Factors Influencing the Adoption of Nanocides in Controlling the Fire Blight among Apple Producers in Iran

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Abstract: Apple producers in the Province of East Azarbaijan were surveyed in order to explore their perception about factors influencing the adoption of nanocides in controlling Fire Blight among apple producers in Iran. As the factor analysis showed, the factors were categorized into four groups, namely marketing, social, regulatory and economic, ordered by the magnitude of their impact.
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1. Introduction

The emerging field of nanotechnology has the potential to bring about changes as big as the European Industrial revolution in the late 18th and early 19th century. A hundred and fifty years ago, the mechanization of industry, the introduction of steam power and improved transportation systems brought huge technological, socioeconomic and cultural changes. Today, nanotechnology is forecast to underpin "the next industrial revolution", leading to far-reaching changes in social, economic and ecological relations (Miller and Senjan, 2006).

As well as developing improved systems for monitoring environmental conditions and delivering nutrients or pesticides as appropriate, nanotechnology can improve our understanding of the biology of different crops and thus potentially enhance yields or nutritional values. In addition, it can offer routes to added value crops or environmental remediation.

In regard to application of Nanocides in encapsulation of pesticides, researchers pointed out the impetus for formulating pesticides on the nano-scale is the changed behavior of the reformulated product: the strength of the active ingredient can be maximized and biological activity is longer-lasting (ETC, 2004).

Nanocide is one of the most effective antibiotics made in human history. It destroys more than 650 species of bacteria, fungi, and viruses. Nanocide is produced by using natural materials and new technology. It has lack of microbial resistance in long use and maintains the sterilized environment for a long time. Nanocide also has an optimum performance in various ph and does not have any side effect.

The adoption of any new technology and innovations has not been an easy task and it is not spontaneous, the technology has to be taught and learned –adopted to existing experience and integrated into production. As is often the case with technological-innovation potential and expectations can outpace reality (Gelb and Bonati, 2005).

Several parameters have been identified as influencing the adoption behavior of farmers and social scientists investigating farmers who adopt the biotechnology showing the demographic variables, technology characteristics, information source, knowledge, awareness, attitude and group influence affect adoption behavior (Oladele, 2005).

Successful adoption of any new technology in developing countries will depend on the availability of technologies appropriate for local agricultural conditions, and policies that enhance the ability of poor farmers to obtain these technologies (Ameden et al., 2005).

A major issue that will affect successful applications of new technology such as bio and nanotechnologies to agriculture is the regulatory climatic governing the release of new products. Developing societies will need to develop and implement regulatory measures to manage any environmental, economic, health and social risks associated with genetic engineering (Ozor, 2008).

The results of the study by Spielman and others (2006) suggest that the regulatory environment governing the introduction of new technologies is slowing the forward movement of research into later stages of product development.

Nanotechnology can play an important role in improving the quality and quantity of agricultural products. Therefore, it is necessary to remove the

impediments faced by farmers and provide basic information to enable the spread of nanotechnology. This would enable nanotechnology to be part of a comprehensive development strategy for agricultural sector.

Developing countries such as Iran have adopted their own nanotechnology programs with a specific focus on agricultural applications. The Iranian Agricultural ministry is supporting a consortium of 35 laboratories working on a project to expand the use of nanotechnology in agro sector. The ministry is also planning to hold training programs to develop specialized human resources in the field (Joseph and Morrison, 2006).

In the year 2001, the Iran presidential technology cooperation office initiated a smart move in the field of nanotechnology. Through these efforts, nanotechnology gained national priority in the country and in 2003 the Iranian Nanotechnology Initiative was set up with the aim of pursuing the development of nanotechnology in Iran.

The attitudes and interests of stakeholders involved in national public debates on the risks and benefits of agricultural technology are having a significant influence on public opinion as well as public policy outcomes in developed and developing countries (Aerni, 2005).

Evidence shows that even small efforts to informing farmers and increasing their knowledge about the new technologies can have big results. However, the promise has yet to be realized due to the lack of information and access to this technology among rural communities. Therefore, it is necessary to remove the impediments faced by rural population and provide basic information in rural areas to enable the spread of new technologies.

Fire Blight is one of the major diseases in granular fruit trees in the world and Iran. Even if the disease spreads in limited areas, it will cause serious damage to trees. Therefore, precise control program to contain the disease and its distribution area should be implemented.

The disease in the provinces of East Azarbaijan has caused serious damages to the apple gardens. Ministry of Agriculture in this province has started a program to recommend the diffusion and adoption of nanocides in controlling Fire Blight in the apple trees among gardeners. The research question for this study is: what are the perceptions of gardeners about factors influencing the adoption of nanocides in controlling Fire Blight among apple producers in Iran?

2. Material and Methods

A series of in-depth interviews were conducted with some senior experts in the nanotechnology to examine the validity of questionnaire. A questionnaire was developed based on these interviews and relevant literature. The questionnaire included both open-ended and fixed-choice questions. The open-ended questions were used to gather information not covered by the fixed-choice questions and to encourage participants to provide feedback. The total population for this study was 61 apple producers in the East Azarbaijan Province.

Measuring respondents' attitudes towards factors influencing the adoption of nanocides 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 was designed to measure the attitudes of respondents about factors influencing the adoption of nanocides in controlling fire blight disease. Four 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 a panel of experts consisting of faculty members at Islamic Azad University, Science and Research Branch and some specialists in the 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 the study. Computed Cronbach's Alpha score was 89.0%, which indicated that the questionnaire was highly reliable. The data collected by interviewing the respondents and analyzed by using ordinal factor analysis technique.

Table 1: Variables and their measurement scale

Variables	Measurement Scale
Regulatory Factors	Five- point Likert
Economic Factors	Five- point Likert
Social Factors	Five- point Likert
Marketing Factors	Five- point Likert

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3. Results

The results of descriptive statistics indicated that majority of respondents were male. The educational level of all respondents was under high school diploma.

The classification of the factors into four latent variables was displayed in table 2. The variables were classified in economic, social, marketing and regulatory factors. The basic idea of factor analysis is to find a set of latent variables that contain the same information. The classic factor

analysis assumes that the both observed and the latent variables are continuous variables.

KMO and Bartlet test were used to show the extent variables have correlation and dependence to each other. In factorial analysis when KMO is less than 0.5, data are not suitable for factorial analysis and when KMO is between 0.5-0.7, data are suitable for factorial analysis. KMO amount and meaningful level of Bartlet test indicated in Table 3, that shows are very suitable fir factorial analysis.

The results show that these factors contributed about 56 percent of variance in the perception of respondents about factors influencing the adoption of nanocides in controlling fire blight disease. Table 2 represents components of each factor, as well as, portion of each factor from the total common variance. As one may observe, about 56% of total common variance is explained by these four factors, where the majority of it has been explained by the marketing factors (17.50%).

Table 2. Classification of factors that influence the adoption of nanocides in controlling fire blight disease by Using Factor Analysis

Category	Variance by Factor
Marketing	17.50
Regulatory	12.19
Economic	10.24
Social	16.11
Total	56.04

Table 3: KMO amount and meaningful level of Bartlet test

Factorial Analysis	KMO	Bartlet Test Sig
Factors	0.664	8201.205 0.00

4. Discussions

A wide range of economic, social, marketing and regulatory factors influences the adoption of nanocides by apple producers. Wheeler (2005) citing Rogers and Pannell pointed the factors which influence the adoption of new innovations by farmers. She mentioned factors such as perception about risk and profitability; uncertainty and certainty about adoption; amount of required information and attitude about risk and uncertainty.

The findings are in accordance with the result of study by Hosseini and Alikarami (2009) that factors such as social and regulatory factors in adopting the new technology. Innovation is not only based on the technology's agronomic suitability to specific environments.

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 for the agriculture sector. 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).

A regulatory process should ensure the democratic control of and public participation in decision making on nanotechnology and other new technologies. It is recommend the initiation of a wide range of participatory processes to enable direct input from the general public into new technology assessment and determination of priorities and principles for public policy, R&D and legislation (Johnston, et al., 2007).

It is becoming increasingly clear that nanotechnology requires a holistic and tightly integrated regulatory framework for dealing with the range of health, ecological, economic, and socio-political issues that this technology raises (Johnston, et al., 2007).

As in the case of any new technology, the gains from modern technology are accompanied with certain negative effects and concerns. The nature and extent of the positive and negative impacts will depend on the choice of technique, place and mode of application of technique, ultimate use of the product, concerned policies and regulatory measures including risk assessment and management ability and finally on the need, priority, aspiration and capacity of individual countries (Ameden et al., 2005).

However, the application of nanotechnology by farmers in Iran faces challenges and obstacles. There is no single appropriate way to introduce and promote nanotechnology in the developing countries: constraints and opportunities vary from country to country and therefore require location-specific approaches.

There is need for more training and education to change the attitude of farmers and enhance their confidence about the role of nanotechnology in agriculture. It is also important to develop policies that benefit small-scale farmers and attend their technological needs.

Based upon the results of this study, it is apparent that there is still need to further research about the role of nanotechnology in agriculture sector in Iran. In this regard, strengthening the linkage between research and extension institutions and increasing the role of farmers in developing appropriate technology would accelerate the adoption by the farmers.

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