World Applied Sciences Journal 7 (2): 197-202, 2009
ISSN 1818-4952

Factors Affecting the Attitudes of Iranian Agricultural Faculty Members Towards Nanotechnology

[1]Seyed Mahmod Hosseini and [2]Rohollah Rezaei

[1]Department of Agricultural Education and Extension,
University of Tehran, P.O. Box 31587-4111 Karaj, Tehran, Iran
[2]Department of Agricultural Extension and Education,
Faculty of Agriculture, Zanjan University, Zanjan, Iran

Abstract: This descriptive survey research was undertaken to study the factors affecting attitudes of agricultural faculty members towards nanotechnology. The statistical population of this study consisted of the agricultural faculty members in Iran (N=225). A sample of 144 persons was selected by using the stratified random sampling method. Data collected using a mailed questionnaire that was validated by a twelve-member panel of experts and the reliability index was established by Cronbach alpha's coefficient. The descriptive results revealed that most of the agricultural faculty members were familiar with nanotechnology and its applications in agriculture at moderate level. Regression analysis indicated that 60.7% of attitudes of agricultural faculty members towards nanotechnology variance were explained by three variables including level of familiarity with nanotechnology, level of familiarity with applications of nanotechnology in agriculture and educational experience as well.

Keywords: Agriculture · Attitudes · Faculty Members · Nanotechnology

INTRODUCTION

Nanotechnology will leave no field untouched by its ground breaking scientific innovations. The agricultural industry is no exception [1]. Nanotechnology will enable making high-quality products at a very low cost and at a very fast pace. It commonly referred to as a generic technology that offers better-built, safer, long lasting, cheap and smart products that will find wide applications in household, communications, medicine as also agriculture and food industry amongst others. Currently, the main thrust of research in nanotechnology focuses on applications like electronics, automation, medicine and life science. The experience gained from this could be used to revolutionize the food and agriculture systems [2].

Nanotechnology has the potential to revolutionize the agricultural and food industry with new tools for the molecular treatment of diseases, rapid disease detection, enhancing the ability of plants to absorb nutrients etc. Smart sensors and smart delivery systems will help the agricultural industry combat viruses and other crop pathogens. In the near future nanostructured catalysts will be available which will increase the efficiency of pesticides and herbicides, allowing lower doses to be used. Nanotechnology will also protect the environment indirectly using alternative (renewable) energy supplies and filters or catalysts to reduce pollution and clean-up existing pollutants [3].

Perception is important part of public understanding of science [4-6]. Over the past 10 years, there has been a variety of efforts to inform the public about nanotechnology. Significant investments by industry, academia and governments, in both developed and developing countries have been made with the hope that advances in nanotechnology will have a profound and positive impact on a number of aspects of their societies lives [7-11]. While investment in research and development are important, the public understanding of any emerging technology can have a dramatic effect on the implementation of that technology. Misconceptions and even a general lack of understanding can lead the people to react negatively to the emerging technology [12-15].

The consensus that the public should be involved in deliberative discussions and assessments of emerging

Corresponding Author: Rohollah Rezaei, Assistant Professor, Department of Agricultural Extension and Education, Faculty of Agriculture, Zanjan University, Zanjan, Iran Tel/ Fax # +98-0-241-5152340

technologies at a much earlier stage of technological developments is a widely shared concern among governmental as well as nongovernmental stakeholders. This is especially the case when emerging technologies might imply unforeseen health and environmental hazards, as several studies by scientists, science organizations, the industry and NGOs have claimed about nanotechnology [16-19].

Nanotechnology is an emerging technology in Iran. In recent years, particularly since the beginning of this decade, this technology has attracted the attention of many scientists, policymakers, planners, economists and even politicians in many universities and some governmental organizations involved in various areas and disciplines. Undoubtedly, engaging the various present and the potential beneficiaries of agricultural sector using the benefits of nanotechnology in the process of technology development can be considered as one of the most important national research and development priorities. Therefore, various authorities and organizations have emphasized studying the knowledge and attitude of people towards nanotechnology at this stage of technology development, especially the *National Committee for Nanotechnology Development of the Ministry of Agriculture*, which funded this study. By taking account of this fact, the major purpose of this study was to investigate the factors affecting the attitudes of agricultural faculty members towards nanotechnology. The specific objectives were to identify:

- The level of familiarity of agricultural faculty members with nanotechnology and its applications in agricultural,
- The attitude of agricultural faculty members towards nanotechnology,
- The factors affecting the attitudes of agricultural faculty members towards nanotechnology.

Literature Review: There were limited literatures related to public understanding and perception towards nanotechnology in Iran especially in agriculture. However, many studies have been conducted in this area internationally, especially in the USA.

Research on public opinion regarding nanotechnology by Besley *et al.* [20] highlighted the range of views while also showing that Americans have a generally optimistic view about the potential personal and societal benefits of nanotechnology advance. Results of national phone survey of Americans' perceptions about nanotechnology (N=1536) by Cobb and Macoubrie [21] indicated that the public opinion about nanotechnology is in its infancy and the knowledge about it is quite limited. Yet, Americans' initial reaction to nanotechnology is thus far generally positive, probably rooted in a generally positive view of science overall. Survey respondents expected benefits of nanotechnology outweigh the risks and they reported feeling hopeful about nanotechnology rather than worried.

A random sample survey supported the notion that Americans generally have an optimistic view of nanotechnology, with potential health benefits topping the list of key benefits and invasion of privacy and military uses emerging as key concerns. Many respondents, unsurprisingly, had no clear views, but a large number evinced low trust in business leaders to appropriately manage the technology [22]. A 2004 Canadian telephone survey and focus groups found that a quarter of Canadians are familiar with nanotechnology and three-quarters are supportive of it after hearing a definition and specific applications. Three-quarters believed that nanotechnology is important for Canadian economy and society and believed it should be supported and regulated by the government [23].

The results of a research regarding the British public's awareness and knowledge of nanotechnology as well as perceived effect on quality of life showed that the public has a low awareness and knowledge of nanotechnology, influenced by age, gender and socioeconomic status. Definitions of nanotechnology by those who had heard of the term centered on small scale and/or potential applications. Of those who tried to give a nanotechnology definition, seven of ten felt it would improve their way of life in the future [24]. A comparison of the US and Canadian survey data from 2005 indicates, however, that the presence in both countries of several identifiable sub-groups who see few benefits to new technology may eventually present substantial challenges to widespread acceptance of nanotechnology [25].

MATERIALS AND METHODS

A descriptive survey research was conducted to achieve the objectives of the study. The population of this study consisted of all the faculty members of agricultural colleges of Shiraz, Sanati Isfahan and Ferdowsi Mashhad universities (N=225). According to the Krejcie and Morgan table [26], a sample of 144 persons was selected using the stratified random sampling method. Data were collected using a mailed questionnaire covering five areas: (1) demographic

characteristics such as sex, age, agricultural faculty members' educational experience (year) and employment status, (2) one question regarding the level of familiarity of agricultural faculty members with nanotechnology, (3) one question regarding the level of familiarity of agricultural faculty members with applications of nanotechnology in agriculture, (4) eight questions about perceptions of agricultural faculty members towards nanotechnology (as dependent variable). Questions regarding the levels of familiarity of agricultural faculty members with nanotechnology and its applications were measured using a five-point Likert scale in which any item was scored from 1 (very low) to 5 (very high). In addition, in order to measure the dependent variable, a five point Likert-type rating scale was developed and used (scored as 5= strongly agree to 1= strongly disagree) for positive items and reverse weighing for negative items. For the scale of "perceptions of agricultural faculty members towards nanotechnology", the total score of the scale was calculated by summing up of each item score. Finally, the total score was used for further analysis.

For determining the validity of the questionnaire, content validity was established. The content validity of the questionnaire was obtained by a twelve-member panel of experts in the field of agricultural extension and education at the University of Tehran and nanotechnology related fields from the Ministry of Agriculture. A pilot study was conducted to determine reliability of the instrument. Cronbach alpha's coefficient for scale of attitudes of agricultural faculty members towards nanotechnology was 0.91, which refers to the reliability of the research questionnaire. The collected data were analyzed using the statistical package for the social sciences (SPSS). Data analysis was carried out in two sections, consisting data description and data inferential analysis. Descriptive statistics such as frequency, percentage and cumulative percentage were used in the descriptive section. Correlation analysis and regression analysis were used in the inferential analysis section.

RESULTS

According to the results, most of the respondents (90.5%) were male and 9.5% were female. The average of respondents' age was 45 years old. For agricultural faculty members, the period of educational experience ranged from 1 to 30 years (13.5 years, on average). As to agricultural faculty members' employment status, more than half of them (51%) were official government employees and the rest (49%) were performing their jobs based on some other arrangements, like temporary employment.

As shown in Table 1, most of the respondents were familiar with nanotechnology at moderate level (42%). In addition, 28.5% and 12.5% of respondents indicated their familiarity with nanotechnology at high or very high levels, respectively. While, only some 17% of respondents were familiar with nanotechnology at low (11.4%) and very low (5.6%) levels.

As the Table 2 describes, the levels of familiarity of the respondents with applications of nanotechnology in agriculture were 7.2% very low, 10% low, 46.1% moderate, 25% high and 11.7% very high.

Table 3 shows attitudes of agricultural faculty members towards nanotechnology. According to results, 89.2% of the respondents agreed with following statement: "nanotechnology is considered as the next industrial revolution". Considering the statement: "nanotechnology causes convergence of scientific field and different expertise", 87% of the respondents indicated their agreement with that and only some 3.5% of them disagreed with this statement. The majority of the respondents (84.5%) believed that "benefits of nanotechnology will be more prevalent than its risks", while, 6.2% of them disagreed with this idea. Also, 80.2% of the respondents agreed with statement: "nanotechnology dose not compete with other technologies and is considered as complementary to others" and 6.7% of them disagreed. Regarding the statement: "development of nanotechnology results

Table 1: Level of familiarity of agricultural faculty members with nanotechnology

level of familiarity with nanotechnology	Frequency	Percent	Cumulative percent
Very low	8	5.6	5.6
Low	16	11.4	17
Moderate	61	42	59
High	41	28.5	87.5
Very high	18	12.5	100
Total	144	100	

Table 2: Level of familiarity of agricultural faculty members with applications of nanotechnology in agriculture

level of familiarity with applications of nanotechnology in agriculture	frequency	percent	cumulative percent
Very low	10	7.2	7.2
Low	14	10	17.2
Moderate	67	46.1	63.3
High	36	25	88.3
Very high	17	11.7	100.0
Total	144	100	

Table 3: Attitudes of agricultural faculty members towards nanotechnology

	Agree		Undecided		Disagree	
statements	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
nanotechnology is considered as the next industrial revolution	128	89.2	11	7.5	5	3.3
nanotechnology causes convergence of scientific field and different expertise	125	87	14	9.5	5	3.5
benefits of nanotechnology are more prevalent than risks	122	84.5	13	9.3	9	6.2
nanotechnology dose not compete with other technologies and is considered as complementary to others	115	80.2	19	13.1	10	6.7
development of nanotechnology results in establishment of poverty and social inequality	31	21.4	75	52.1	38	26.5
nanotechnology and consequences resulting from it can be discussed as a serious threat for human societies	25	17.1	43	29.9	76	53
nanotechnology and its applications has imaginary perspective	14	10	34	23.4	96	66.6
nanotechnology is considered as a temporary technological wave	11	7.4	29	20.5	104	72.1

Table 4: Results of regression analysis related to attitudes of agricultural faculty members towards nanotechnology

independent variables	R	R^2	R^2 Ad.	B	Beta	Sig.
constant	-	-	-	2.26	-	0.02
level of familiarity of agricultural faculty members with nanotechnology	0.675	0.455	0.368	1.86	0.493	0.000
level of familiarity of agricultural faculty members with applications of nanotechnology in agriculture	0.771	0.594	0.599	1.14	0.202	0.028
agricultural faculty members' educational experience	0.779	0.607	0.602	0.83	0.115	0.042

in establishment of poverty and social inequality", 21.4 and 26.5 percent of the respondents were agreed and disagreed, respectively. Relatively a small percent of the respondents (17.1%) believed that "nanotechnology and consequences resulting from it can be discussed as a serious threat for human societies". Ten percent (10%) of respondents agreed with the statement: "nanotechnology and its applications have imaginary perspective" and 65.6% of them disagreed with mentioned statement, too. Finally, only 7.4% of respondents indicated that "nanotechnology will be as a temporary technological wave", meanwhile, most of them (72.1%) were disagree with this idea.

The multivariate regression with stepwise method used for predicting impacts of independent variables on "attitudes of agricultural faculty members towards nanotechnology". The results of this analysis showed that the variable "level of familiarity of agricultural faculty members with nanotechnology" was entered in the equation in the first step. Multiple correlation coefficients (R) were 0.675 and coefficient determination (R^2) was 0.455. It means that 45.5% of the changes in dependent variables are explained by the above mentioned variable.

In the second step, the variable "level of familiarity of agricultural faculty members with applications of nanotechnology in agriculture" was entered in the equation. The variable increased R and R^2 to 0.771 and 59.4%, respectively, which describes 13.9% of the changes in dependent variable.

"Agricultural faculty members' educational experience" was entered in the equation in the third step. This variable increased R and R^2 to 0.779 and 60.7%, respectively. Thus, 1.3% of the changes in the dependent variable were described by the "agricultural faculty members' educational experience". These results are viewed in Table 4.

Taking the above results and those in table 4 into account, linear equation resulted from regression analysis is as follows:

$$Y= 2.26 + 1.86X1 + 1.14X2 + 0.83X3$$

The components of the equation include:

Y = Attitudes of agricultural faculty members towards nanotechnology,
X1 = Level of familiarity of agricultural faculty members with nanotechnology,
X2 = Level of familiarity of agricultural faculty members with applications of nanotechnology in agriculture,
X3 = Agricultural faculty members' educational experience.

According to the results shown in table 4, the variable "level of familiarity of respondents with nanotechnology" (*Beta*=0.493) had the greatest influence on the their attitudes towards nanotechnology.

CONCLUSION

This analysis was one part of a multifaceted study and it represented only a portion of what will eventually be reported from the survey. The study started by presenting data on respondents' familiarity with nanotechnology and its applications in agriculture. Clearly, most of the respondents were familiar with nanotechnology and its applications in agriculture at moderate level. Results related to attitudes of agricultural faculty members towards nanotechnology revealed that most of the respondents believed that potential benefits of nanotechnology outweigh its perceived risks. Also, most of the respondents considered nanotechnology "as the next industrial revolution and not as a threat for the human societies". At the same time, most of the respondents believed that "nanotechnology and its applications have no imaginary perspective and are not as a temporary technological wave". In general, the results of this study regarding the attitudes of agricultural faculty members towards nanotechnology indicated that respondents at this early stage of technology development hold a positive attitude towards nanotechnology and its benefits. However, this finding has been confirmed by various studies such as Cobb and Macoubrie [21, Macoubrie [26] and Besley *et al*. [20].

The findings of regression analysis also showed that 60.7% of attitudes of agricultural faculty members towards nanotechnology variance were explained by the two variables, level of familiarity with nanotechnology and its applications in agriculture. Therefore, it is suggested that in order to create a positive attitude in people and to lead them to programs related to agricultural nanotechnology, suitable environment should be provided for making the beneficiaries of the technology, particularly the faculty members in agricultural faculties informed and interested by using various educational, extension, in-service training strategies practiced by relevant governmental organizations and private sector.

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