Factors Influencing Commercialization of Nano and Biotechnologies in Agriculture Sector of Iran

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Abstract: Faculty members and researchers in Agricultural Biotechnology Research Center in Iran were surveyed in order to explore their perception about the factors influencing the commercialization of nano and biotechnologies in agricultural sector. The data was analyzed by using ordinal factor analysis technique. Based on the perception of the respondents and ordinal factor analysis, factors were categorized into seven groups, namely infrastructural, production, management, economic, research.

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1. Introduction

Modern technologies can play an important role in increasing production and improving the quality of food produced by farmers. Many believe that modern technologies will secure growing world food needs as well as deliver a huge range of environmental, health and economic advantages (Wheeler, 2005).

Modern technology such as nano has the potential to revolutionize agriculture and food systems. Agricultural and food systems security, disease treatment delivery system, new tools for molecular and cellular biology, new material for pathogen detection, protection of environment, and education of the public and future workforce are examples of the important links of nanotechnology to the science and engineering of agriculture and food systems (Scott and Chen, 2003).

However, full potential of these technologies has not been realized yet and in this regard, examining the factors which influence the commercialization should be considered as a major step toward widespread application of these modern technologies. This would enable nano and biotechnologies to be part of a comprehensive development strategy for agricultural sector.

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).

But the challenges of bringing new technology to market in the agricultural industry are changing – it is no longer adequate to conceive a new invention and convince farmers with a strong marketing campaign that they should adopt the technology that results from this invention. The business challenges in the commercialization of agricultural technology are both more complex and broader with respect to those who will be impacted by that technology (Boehlje, 2004).

The commercialization of new technologies, or the process of introducing new technology to market, has been a particular facet garnering much attention. Patent protection and capital investment are necessary components for the effective commercialization of innovations (Boulay et al., 2008).

Commercialization entails a sequence of steps to achieve market entry of new technologies, processes, and products. Jolly (1997) outlined a five-stage model of the commercialization process. Technology exploration begins with the imaging stage. This stage primarily addresses the basic research related to a new concept. The second stage proposed by Jolly is the incubating stage in which generic market applications and technology concepts are examined. In the demonstrating stage, the technology is moved into products with market application through various means such as prototyping. The promoting stage is the beginning of market entry and expansion. Finally, the sustaining stage focuses on the long-term market placement of the products. New technologies are a part of each of these stages at some point in their development (Boulay et al., 2008).

Naseri in his thesis entitled commercialization, processes and models in developing and developed countries introduced some factors in the way of commercialization of nanotechnology: human, management, social, cultural and economic factors (Droby et al 2009, Port, 1989).

Oriakhi (2004) in his research about commercialization of nanotechnologies reported that beliefs and convictions of consumers about nano, cultural and social challenges, lack of coordination between agencies, lack of targeted research projects, management challenges, lack of financial resources and uncertainty of industies about universities have affected agricultural commercialization in nanotechnology.

Different factors influence the process of commercialization of nano product. The most important factor in launching a new business is intellectual property rights which is the first step in commercialization of nano (Palmintera, 2007).

Iran has adopted its 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 (Joseph and Morrison, 2006).

Rezaee (2008) in his resaerch about recognizing mechanisms in diffusion of nanotechnology in agriculture sector of Iran, pointed out to the policy, infrastructure, financial, educational, and regulatory factors which influence the diffusion of nanotechnology.

Hosseini and Alikarami (2009) indicated that extension/education, environmental, research and economic factors have positive impacts on the adoption of biotechnology by horticultural prodiucers in Iran. The question is what are the factors influencing the commercialization of nano and biotechnologies in agricultural sector of Iran? The purpose of this study is to determine the factors in commercialization of nano and biotechnologies in agricultural sector of 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 52 faculty members and researchers at Agricultural Biotechnology Research Center (ABRC). Data were collected by using questionnaire through interview schedules.

The data was analyzed by using ordinal factor analysis technique. The basic idea of factor analysis is the following. For given set of observed variables $Y_{1,...,}$ Yn one wants to find a set of latent variables $\xi_1,...\xi_k$, k<n that contain essentially the same information. The last version of their statistical software, named LISREL 8.8 can handle such analysis. Briefly, we used: 1) Goodness of fitness which its null hypothesis indicates that the model is valid (we prefer to accept the null hypothesis, i.e., p-value>0.05); 2) RMSEA (Root Mean Square Error of Approximation) which takes into account the error of approximation in the population and asks “How well would the model fit the population covariance matrix if it were available?” (p-value less than 0.05 indicates good fit, and higher than 0.08 represents reasonable errors of approximation in the population).

3. Results

Table 1 summarizes the demographic profile and descriptive statistics of respondnets. The results of descriptive statistics indicated that majority of extension experts were male with a mean age of 33 years old. Majority of respondents had a master degree with major in agriculture.

Table 2 shows the grouping of factors (determined via ordinal factor analysis) into seven latent variables. As the ordinal factor analysis showed, the factors were categorized into seven groups, namely infrastructural, production, management, economic, research, social/cultural and technical factors ordered by the magnitude of their impact.

Table 1. Personal Characteristics of respondents

Sex	Female (26.9%)	Male (73.1%)
Age/year	Mean=33	
Degree	Master Degree (57.7%)	PhD (42.3%)

Table 2. Classification of factors by Using Ordinal Factor Analysis

Categories	Variance by Factor
Infrastructural	13.78
Production	13.71
Management	12.16
Economic	9.75
Research	9.19
Social/Cultural	8.06
Technical	6.41
Total	73.06

The value of RMSEA was 0.709 which shows the reasonable fit of model.

4. Discussions

As the ordinal factor analysis showed, factors were categorized into seven factors namely, namely infrastructural, production, management, economic, research, social/cultural and technical factors ordered by the magnitude of their impact. The factors were then ordered by the magnitude of their impact (fig.1).

A wide range of economic, social, physical and technical challenges influences adoption of agricultural production technology. 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 show that infrastructural factors are the most important factors, a result that echoes the findings of Oriakhi (2004) and Droby et al (2009). 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).

Production factors are always potentially important factors in development of modern technology such as nano and biotechnologies. 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).

The findings also reflect an important fact that negative attitudes of consumers and producers directly impact the commercialization of nano and biotechnologies in agricultural sector... This has been pointed out by several authors including Droby et al (2009) and Port (1989).

Like any other new technology, public confidence, trust and acceptance are likely to be one of the key factors determining the commercialization of nano and biotechnologies in agriculture and the public should be educated that explain the value-added of these modern technologies (Scott and Chen, 2003).

It is becoming increasingly clear that commercialization of nano and biotechnologies require 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 complex technology impacting wide range of processes and developments, the gains from modern biotechnology are accompanied with certain negative effects and concerns. The nature and extent of the positive and negative impacts will depend on the choice of the technique, place and mode of application of the 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).

Overall, these findings suggest the commercialization of nano and biotechnologies varies from country to country and therefore in Iran like many countries requires a location-specific approach.

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