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Adoption level of smart agriculture practices in south-west zone and north-east zone of Haryana

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ABSTRACT

Present study was carried out in Hisar and Kaithal districts of Haryana to find out adoption level of smart agriculture practices. The data were collected with the help of well-structured and pre-tested interview schedule and analyzed through Statistical Package for Social Sciences (SPSS) for tabulating results and drawing conclusions. It was observed that adoption level was high about conjunctive use of water (63.52%), certified seed for crop production (71.11%), seed cum fertilizer drill machine (62.04%), integrated nutrient management (60.93%), recommended nozzle for spray (97.04%), abandoning crop stable burning (88.52%), cropping system having high productivity (73.70%), kisan mela visit (46.11%), and storing produce for future sale (43.52). Study also observed that 43.00% (r^2=0.43) variation in the adoption of the respondents regarding smart agriculture practices when other factors were kept constant.

Key words: Agriculture, Adoption, Haryana, Practices

Agriculture constitutes important part of Indian economy and at present, it is among the top two farm producers in the world. Two-thirds of India's population directly or indirectly depends on agriculture and allied activities for livelihood. Agriculture sector of India occupies almost 43% of India's total geographical area (Arjun 2013).

Population growth and dietary changes will drive global food demand to unprecedented levels in the coming decades. To keep pace, food production will have to increase 60% by 2050 (FAO 2013). While, number of farmers with marginal land holdings increased from 36 million in 1971 to 93 million in 2011 (Anonymous 2011). With the population growth rate of 1.58%, India is predicted to have more than 1.53 billion people by the end of 2030. Whereas, natural resources such as land, water, forests, livestock, fisheries is deteriorating and degrading at a very fast rate due to unmindful agricultural intensification, imbalanced use of fertilizers, overuse and inefficient use of irrigation water and deforestation. Therefore, there is immense need of smart agricultural practices (SAPs) to enhance the production and productivity through sustainable use of natural resources and reduce the input cost, increase the net profit, and generate employment.

Keeping this view, the present study was taken with the objective to identify the adoption level of smart agriculture practices in south-west zone and north-east zone of Haryana.

MATERIALS AND METHODS

The study was conducted in Haryana in 2017. Two districts, viz. Hisar from south-west zone and Kaithal from north-east zone were selected, purposively. Further, three villages from each district were selected, randomly. Thus, six villages namely, Ladwa, Shahrwa and Rawalwas Khurd villages from Hisar; while, Kaul, Rasina and Bhana villages from Kaithal were selected, randomly. Further, thirty farmers were selected, randomly from each selected village. Thus, a total number of 180 respondents were interviewed for the present study. A schedule was developed to measure the adoption level after paid a deep discussion with advisory committee, experts and professionals. Available research based literature were also reviewed for the preparation of the interview schedule. The responses of farmers were obtained on three-point continuum scale as full adoption, partial adoption and no adoption and weightage was given as 3, 2 and 1, respectively. Aggregate total weightage score was calculated for each statement separately and on the basis of calculated score, total weighted score and weighted mean score were obtained. Further, rank orders were assigned based on the weighted mean score.

Adoption index was calculated with the following formula:

$$\text{Adoption index (AI)} = \frac{\text{Total obtained adoption score}}{\text{Maximum possible obtained adoption score}} \times 100$$

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RESULTS AND DISCUSSION

Soil and water management practices

It is evident from Table 1 that 'conjunctive use of water' practice was highly adopted with adoption index (AI) 63.52%, followed by 'soil and water testing' (48.89%), 'soil conservation measures' (43.33%) and 'water saving technology' (37.41%) ranked 2nd, 3rd and 4th, respectively.

Canal was the main source of irrigation, so conjunctive use of water was highly adopted while sufficient water is present in the area of north-east of Haryana, therefore, water saving technology is not common among farmers' and thus not adopted or it may be the reason of low adoption. Hadgu *et al.* (2015) suggested that farmers should adopt soil and water conservation practices. The findings were confirmed with the findings of Dudi and Meena (2016) who reported that medium adoption was observed in case of irrigation management.

Seed and seed rate

Table 2 showed that 'certified seed for crop production' was highly adopted by the farmers with adoption index (AI) 71.11%, followed by 'recommended variety for sowing' (60.37%), 'recommended sowing time' (58.89%) and 'recommended sowing seed rate, (58.70%) ranked 2nd, 3rd and 4th, respectively. Whereas, 'treatment by recommended fungicides' ranked 5th with lowest adoption index.

Certified seed is sale by the various private companies so it was highly adopted among all, while, sowing time may be effective due to weather or farmer condition and farmers increase the seed rate according to local advise or their willing so these practices were not adopted by the farming community. Similar results were also reported by Singh (2008) and partially support by reports of Chaudhary *et al*. (2013), Dudi and Meena (2016).

Farm power machinery

Table 3 indicated that 'seed cum fertilizer drill machine' ranked 1st with highest adoption index (AI) 62.04%, followed by 'laser land leveler' (52.59%), 'happy seeder' (47.78%) and 'residue management by rotavator' (45.93%) ranked 2nd, 3rd and 4th, respectively. However, adoption level was poor about 'bed planter for bed planting'.

Adoption level was high to low may be due to financial situation of the farmers because majority of the farmers belonged to small land holding category. Singh *et al.* (2008) in his study reported that lack of money to purchase new machines was major constraint in adoption of farm power machinery.

Manures and fertilizer

Data in Table 4 showed that 'integrated nutrient management (INM)' ranked 1st with highest adoption index (AI) 60.93%, followed by 'recommended time of application of fertilizers' and 'organic manures to the soil' both were ranked 2nd with equal AI 59.63%. Whereas,

Table 1 Adoption level of soil and water management practices (n=180)

Practice	Fully adopted (%)	Partially adopted (%)	Not adopted (%)	Total weighted score	Weighted mean score	Adoption in %	Rank order
Soil and water testing	12 (6.67)	60 (33.33)	108 (60.00)	264	1.47	48.89	II
Conjunctive use of water	26 (14.44)	111 (61.67)	43 (23.89)	343	1.91	63.52	I
Soil conservation measures	8 (4.44)	38 (21.11)	134 (74.44)	234	1.30	43.33	III
Water saving technology	7 (3.89)	8 (4.44)	165 (91.67)	202	1.12	37.41	IV

Table 2 Adoption level of seed and seed rate (n=180)

Practice	Fully adopted (%)	Partially adopted (%)	Not adopted (%)	Total weighted Score	Weighted mean score	Adoption in %	Rank order
Certified seed for crop production	39 (21.67)	126 (70.00)	15 (8.33)	384	2.13	71.11	I
Recommended variety for sowing	7 (3.89)	132 (73.33)	41 (22.78)	326	1.81	60.37	II
Recommended sowing time	1 (0.56)	136 (75.55)	43 (23.89)	318	1.77	58.89	III
Recommended seed rate	0 (0.00)	137 (76.11)	43 (23.89)	317	1.76	58.70	IV
Treatment by recommended fungicides	0 (0.00)	31 (17.22)	149 (82.78)	211	1.17	39.07	V

Table 3 Adoption level of farm power machinery (n=180)

Practice	Fully adopted (%)	Partially adopted (%)	Not adopted (%)	Total weighted score	Weighted mean score	Adoption in %	Rank order
Laser land leveler	10 (5.56)	84 (46.67)	86 (47.77)	284	1.58	52.59	II
Happy seeder	8 (4.44)	62 (34.44)	110 (61.11)	258	1.43	47.78	III
Residue management by rotavator	7 (3.89)	54 (30.00)	119 (66.11)	248	1.38	45.93	IV
Bed planter for bed planting	3 (1.67)	30 (16.67)	147 (81.66)	216	1.20	40.00	V
Seed-cum-fertilizer drill machine	24 (13.33)	107 (59.44)	49 (27.22)	335	1.86	62.04	I

Table 4 Adoption level of manures and fertilizer (n=180)

Practice	Fully adopted (%)	Partially adopted (%)	Not adopted (%)	Total weighted score	Weighted mean score	Adoption in %	Rank order
Integrated nutrient management (INM)	7 (3.89)	135 (75.00)	38 (21.11)	329	1.83	60.93	I
Recommended time of application of fertilizers	6 (3.33)	130 (72.22)	44 (24.44)	322	1.79	59.63	II
Recommended time of interval for fertilizers	6 (3.33)	121 (67.22)	53 (29.44)	313	1.74	57.96	IV
Foliar application of fertilizers	2 (1.11)	33 (18.33)	145 (80.56)	217	1.21	40.19	VI
Proper method of application of fertilizers	3 (1.67)	122 (67.78)	55 (30.55)	308	1.71	57.04	V
Organic manures to the soil	8 (4.44)	126 (70.00)	46 (25.56)	322	1.79	59.63	II
Gypsum in field	7 (3.89)	124 (68.89)	49 (27.22)	318	1.77	58.89	III

'gypsum in field' (58.89%), 'recommended time of interval for fertilizers' (57.96%), 'proper method of application of fertilizers' (57.04%), and 'foliar application of fertilizers' (40.19%) ranked 3rd, 4th, 5th and 6th, respectively.

For adoption of such technologies, demonstration should be carried out at farmers' fields so that their doubts can be sought out and adoption level can be increased. These findings were found to partially support by reports of Chowdhury and Ray (2009), Yadav *et al.* (2013) and Arshed *et al.* (2014).

Plant protection measures

Examination of the data presented in Table 5 indicated that 'recommended nozzle for spray' was highly adopted, followed by 'integrated pest management (IPM)' (60.56%) ranked 2nd. Moreover, 'recommended dose of insecticides and fungicides' (59.07%), 'recommended insecticides and fungicides' (57.78%), 'recommended schedule of spray' (55.56%), and 'mechanical control' (47.41%) ranked 3rd, 4th, 5th and 6th, respectively. However, adoption was very poor about 'biological control' ranked 7th with lowest adoption index.

Adoption of these practices can be increased through the demonstrations in farming community. These research findings were found to be partially support by the reports of Singh (2008), Chowdhury and Ray (2009) and Yadav *et al.* (2013).

Improved agronomic management practices

Adoption of improved agronomic management practices is presented in Table 6. 'Crop stable burning is abandoned' ranked 1st with highest adoption index (AI) 88.52%, followed by 'improved cropping system to match soil and climate' (72.96%) ranked 2nd. Whereas, 'integrated weed management (IWM)' (57.59%) and 'proper crop rotation' (54.44%) ranked 3rd and 4th, respectively. While, 'crop diversification' (50.00%), 'agricultural waste management' (46.67%), 'shelter belt against wind erosion' (39.44%), 'drainage system' (39.26%), 'zero tillage' (36.30%), and 'integrated farming system (IFS)' (35.00%) ranked 5th, 6th, 7th, 8th, 9th and 10th, respectively. However, adoption level was very poor about 'mulching practices' with lowest AI.

Various programs through mass media and campaigns for creating more awareness should be organized by state

Table 5 Adoption level of plant protection measures (n=180)

Practice	Fully adopted (%)	Partially adopted (%)	Not adopted (%)	Total weighted score	Weighted mean score	Adoption in %	Rank order
Integrated pest management (IPM)	7 (3.89)	133 (73.89)	40 (22.22)	327	1.82	60.56	II
Recommended insecticides and fungicides	7 (3.89)	118 (65.56)	55 (30.55)	312	1.73	57.78	IV
Recommended dose of insecticides and fungicides	6 (3.33)	127 (70.56)	47 (26.11)	319	1.77	59.07	III
Recommended schedule of spray	4 (2.22)	112 (62.22)	64 (35.56)	300	1.67	55.56	V
Mechanical control	2 (1.11)	72 (40.00)	106 (58.89)	256	1.42	47.41	VI
Biological control	2 (1.11)	28 (15.56)	150 (83.33)	212	1.18	39.26	VII
Recommended nozzle for spray	170 (94.44)	4 (2.22)	6 (3.33)	524	2.91	97.04	I

Table 6 Adoption level of improved agronomic management practices (n=180)

Practice	Fully adopted (%)	Partially adopted (%)	Not adopted (%)	Total weighted score	Weighted mean score	Adoption in %	Rank order
Proper crop rotation	32 (17.78)	50 (27.78)	98 (54.44)	294	1.63	54.44	IV
Improved cropping system to match soil and climate	42 (23.33)	130 (72.22)	8 (4.44)	394	2.19	72.96	II
Crop diversification	20 (11.11)	50 (27.78)	110 (61.11)	270	1.50	50.00	V
Drainage system	2 (1.11)	28 (15.56)	150 (83.33)	212	1.17	39.26	VIII
Integrated farming system (IFS)	1 (0.56)	7 (3.89)	172 (95.55)	189	1.05	35.00	X
Integrated weed management (IWM)	7 (3.89)	71 (39.44)	102 (56.67)	311	1.72	57.59	III
Shelter belt against wind erosion	1 (0.56)	31 (17.22)	148 (82.22)	213	1.18	39.44	VII
Zero tillage	1 (0.56)	14 (7.77)	165 (91.67)	196	1.08	36.30	IX
Agricultural waste management	1 (0.56)	70 (38.89)	109 (60.55)	252	1.40	46.67	VI
Mulching practices	1 (0.56)	6 (3.33)	173 (96.11)	188	1.04	34.81	XI
Crop stable burning is abandoned	144 (80.00)	10 (5.56)	26 (14.44)	478	2.65	88.52	I

agriculture department to avoid crop stable burning. The present findings were in line with the findings of Vashishtha *et al.* (2010).

Miscellaneous agronomic management practices

It is evident from Table 7 that 'cropping system having high productivity' ranked 1st with highest adoption index (AI) 73.70%, followed by 'cropping pattern feasible for area' (73.15%) and 'manually weeding' (64.07%) ranked 2nd and 3rd, respectively. Whereas, 'spices and condiments' (59.63%), 'cash crops' (46.67%), 'gap filling' (46.11%), 'rouging practice' (42.41%), 'agro-forestry' (36.30%), 'mixed and relay cropping' (34.07%), and 'medicinal and aromatic plants' (33.89%) ranked 4th, 5th, 6th, 7th, 8th, 9th and 10th, respectively.

Manually weeding practices are common among farmers so adoption was high while, cropping pattern of northeast Haryana is mainly rice based and farmers do not

Table 7 Adoption level of miscellaneous agronomic management practices (n=180)

Practice	Fully adopted (%)	Partially adopted (%)	Not adopted (%)	Total weighted score	Weighted mean score	Adoption in %	Rank order
Cropping pattern feasible for area	48 (26.67)	119 (66.11)	13 (7.22)	395	2.19	73.15	II
Cropping system having high productivity	51 (28.33)	116 (64.44)	13 (7.22)	398	2.21	73.70	I
Cash crops	3 (1.67)	66 (36.67)	111 (61.66)	252	1.40	46.67	V
Agro-forestry	1 (0.56)	14 (7.78)	165 (91.66)	196	1.09	36.30	VIII
Mixed and relay cropping	1 (0.56)	2 (1.11)	177 (98.33)	184	1.02	34.07	IX
Medicinal and aromatic plants	1 (0.56)	1 (0.56)	178 (98.88)	183	1.02	33.89	X
Spices and condiments	1 (0.56)	140 (77.78)	39 (21.66)	322	1.79	59.63	IV
Gap filling	1 (0.56)	67 (37.22)	112 (62.22)	249	1.38	46.11	VI
Manually weeding	0 (0.00)	166 (92.22)	14 (7.78)	346	1.92	64.07	III
Rouging practice	2 (1.11)	45 (25.00)	133 (73.89)	229	1.27	42.41	VII

want to leave the existing rice-wheat cropping pattern so adoption was low in cash crop. It can be concluded that improved practices are mostly adopted by the farmers who had more land holding as compared to small. The present findings partially supported with the findings of Vashishtha *et al.* (2010) who reported that majority of the farmers adopted the medium level of the production technology.

Extension management practices

From the Table 8 it is apparent that mostly farmers 'visit

Table 8 Adoption level of extension management practices (n=180)

Practice	Fully adopted (%)	Partially adopted (%)	Not adopted (%)	Total weighted score	Weighted mean score	Adoption index (%)	Rank order
Visit the kisan mela *(Kharif* and *Rabi)*	2 (1.11)	65 (36.11)	113 (62.78)	249	1.38	46.11	I
Any demonstration attended	3 (1.67)	41 (22.78)	136 (75.55)	227	1.26	42.04	V
Any training or workshop	3 (1.67)	50 (27.78)	127 (70.55)	236	1.31	43.70	IV
SMS services regarding agricultural information	8 (4.44)	28 (15.56)	144 (80.00)	224	1.24	41.48	VI
Smart phone apps for agricultural information	1 (0.56)	15 (8.33)	164 (91.11)	197	1.09	36.48	IX
Call to kisan call centre/ATIC	2 (1.11)	6 (3.33)	172 (95.56)	190	1.06	35.19	X
Membership of any agricultural organization	1 (0.56)	38 (21.11)	141 (78.33)	220	1.22	40.74	VII
Member of any agricultural magazine (Haryana Kheti etc.)	5 (2.78)	22 (12.22)	153 (85.00)	212	1.18	39.26	VIII
Consult with extension personnel for updating the knowledge	9 (5.00)	42 (23.33)	129 (71.67)	240	1.33	44.44	III
Approach to SAUs or KVK or agriculture institute etc	5 (2.78)	57 (31.67)	118 (65.55)	247	1.37	45.74	II

Table 9 Adoption level of any other practices (n=180)

Practice	Fully adopted (%)	Partially adopted (%)	Not adopted (%)	Total weighted score	Weighted mean Score	Adoption in %	Rank order
Store your produce for future sale	7 (3.89)	41 (22.78)	132 (73.33)	235	1.31	43.52	I
Post-harvest management practices	1 (0.56)	3 (1.67)	176 (97.77)	185	1.03	34.26	IV
Contract farming	1 (0.56)	16 (8.89)	163 (90.55)	198	1.10	36.67	III
Registered for crop insurance	7 (3.89)	31 (17.22)	142 (78.89)	225	1.25	41.67	II

the Kisan Mela *(Kharif* and *Rabi)'* ranked 1st with highest adoption index followed by 'approach to SAUs or KVK or agriculture institute' (45.74%), 'consult with extension personnel for updating the knowledge' (44.44%), 'any training or workshop' (43.70%), and 'any demonstration attended' (42.04%) ranked 2nd, 3rd, 4th and 5th, respectively. Whereas, 'SMS services regarding agricultural information' (41.48%), 'membership of any agricultural organization' (40.74%), 'member of any agricultural magazine (Haryana Kheti etc.)' (39.26%) and 'smart phone apps for agricultural information' (36.48%) ranked 6th, 7th, 8th and 9th, respectively. It was surprising that adoption was very poor about 'call to kisan call centre/ATIC'.

In the light of the results obtained, it is necessary to hold awareness campaigns, training and meetings with farmers so that the farming community can adopt advance agricultural technologies. Sezgin *et al.* (2011) also reported that participation in extension studies, mass media and benefitting from agricultural incentives were effective on the adoption of innovations, while, Anavrat (2015) reported that growers need to be required information and technology timely for accelerating their better adoption.

Any other practices

It is clear from Table 9 that 'store your produce for future sale' with adoption index (AI) 43.52%, followed by 'registered for crop insurance' (41.67%), 'contract farming' (36.67%) and 'post-harvest management practices' (34.26%) ranked 2nd, 3rd and 4th, respectively.

Above said practices influenced by the education and financial situations of the farmer. Study got strength from the findings of Varadan and Kumar (2012).

Relationship between farmers' personality traits and their adoption level towards smart agriculture practices

The correlation coefficient between the farmers personality traits like education, land holding, cropping system, farming system, irrigation facilities, mass media exposure, extension contacts, risk orientation, economic motivation, and innovation proneness with the adoption level had positive and significant correlation, while, only age do not show any significant association at 0.05 level of probability. While in case of the partial regression coefficient of farmers' education, cropping system, farming system, irrigation facilities, mass media exposure, extension contacts, and innovation proneness were found significant. However, age, land holding, risk orientation, and economic motivation did not significantly contribute to the adoption of smart agricultural practices. These finding were found to partially support by report of Yadav *et al.* (2013).

Further, it is revealed that all the eleven independent variables included in the study jointly contributed 43.00% variation in the adoption of the respondents regarding smart agricultural practices when other factors were kept constant. This means that only 43.00% (r^2=0.43) of the variation in the dependent variable was due to these variables and remaining 57.00% variations is due to other variables.

Study concluded that there was a gap in adoption level of smart agriculture practices (SAPs). Thus, there is an immense need to motivate and encourage the farmers to adopt smart agriculture practices (SAPs) by organizing continuous trainings, campaigns, lectures and demonstrations.

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