condition of crops and soils	0.00	0.00	0.00	0.00	0.00
Agricultural robots enabling crop production automation	1.29	0.00	0.00	0.00	5.21
None of the digital solutions are used	65.81	94.34	82.80	63.83	19.79

Source: own study.

Table 3. Characteristics of respondents and surveyed farms in the group in general and depending on farm size [% of responses]

Specification		Farm size				
		Total	up to 2.7 ha	>2.7ha≤4ha	>4ha≤7.8ha	>7.8ha
Age	up to 35	10.80	13.21	9.68	5.32	14.58
	35-50	39.59	28.30	36.56	42.55	52.08
	>50	49.61	58.49	53.76	52.13	33.33
Gender	Female	35.99	53.77	36.56	34.04	17.71
	Male	64.01	46.23	63.44	65.96	82.29
Respondents' education	Elementary	6.43	9.43	9.68	5.32	1.04
	Vocational agricultural	16.71	3.77	15.05	21.28	28.13
	Vocational other than agricultural	26.99	39.62	33.33	28.72	5.21
	Secondary agricultural	14.14	0.94	5.38	13.83	37.50
	Secondary other than agricultural	23.65	29.25	27.96	24.47	12.50
	Higher agricultural	1.80	0.00	0.00	1.06	6.25
	Higher other than agricultural	10.28	16.98	8.60	5.32	9.38
Employment	On the farm exclusively	58.61	40.57	51.61	57.45	86.46
	On and off the farm	41.39	59.43	4839	42.55	13.54
Organizational form	Individual farm	99.74	100.00	97.85	100.00	98.96
	Agricultural enterprise	0.26	0.00	0.00	0.00	1.04
Type of farm	Conventional Farm	96.14	98.11	96.77	97.87	91.67
	Organic farm	2.83	1.89	3.23	2.13	4.17
	Farm with integrated production	1.03	0.00	0.00	0.00	4.17
Dominant production direction	Crop production	79.18	96.23	84.95	7.66	56.25
	Animal production	20.57	3.77	15.05	21.28	43.75
Production directions	Cattle breeding	19.02	11.32	17.20	23.40	25.00
	Pig breeding	13.37	6.60	10.75	9.57	27.08
	Poultry breeding	48.84	67.92	50.54	48.94	26,04
	Sheep/goat breeding	3.08	0.00	5.38	3.19	4.17
	Horse breeding	1.80	0.94	2.15	1.06	3.13
	Creal cultivation	91.52	78.30	96.77	94.68	97.92
	Oil plant cultivation	22.37	7.55	19.35	23.40	40.63
	Legume cultivation	9.77	14.15	9.68	8.51	6.25
	Field vegetable cultivation	45.24	65.09	45.16	40.43	28.13
	Berry cultivation	2.57	2.83	5.38	2.13	0.00
	Fruit growing	15.42	27.36	10.75	10.64	11.46
	Greenhouse production	9.25	15.09	10.75	8.51	2.08
	Fodder plant cultivation	37.79	29.25	43.01	42.55	37.50
	Processing of agricultural products	10.03	1.89	6.45	10.64	21.88
	Provision of agricultural services	5.40	0.94	1.08	7.45	12.50
	Agritourism	1.29	0.00	2.15	3.19	0.00
	Zootherapy	0.26	0.00	0.00	0.00	1.04
	Shop operating at a farm	0.77	0.00	0.00	1.06	2.08
	Others	0.00	0.00	0.00	0.00	0.00

Source: own study.

Table 4. Barriers to the use of decision support applications and cloud-based farm management systems in the study group in general and depending on selected farm and respondents characteristics

Specification	**Total**	Farms with an area of up to 4 ha	Farms with an area of over 4 ha	Respondents up to 50 years of age	Respondents over 50 years of age	Respondents with agricultural education	Respondents with education other than agricultural
Financial barrier	**55.01**	37.19	73.68	66.84	43.01	78.57	43.51
The belief that there is no need to implement such solutions	**43.19**	67.34	17.89	26.02	60.62	15.87	56.49
Hardware shortages	**38.05**	26.63	50.00	47.45	28.50	55.56	29.39
The need to improve IT skills	**22.11**	9.05	35.79	26.02	18.13	31.75	17.56
Lack of trust in such systems and their creators	**19.02**	20.60	17.37	9.69	28.50	11.11	22.90
Technical problems (the quality of local infrastructure makes it difficult to access high-speed Internet)	**16.20**	11.56	21.05	23.47	8.81	27.78	10.69
These systems are not intuitive/difficult to use	**16.20**	5.03	27.89	21.43	10.88	26.19	11.45
Lack of systems that fully meet the needs of farm (too few options available)	**13.11**	7.54	18.95	20.41	5.70	18.25	10.69
Lack of knowledge of such solutions until taking part in the study	**12.85**	19.10	6.32	5.10	20.73	9.52	14.50
Lack of access to training in the use of this type of solutions	**8.23**	1.51	15.26	12.24	4.15	15.87	4.58
Concern about sharing agricultural activity data with applications	**7.46**	4.02	11.05	8.16	6.74	8.73	6.87
Lack of time to learn how these systems work	**5.66**	3.52	7.89	7.14	4.15	7.94	4.58
I do not see any barriers to using these solutions	**1.29**	1.01	1.58	2.04	0.52	0.79	1.53

Source: own study.

Table 5. Assessment of the usefulness of functions available within cloud-based farm management systems in the surveyed farms in general and depending on selected farm and respondents characteristics

Specification	**Total**	Farms with an area of up to 4 ha	Farms with an area of over 4 ha	Respondents with agricultural education	Respondents with education other than agricultural	Users of at least one decision support system in total (n=127)	Not using decision support systems (n=262)
Possibility to receive information about the risk of plant infection/disease	**77.63**	65.83	90.00	91.27	70.99	100.00	66.79
Access to accurate weather forecast for individual agricultural plots	**61.95**	48.24	76.32	80.95	52.67	92.91	46.95
Possibility to estimate the consumption of raw materials (e.g. consumption of seed, plant protection products, fodder)	**61.70**	42.71	81.58	86.51	49.62	96.85	44.66

Yield prediction (depending on the resources used, detailed weather forecasts)	**58.61**	39.20	78.95	80.95	47.71	95.28	40.84
Collecting and storing data sent by sensors about soil moisture, air temperature, and nutrient content in crops	**55.27**	35.18	76.32	80.16	43.13	95.28	35.88
Remote information exchange with other farmers	**48.33**	31.66	65.79	68.25	38.55	81.10	32.44
Records of sales, inventories, payments, profits	**47.56**	24.62	71.58	72.22	35.50	91.34	26.34
Research on the impact of farm activities on the natural environment	**37.28**	20.10	55.26	61.90	25.19	77.17	17.94
Possibility to collect and process information from systems tracking animals' behavior, condition and physical activity	**32.13**	13.57	51.58	58.73	19.08	66.93	15.27
Remotely assigning tasks to employees	**19.54**	5.53	34.21	38.89	9.92	51.97	3.82
Remotely receiving information from employees (about the progress of work, problems)	**19.28**	5.53	33.68	38.10	9.92	50.39	4.20

Source: own study.