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A confirmatory factorial analysis affecting the development of nanotechnology in agricultural sector of Iran

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The major purpose of this study was to examine the factors influencing the development of nanotechnology in agricultural sector of Iran. The methodology used in this study involved a combination of descriptive and quantitative research and included is the use of factor and descriptive analysis as data processing methods. The research population include researchers in the field of nanotechnology in the West Azarbaijan Province (N=74). The data collected by interviewing the respondents and analyzed by using factor analysis technique. Based on the perception of the respondents, about 50% of total common variance is explained by research, educational and informative factors, where the majority of it has been explained by the research factor (19.43%).

Key words: Nanotechnology, development agriculture, affective factors, West Azarbaijan Province, Iran.

INTRODUCTION

Agriculture sector is a fundamental basis for development of agriculture in developing countries. Iran is no exception and policymakers have recognized the nanotechnology as a strategic issue in the agriculture sector.

Nano technology as a new and emerging technology along with the biotechnology and information technology will undoubtedly be cover a spectrum of issues related to agriculture sector.

Miller and Senjan (2006) referring to growing population in many developing countries and their dependency to agriculture and its related industries, emphasized on the role of nanotechnology in meeting food needs.

With the current application and advancements soon to come, nanotechnology will have a great impact on the direction that agriculture will take. Scientists are blazing a trail for a new technology and looking at every possible avenue to improve upon current methods in every possible field. In the field of agriculture, there are still many possibilities to explore and a great deal of potential with up-coming products and techniques (Johnson, 2005).

Farm applications of nanotechnology are also commanding attention. Nanomaterials are being developed that offer the opportunity to more efficiently and safely administer pesticides, herbicides, and fertilizers by controlling precisely when and where they are released. For example, an environmentally friendly pesticide is in development that uses nano materials to release its pest killing properties only when it is inside the targeted insect. For livestock, the ability of certain nanomaterials to control dosage could reduce the amount of growth hormones needed to boost livestock

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Table 1. Variables and their measurement scale

Variable	Measurement scale
Informative factors	Five- point Likert
Educational factors	Five- point Likert
Research factors	Five- point Likert

Table 2. KMO measure and Bartlett's test to assess appropriateness of the data for factor analysis.

KMO	Bartlett's test	
0.723	Amount	Sig.
	551.706	0.000

production. There also are nano materials in the late stages of development that can detect and neutralize animal pathogens in livestock before they reach consumers (Kuzma and VerHage, 2006).

Soleimanpour et al. (2011) citing Moraru et al. (2005) and Rockefeller Foundation (2005) stated that nanotechnology will leave no field untouched by its ground breaking scientific innovations. The agricultural industry is no exception. Nanotechnology will have major, long-term effects on agriculture and the production of food, but it remains unclear whether effects on developing country agriculture and nutrition will be positive or negative. Nanotechnology may help make food products cheaper and production more efficient and more sustainable through using less water and chemicals, which would be a great help to developing world agriculture.

United Nations reported that one of the most important potential of nanotechnology is in the agricultural sector, but its potential has not been recognized in many developing countries (Kalpana Sastry et al., 2007).

Applications of nanotechnology have the potential to change the entire agriculture sector and food industry chain from production to conservation, processing, packaging, transportation, and even waste treatment. Strategic applications of Nano Science can do wonders in the agriculture scenario. Nano Science concepts and Nanotechnology applications have the potential to redesign the production cycle, restructure the processing and conservation processes and redefine the food habits of the people (SAINCE, nd).

The nanotechnology has the potential to treat the diseases and to detect the pathogen. Nanotechnology with its new devices can treat plant diseases and can increase the ability of plants to absorb nutrients.

The major purpose of this study was to examine the perception of agricultural experts about factors influencing the development of nanotechnology in agriculture sector of Iran.

MATERIALS AND METHODS

The methodology used in this study involved a combination of descriptive and quantitative research and survey method was used to collect the data. The collected data was analyzed by using factor and descriptive analysis as data processing methods.

The research population included agricultural researchers in the field of nanotechnology in the West Azarbaijan Province who were employed in agricultural research centers in the province (N=74). The data collected by interviewing the respondents and analyzed by using factor analysis technique.

Measuring respondents' attitudes towards factors influencing the development of nanotechnology in agriculture sector of Iran has been achieved largely though structured questionnaire surveys. The final questionnaire was divided into several sections. The first section was designed to gather information about personal characteristics of respondents. The second section dealt with questions about perception of respondents about factors influencing the development of nanotechnology. Three factors were presented in a 5-point Likert format. The variables and their measurement scale are presented in Table 1.

Content and face validity were established by experts consisting of faculty members at Science and Research Branch, Islamic Azad University, and some experts in the field of nanotechnology. Minor wording and structuring of the instrument were made based on the recommendation of the panel of experts.

A pilot study was conducted to determine the reliability of the questionnaire for this study. Computed Cronbach's Alpha score was 85.0%, which indicated that the questionnaire was highly reliable.

To determine the appropriateness of data and measure the homogeneity of variables about factors influencing the commercialization developing agricultural biotechnology from the viewpoints of biotechnology experts in Iran, the Kaiser-Meyer-Olkin (KMO) and Bartlett's test measures were applied. These statistics show the extent to which the indicators of a construct belong to each other. KMO and Bartlett's test obtained for these variables show that the data are appropriate for factor analysis (Table 2). The Kaiser criterion also was utilized to arrive at a specific number of factors to extract. Based on this criterion, only factors with Eigen-values greater than one were retained.

RESULTS

It was reported that slightly less than 60% of respondents were male and more than 70% of the respondents had earned a 4 year degree. Of those who responded to question, 23% had earned master degree and nearly 2% had earned doctoral degree. The results show that majority of respondents had a degree in agronomy (n=149). The mean age of respondents was 39.5 years and mean of their working experience was 13 years.

The classification of the factors into three factors is displayed in Table 3. The factors are classified in research, educational and informative factors.

Table 3 represents components of each factor, as well as, portion of each factor from the total common variance. As one may observe, about 50.48% of total common variance is explained by these three factors, where the majority of it has been explained by the research factor.

The varimax rotated factor analysis is shown in Table 4. In determining factors, factor loadings greater than

Table 3. Number of extracted factors, eigen-values and variance explained by each factor.

Factors	Eigen-value	% of variance	Cumulative % of variance
Research	3.70	19.43	19.43
Educational	3.06	16.10	35.53
Informative	2.84	14.95	50.48

Table 4. Variables loaded in the factors using varimax rotated factor analysis.

Factors	Variable	Factor loadings
Research	International Cooperation in R and D in Nanotechnology	0.874
	Establishing research networks in nanotechnology	0.721
	Protecting the intellectual property right for researchers	0.691
	Developing priorities in research about nanotechnology	0.627
	Helping partnership among investors and entrepreneurs to cooperate with research centers	0.593
	Establishing investment funds for supporting research centers	0.590
	Supporting research infrastructures in the nanotechnology	0.583
	Targeting the applied research in nanotechnology	0.551
Educational	Linkages between researchers, educators and stakeholders in the field of nanotechnology	0.784
	Feedbacks from farmers about their needs	0.684
	Holding joint workshops with countries pioneer in nanotechnology	0.610
	Diffusion of findings about nanotechnology	0.637
	Holding conferences about nanotechnology	0.555
Informative	Publishing scientific journals about nanotechnology	0.874
	Publishing printed documents about nanotechnology in agricultural related journals	0.799
	Publishing printed materials about nanotechnology	0.720
	Establishing web sites about nanotechnology in agriculture	0.437

0.50 were considered as to be significant. As anticipated, the first factor accounts for 19.43% of variance and 8 variables were loaded significantly.

A relevant name for this on loading's pattern is “research factor”. Eigen-value of this factor is 3.70, which is placed at the first priority in developing nanotechnology in agricultural sector of Iran. The second factor contains 5 variables relating to “educational factor”. The eigen-value for this factor is 3.06 which explain 16.10% of the total variance. The name assigned to the third factor is “informative factor”. This factor with eigen-value of 2.84 explains 14.95% of the total variance of factors influencing the development of nanotechnology in agricultural sector of Iran.

DISCUSSION AND CONCLUSION

As the factorial analysis showed, slightly more than 50% of variance could be explained by three variables of research, education and informative factors which would affect the development of nanotechnology in the agriculture sector of Iran. Oladele and Tobit (2005) reported that beside demographic variables, variables such as information sources, knowledge, awareness and attitudes of stakeholders through educational materials and information giving would affect the development and adoption of nanotechnology.

The research factor was found to be the most important factors that affect the development of nanotechnology. In this regard, it is important to develop an appropriate technology in research centers. Ameden et al. (2005) referred to this fact that successful adoption of any new technology in developing countries will depend on the availability of technologies appropriate for local agricultural conditions.

Like any other new technology, public confidence, trust and acceptance are likely to be the key factors determining the success or failure of nanotechnology applications. It is well known that uncertainties and lack of knowledge of potential effects and impacts of new technologies, or the lack of a clear communication of risks and benefits can raise concern amongst public (Chaudhry et al., 2008).

In regard to public awareness, the results show that extension/education factors could inform public about importance and benefits of nanotechnology. Nano-technology has the potential to play a significant role in agriculture production. The public should be educated that explain the value-added, increased safety and food security due to application of nanotechnology (Scott and Chen, 2003).

Based on the results of this study, it is important to identify other factors that affect the development of nanotechnology in agriculture sector of Iran. The findings show that other factors such as social, economic and policy making factors.

Meghani (2008) emphasize on this issue that institutional factors and support systems are also crucial in determining the social and economic impact of technology and social and cultural factors affect the perception of producers and customers about the technology (Meghani, 2008). The results of this study present a clear challenge for development of nanotechnology in agricultural sector of Iran. It is obvious that educational factors are likely to be one of the key factors influencing development of nanotechnology in agriculture sector. It is well known that existence of information sources and technical knowledge would accelerate the process of more research about nanotechnology in Iran.

It is also important to point out that providing information about importance of nanotechnology and presenting beneficiaries about opportunities and challenges that this new technology bring about, would accelerate the process of developing nanotechnology.

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