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INFORMATION PROCESSING IN AGRICULTURE 3 (2016) 183–189

journal homepage: www.elsevier.com/locate/inpa

Agricultural experts' attitude towards precision agriculture: Evidence from Guilan Agricultural Organization, Northern Iran

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A R T I C L E I N F O

Article history:
Received 7 May 2016
Received in revised form
13 July 2016
Accepted 14 July 2016
Available online 21 July 2016

Keywords:
Attitudes
Factor analysis
Precision agriculture
Experts' attitude

A B S T R A C T

Identifying factors that influence the attitudes of agricultural experts regarding precision agriculture plays an important role in developing, promoting and establishing precision agriculture. The aim of this study was to identify factors affecting the attitudes of agricultural experts regarding the implementation of precision agriculture. A descriptive research design was employed as the research method. A research-made questionnaire was used to examine the agricultural experts' attitude toward precision agriculture. Internal consistency was demonstrated with a coefficient alpha of 0.87, and the content and face validity of the instrument was confirmed by a panel of experts. The results show that technical, economic and accessibility factors accounted for 55% of the changes in attitudes towards precision agriculture. The findings revealed that there were no significant differences between participants in terms of gender, field of study, extension education, age, experience, organizational position and attitudes, while education levels had a significant effect on the respondent's attitudes.

1. Introduction

Innovation is an important factor in the success and survival of knowledge-based organizations. The innovation process is managed for the creation of value, services, products, technology and new business systems [1]. With the introduction of agricultural informatization, the traditional agriculture has been reformed by advanced ICTs, eventually contributing to the significant improvements in agricultural productivity and sustainability [2]. Precision agriculture (PA) is this century's most valuable innovation in farm management that is based on using ICTs. This most recent innovation technology is based on sustainable agriculture and healthy food production, and it follows three principles: profitability and increasing production, economic efficiency, and the reduction of side effects on the environment [3]. PA is such a new emerging and highly promising technology, that it is spreading rapidly in the developed countries. PA research started in the US, Canada, Australia, and Western Europe in mid-tolate 1980s. Although a considerable research effort has been expended, it is still only a portion of farmers who have practiced any type of PA technologies [4]. PA is conceptualized by a

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Peer review under responsibility of China Agricultural University.
http://dx.doi.org/10.1016/j.inpa.2016.07.001
2214-3173

system approach to re-organize the total system of agriculture towards a low-input, high-efficiency, and sustainable agriculture [5]. Precision agriculture is a management strategy that uses information technology to bring data from multiple sources to bear on decisions associated with crop production [6,7]. It is aimed at diversifying the management of situations and time in order to achieve maximum utility in various parts of the field; it should be pathological, since there is heterogeneity in different parts of the field. Quantifying the impact of changes in crop function plays an important role in precision agriculture because the overtime changes are unstable. Precision agriculture requires advanced technology for its implementation, such as intelligent agricultural machinery, and it is also time-consuming. Primarily, the farmer must accept it as a management system, trust it and, finally, apply it in order to achieve full utility. Along with the various attempts to achieve sustainable agriculture in communities, various strategies have been implemented [8].

For the optimal and stable use of agricultural lands, proper planning and the utilization management of land is essential so that the implementation of maximum seminal utilization can be accomplished, and economic and social development and improvement, as well as environmental protection, can be expressed [9]. Agricultural development in Iran actually requires the participation of specialists and the application of scientific principles to crop production [10] thus, the importance of precision agriculture with a sustainable approach for development. It is first necessary to examine the factors relating to seminal attitudes in order to promote and expand it.

The results indicated that attitude to use, is the most determinant of intention to adoption of precision agriculture technologies. Various studies have shown that an antecedent to adoption or decision to adoption is creating suitable attitude toward new technology [11]. An attitude can be seen as a special preparation of a person's mental readiness to deal with phenomena, problems, matters and events, and a readiness with excitement which is due to each individual's past and their different experiences in life. All various definitions of attitude which are expressed refer to attitude as a learnable and partly durable reality which is expensed as the person's orientation and, based on it, the person judges about phenomena in a positive or negative way [12]. Oppenheim [13] defines an attitude as a state of readiness to act, a willingness to act or as a special reaction regarding a specific stimulus. He believes that they are strengthened by opinions and beliefs (perception factors) and that they often absorb strong feelings (sense factors), leading to certain types of behavior (motion factors). He suggests that attitude is only very rarely the product of a balanced conclusion after a careful assembly of evidence.

Studying the different attitudes of people regarding different themes/bases is important because it helps managers and stakeholders to understand the activators regarding thinking about certain issues [14]. Attitudes are shaped or changed by education (direct and indirect) [15]. Studying the attitudes of the Guilan Agricultural Organization's experts (as the most important executives in agriculture) can identify the strengths and weaknesses of organizations and empower them. According to Omidi Najafabadi et al. [16], the various challenges involved can be classified in terms of nine latent variables, namely: educational, economic, operator demographic, technical, data quality, high risk, time, educational institution, incompatibility challenges. The results suggest educational and economic challenges as the two most important challenges in the application of precision agriculture. Among the variables which contribute to educational challenges, a lack of local experts and a lack of knowledgeable research and extension personnel have more of an impact when compared to others, while a lack of allocations of funds to precision agriculture and initial costs have more of an impact among the economic challenges compared to the other variables.

Hosseini et al. [17] studied the infrastructures of precision agriculture's implementation possibility perspective of the Fars jihad-e-Keshavarzi Agriculture Organization experts in Iran. According to F-test results, educational, economic, technical, management and policy factors affect the possibility of precision agriculture's application. There were no significant differences between social factors and the possibility of precision agriculture's application/implementation. Moreover, educational, economic and technical factors accounted for 69% of the changes toward the dependent variable. A study by Mennalled et al. [18] on the evaluation of agricultural professionals' perceptions and knowledge of sustainable agriculture assessed the needs, knowledge and interests of agricultural professionals who were likely to enroll on an online extension course in sustainable agriculture. This study highlighted the importance of understanding the level of knowledge, concerns and interests of the target audience.

It is vital that Iran moves toward precision agriculture technologies quickly due to potential capacities and it cannot be actualized unless different agricultural operators are involved. Due to the key role of agricultural experts in innovation adoption by farmers [6], this study was conducted to determine the perceptions of agricultural experts in Guilan, regarding the implementation of precision agriculture. The following research objectives guided the study:

1. Describe the demographic characteristics of the agricultural experts.
2. Describe the perceptions of agricultural experts towards precision agriculture.
3. Identify factors underlying agricultural experts' perceptions of precision agriculture.

2. Materials and methods

Agricultural experts in Guilan Province, near the Caspian Sea, in the north of Iran were the statistical population of this study. Guilan covers an area of 14,711 km and has a population of 2,403,716. This province has 400,000 ha of agricultural land, 60% of which is allocated to rice cultivation. Guilan has 230,000 ha of paddy fields with an annual production of 700,000 tons of white rice (Fig. 1). This amount is equivalent to 30% of the country's rice production. This statewide study

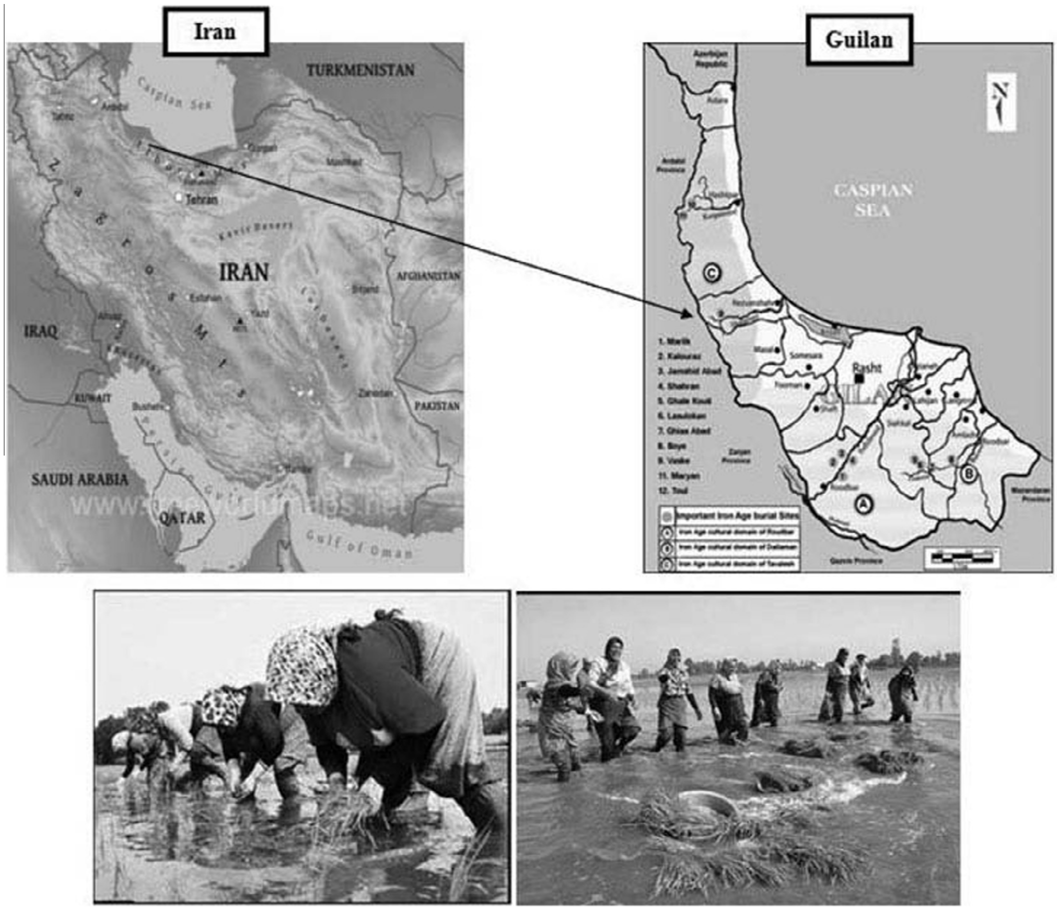

Fig. 1 – Site of study, and photos characterizing rice cultivation in the Guilan Province of northern Iran [23].

used a descriptive research design. The target population consisted of all the experts in different fields of agriculture (agronomy, horticulture, extension, mechanization, engineering) in Guilan Province ($n = 234$) in northern Iran. According to the table for determining the sample from a given population, as developed by Bartlett et al. [19], 133 experts were selected using the cluster sampling method. The survey instrument was a self-made questionnaire that tested for validity prior to implementation as well as testing and developing for reliability using the alpha coefficient. Two sections were included in the questionnaire: (1) the first section employed seven multiple choice questions and open ended questions to gather participants' sociodemographic information and past experience including gender, age, experience, level of education, organizational position, field of study and attendance of precision agriculture courses and (2) section two that served to describe the PA experts towards precision agriculture. Twelve statements about PA were listed. Participants were asked to indicate the level of agreement with the statement on a five-point Likert type scale (none = 1 to very much = 5). Validity is the most important consideration in developing a research instrument [20]. To establish face validity and content validity for this survey instrument, a panel of experts consisting of three faculty and three agricultural experts reviewed and revised the survey instrument. A pilot study was conducted with a small group of agricultural experts ($n = 15$) from Guilan Province. Adequacy, feasibility and reliability were verified by the pilot study. Cronbach's alpha determines the internal consistency in a survey instrument to gauge its reliability [21]. The Cronbach's alpha reliability coefficient of section two of the survey instrument for this study was 0.87. Nunnaly [22] indicated 0.70 or higher to be an acceptable reliability coefficient. Following the collection period, data were coded and entered into SPSS. Descriptive statistics of central tendency and variability were calculated to summarize the data. Exploratory factor analysis was used to identify factors underlying agriculture experts' perceptions of PA.

3. Results and discussion

Findings showed that 88.7% ($f = 118$) of the respondents were male (Table 1). The mean age of the Agricultural Organization experts was 42.36 years (SD = 86.2). Their average experience was 17.5 years (SD = 6.91). The results showed that more than half (51.9%) of the respondents worked as an expert in their organization. The majority of the respondents were B.Sc. degree holders (74.2%). Results revealed that 84.2% of the respondents had studied in the agricultural field and more

Table 1 – Descriptive statistics of experts' personal characteristics.

Characteristics	Groups	Frequency	Percentage	Mean	SD
Gender	Male	118	88.7		
	Female	15	11.3		
Age (yr)	20–30	4	3	42.36	86.2
	30–40	33	24.8		
	40–50	80	60.2		
	50>	13	9.8		
Experience (yr)	⩽5	7	5.3	17.5	6.91
	6–10	20	15		
	10–20	57	42.9		
	20⩾	49	36.8		
Organizational position	Expert	69	51.9		
	Supervisor	36	27.1		
	Head	16	12		
	Assistant	10	7.5		
	Manager	2	1.5		
Level of education	Bachelor of	99	74.2		
	Science	34	25.6		
	Master of Science and PhD				
Field of study	Agricultural	112	84.2		
	Non-agricultural	21	15.8		
Attending PA training courses	Yes	72	54.1		
	No	61	45.9		

than half (54.1%) had passed an extension course regarding precision agriculture.

The second objective of this study was to describe the perceptions of Guilan agricultural experts towards precision agriculture. The means and standard deviations of the experts' perceptions towards statements regarding precision agriculture are shown in Table 5.

To classify the respondents in terms of their attitudes towards precision agriculture, the following formulation was used [24,25].

A: weak: A < mean − SD
B: average: mean − SD ⩽ B ⩽ mean
C: good: mean < C ⩽ mean + SD
D: excellent: mean + SD > D

Based on the mean and standard deviation differences, scores of less than 1.73 were considered weak attitudes, scores between 1.73 and 2.25 were considered average attitudes, scores between 2.25 and 2.77 were considered good attitudes, and scores of more than 2.77 were considered excellent attitudes toward precision agriculture, as shown in Table 2.

Table 3 shows the effects of the experts' sociodemographic characteristics on precision agriculture. According to the t-test and F-test findings, there were no significant differences between gender, field of study, attending PA training courses, age, experience, organizational position or attitudes; in addition, the level of education had a significant effect on the respondents ($p < 0.05$).

Common factor analysis is appropriate when measured variables are assumed to be a linear function of a set of latent variables [26]. The four commonly used decision rules were applied to identify the factors: (a) a minimum Eigen value of 1; (b) a minimum factor loading of 0.4 for each indicator item; (c) simplicity of the factor's structure; and (d) exclusion of single-item factors. By using Bartlett's test and the Kaiser–Meyer–Olkin (KMO) test, it can be determined whether the research variable is appropriate. In this study, for the factor analysis, KMO = 0.778, Bartlett = 499.348 and $p < 0.05$.

The findings of the exploratory factor analysis indicated that, based on the attitudes of the Agricultural Organization

Table 2 – Distribution of experts' attitude toward PA.

Level of attitude	Frequency	Percent	Cumulative percent
Weak	21	15.8	15.8
Average	59	44.4	60.2
Good	36	27	87.2
Excellent	10	12.8	100

Table 3 – Effects of sociodemographic characteristics on PA.

Variables	t	F	p-value
Gender	0.417		0.678
Field of study	−0.272		0.786
Attending PA training courses	0.008		0.994
Age		1.56	0.202
Job experience		0.878	0.454
Organizational position		0.303	0.876
Level of education		3.98	0.048

Table 4 – The extracted factors and eigenvalue, percent of eigenvalue's variance, and cumulative percentage.

Factors	Eigenvalue	Eigenvalue's variance%	Cumulative percent
Economic	2.89	22.20	22.20
Technical	2.44	18.76	40.96
Accessibility	1.8	13.88	54.84

experts in Guilan Province, three factors affected their attitudes regarding precision agriculture. These factors were labeled (1) economic (2) technical, and (3) accessibility. The first factor, with an eigenvalue of 2.89, accounted for 22.20% of the total variance such that these three factors accounted for 55% of the variance of effective factors in precision agriculture. The extracted factors with their eigenvalues, percentage of variance and cumulative percentage are presented in Table 4. The Cronbach's alpha reliability estimates for each sub-scales were 0.89 for the economic factor, 0.87 for technical factor, and 0.76 for accessibility factor (Table 5).

Table 4 indicates each eigenvalue of the three extracted factors of precision agriculture that factor loading greater than 0.4 was considered as a standard eigenvalue for each factors and variables with factor loading of less than 0.4, were excluded from the analysis. The economic factor had 22.2% of total variance, that is, the greatest effect. In other words, economic factor determines 22.2% of perception of experts towards PA. The main variables in the formation of this factor are optimal use of input, environmental effectiveness of PA and cost effectiveness of PA (Table 5). Pierpaoli et al. [27], reported that focusing on economic is one of the drivers to related to the intention of adopting new technologies in agriculture. In addition, many authors have confirmed the environmental and economic benefits derived from PA [28,29]. Technical factors determine 18.76% of perception of experts towards PA. Main variables in the formation of this factor were different degrees of importance in various stage of agriculture, technical and economic feasibility of PA in the great land and implication of government investment in PA (Table 5). These findings are in accordance with Pierpaoli et al. [27] study. They reported that farm size was one of the most important aspects influencing the adoption of PA technologies in the relevant literature. Farm size is the most frequently cited parameter affecting the use of new PA technologies. A farm can be defined as "large" if the total cultivable area is bigger than 500 hectares [28] confirming the economy-of-scale benefits related to the implementation of

Table 5 – Results of factor analysis on the attitude of the Guilan Agricultural Organization's experts regarding PA.

Variables	M	SD	Economic	Technical	Accessibility	α
Cost effectiveness of PA	1.79	0.87	0.656			0.89
Environmental effectiveness of PA	1.79	0.90	0.724			
Optimal use of input	1.63	0.82	0.786			
PA as a complicated management system	2.60	1.09	0.629			
Requirement of scientific teamwork	1.73	0.82	0.580			
The importance of data collected compared with other sources	1.94	0.90	0.527			
Time consuming	2.44	1.02		0.417		0.87
Technical and economic feasibility of PA in the great land	2.83	1.06		0.743		
Different degrees of importance in various stage of agriculture	2.32	0.92		0.780		
Implication of government investment in PA	1.91	1.02		0.736		
The existence of necessary technology in Guilan province	3.53	0.84			0.711	0.76
The ability to use precision agriculture in Guilan province	2.97	0.98			0.752	

Original Scale: 1 = None to 5 = Strongly Agree.

PA technologies (bigger is the size, greater is the intention to purchase PA technologies). Finally accessibility factor could explain 13.88% of perception. The availability of facilitating factors such as technical support or the possibility of a trial period with PA technology are reported by Adrian et al., [7].

4. Conclusion

The application of PA technologies is an alternative to sustainable agriculture. This is one of the fastest growing alternative agricultural systems in the world. The presence of experts about PA initiates a learning process, enabling potential users to become more aware and confident about PA tools, and thus promoting the perception of an "easy to use" technology [27]. Considering the role of precision agriculture on environmental sustainability and economic efficiency and growth, the present study was designed to identify effective constructions of the attitudes of agricultural experts in Guilan Province regarding PA. Primarily, in this regard, a series of effective variables regarding PA were extracted from the literature review. Based on the factor analysis conducted in this study, three effective constructions were classified. The first extracted factor was an economic factor, which included credit, a sufficient budget for essential equipment and machinery for the establishment of PA, cost reductions and increasing profits. The economic factor had 22.20% of the total variance. Omidi Najafabadi et al. [16] and Hosseini et al. [17] noted the importance of economic factors in precision agriculture. The second factor was a technical factor, which determined 16.76% of the total variance. The technical factor is necessary for the implementation of precision agriculture strategies and achieving maximum utility. Omidi Najafabadi et al. [16] and Hosseini et al. [17] noted the importance of technical factors in PA. The accessibility factor was the last extracted factor, which plays an important role in the training and orientation of consultants, farmers, educators and agricultural students, etc., regarding precision agriculture. Omidi Najafabadi et al. [16] and Hosseini et al., [17] believe that technical factors' role in training and the extension of precision agriculture is inevitable. According to the findings, it is clear that there are various factors that affect the attitudes of the Agricultural Organization's experts regarding precision agriculture. In other words, the perception and adoption of precision agriculture represent a complex management strategy. Therefore, economic, technical and accessibility factors should constitute the priority programs of the Agricultural Organization. According to the above considerations, components identified in this study should be recommended by agricultural experts and managers to identify the current situation and improve the required position.

Finally, as mentioned Rezaei-Moghaddam and Salehi [11], it is necessary to change our thinking regarding the agricultural system in Guilan. The application of PA technologies is an alternative to sustainable agriculture. The paper emphasizes the importance of changing Guilan experts' attitude towards using PA technologies. We should pay attention to this in educational programs. First of all, when specialists observe the results and effects of the precision technologies, this leads to changes in their attitudes. Also, there is necessity to show ease of use and usefulness of these technologies to them.

Acknowledgments

Financial support by Rasht Branch, Islamic Azad University, Iran Grant No. 4.5830 is acknowledged.

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