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Full Length Research Paper

Limiting Factors of marketing biotechnologies and Nanotechnologies in the agricultural sector of Iran

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The major purpose of this study was to determine challenges in commercialization of nano and biotechnologies in agicultural sector of Iran. The total population for this study was 50 participants who attended a workshop on commercialization of nano and biotechnologies in agriculture at biotech 2010 exhibition in Tehran. The results showed that the social and cultural challenges caused 39% of variance on the perception of the respondents about challenges influencing the commercialization of nano and biotechnologies in agricultural sector of Iran. The commercialization of nano and biotechnologies in Iran faces challenges and obstacles and require location-specific approaches.

Key words: Commercialization, challenges, agriculture sector, Iran, nanotechnologies, biotechnologies.

INTRODUCTION

Modern technologies such as bio and nano 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).

Proponents of modern technologies such as biotechnology tout biotechnology as providing additional food, fiber, and medicines for human populations. Proponents envision biotechnology as providing this additional food, fiber, and medical resources without increasing, and possibly decreasing, human demands upon land and plant-fauna habitats (Kershen, 1999).

Nanotechnology as the latest innovation 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 (150) 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).

Nanotechnology 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).

UN survey on potential applications of nanotechnology in developing countries have identified agricultural productivity enhancement as the second most critical area of application for attaining the millennium development goals while energy conversion and storage was ranked first and water treatment as the third areas needing focus (Sastry et al., 2007).

However, the full potential of nanotechnology in the agricultural and food industry has still not been realized (Joseph and Morrison, 2006). 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.

A major issue that will affect successful applications of new technology such as bio and nanotechnologies to

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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).

According to Ozor the basic modern agricultural biotechnology research is costly and too demanding of scientific skills for the limited resources of most of the developing countries. As a result, there are numerous challenges, erroneous ideas and beliefs which encumber research, development and adoption of modern biotechnology (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 the 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. Technology exploration begins with the imaging stage. This stage primarily addresses the basic research related to a new concept. The second stage proposed by Boulay and others (2008) 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.

The most basic business challenge in introducing any new technology is that of creating value for the customer. But even if the technology will create value for the customer, the rate of adoption and speed of comercialization – in essence the time to market – may dramatically impact the financial/business success of the technology. Technological innovation typically requires large capital outlays, and consequently access to capital/financial markets is critical to the success of discovery and commercialization of new technology. Some have argued that technology, and biotechnology in particular, is best served by patient and private capital rather than impatient public capital providers. A fourth challenge in commercializing agricultural technology is that of value capture. Even though new technology may create value for the user, if the provider does not have a mechanism for capturing some of that value, it is unlikely that the technology will be commercialized. Consequently, technology has value only if can be marketed worldwide and this type of technology faces more difficult comercialization challenges compared to technology that is commercially viable based on introduction and utilization in markets that will protect intellectual property. A final challenge in the commercialization of technology is the decision process by which R and D expenditures are allocated and commercialization is funded. Technology development and commercialization are clearly issues that need critical and costly strategic decisions in a profoundly uncertain environment. Uncertainty exists with the breakthroughs necessary to develop the technology, with the market acceptance of the technology, and with the ability of competitors to bring similar technology to market (Boehlje, 2004).

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

Oriakhi (2004) reported that beliefs and convictions of consumers about nano technology, 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 right which is considered the first step in commercialization of nano (Palmintera, 2007).

Iran has adopted its own nano and biotechnologies 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).

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). Given a key role that experts have on challenges which influence the commercialization of moder technologies, their views will be critical for development of these technologies. The question is what are the challenges in

Table 1. Variables and their measurement scale.

Variable	Measurement scale
Attitudes about challenges influencing the commercialization of nano and biotechnologies	Five- point Likert
Attitudes about commercialization of nano and biotechnologies	Five- point Likert

Table 2. Personal characteristics.

Sex	Female (26.9%) Male (73.1%)
Age/year	Mean=33
Degree	Master (57.7%)
Main Occupation	Researcher (46.8%)

commercialization of nano and bio technology in agricultural sector?

MATERIALS AND METHODS

The methodology used in this study involved a combination of descriptive and quantitative research and included the use of correlation, regression and descriptive analysis as data processing methods. The total population for this study was 50 participants who attended a workshop on commercialization of nano and biotechnologies in agriculture at biotech 2010 exhibition in Tehran.

Measuring respondent's attitudes towards commercialization has been achieved largely though structured questionnaire surveys. The usual questionnaire approach to measure attitude is to include a range of semantic-differential and Likert items to operationalize the attitude construct. The final questionnaire was divided into two 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 challenges influencing commercialization of modern technology in agriculture. The respondents were asked to indicate their agreements by marking their response on a five point Likert-type scale. The last section was to measure the attitudes of perception about commercialization of modern technologies. Respondnets were asked to respond to questiones about technical, production and business factors. 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 experts in biotech research centers in ministry of agriculture. Minor wording and structuring of the instrument were made based on the recommendation of the panel of experts.

A pilot study was conducted with experts in the nano and biotechnologies who had not been interviewed before the earlier exercise of determining the reliability of the questionnaire for the study. Computed Cronbach's alpha score was 93.0%, which indicated that the questionnaire was highly reliable.

Key dependent variable in the study included attitudes about commercialization which were measured by perception of respondents. The independent variables in this study were social, economic, managerial and infrastructural challenges which influence the commercialization of modern technologies in agriculture. For measurement of correlation between the independent variables and the dependent variable correlation coefficients have been utilized and include person test of independence.

RESULTS

Table 2 shows the demographic profile and descriptive statistics. The results of descriptive statistics indicated that majority of respondents were male with a mean age of 33 years old. More than half of respondents had earned a master degree and less than half of respondents were researchers.

Table 3 shows the means of respondents' views about infrastructural challenges which influence the commercialization of modern technologies in agriculture sectors. As can be seen from this table, the highest mean refers to lack of appropriate program planning (mean=4.38) and the lowest mean to limited number of skillful and experienced human resources (mean=3.75).

Table 4 shows the results of respondents' perception about managerial factors which influence the commercialization of modern technologies in agriculture sectors The highest mean number refers to lack of vision by mangers of firms (mean=4.31) and the lowest mean number was lack of participation by public sector in research (mean=2.97).

The results of respondents' view about the social and cultural factors which influence the commercialization of modern technologies is presented in Table 5. The highest mean number refers to lack of coordination among researchers and investors (mean=4.28) and the lowest mean number refers to low rate of adoption of the technologies (mean= 3.65). Table 8 shows the result for regression analysis by stepwise method. Independent variables that were significantly related to perception of respondents about challenges influencing the commercialization of nano and biotechnologies in Table 7 were subjected to regression analysis. The result indicated that 39% of the variance in the perception of respondents

Table 3. Means of respondents' views about infrastructural challenges which influence the commercialization of modern technologies in agriculture sector (1=strongly disagree; 5=strongly agree).

Variable	Mean	SD
Lack of appropriate program planning	4.38	0.69
No mutual confidence between academic centers and industry	4.15	0.69
Lack of technical knowledge	4.01	0.75
Inappropriate mechanisms to present research findings	3.98	0.81
Weak intellectual property rights	3.93	0.81
No central authority to standardized research findings	3.88	0.95
No trademark	3.76	0.92
Limited skillful and experienced human resources	3.75	1.06

Table 4. Means of respondents' views about managerial challenges which influence the commercialization of modern technologies in agriculture sector (1=strongly disagree; 5=strongly agree).

Variable	Mean	SD
Lack of vision among mangers	4.31	0.67
Lack of knowledge about business models	4.07	0.74
Lack of feasibility studies	4.19	0.84
Inappropriate management of technological parks	4.00	0.80
No clear business plans	4.15	0.84
Weak coordination among related organizations	4.01	0.86
Lack of objectivity in projects	4.15	0.89
Lack of support for domestic products	4.03	0.98
Lack of applied research	3.98	0.99
Lack of participation by public sector in research activities	2.97	1.07

Table 5. Means of respondents' views about social and cultural challenges which influence the commercialization of modern technologies in agriculture sector (1=strongly disagree; 5=strongly agree).

Variable	Mean	SD
Lack of knowledge about new technologies by producers	4.17	0.68
Lack of coordination among researchers and investors	4.28	0.80
Negative belief among producers	4.02	0.92
Negative belief among consumers	4.11	1.00
Low rate of adoption of new technologies	3.65	0.76
Lack of knowledge among consumers	3.98	1.07

could be explained by social challenges.

DISCUSSION

As the regression analysis showed, social/cultural challenges caused 39% of variance on the perception of the respondents regarding the commercialization of nano and biotechnologies in agricultural sector of Iran. Innovation is not only based on the technology's agronomic suitability to specify environments. Institutional factors and support systems are also crucial in determining the social and economic impact of biotechnology and social and cultural factors affect the perception of producers and customers about the biotechnology (Meghani, 2008).

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

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, 2008).

The findings showed that infrastructural challenges

Table 6. Means of respondents' views about economic challenges which influence the commercialization of modern technologies in agriculture sector (1=strongly disagree; 5=strongly agree).

Variable	Mean	SD
Lack of long term investment	4.38	0.69
Uncertainty about profitability	3.95	0.74
Lack of investment by private sectors	4.01	0.82
High risk of investment	4.03	1.04
Inappropriate financial resources	4.07	1.06
Lackof financial and credit system in research institutions	4.11	1.09
Economic Sanctions	3.76	1.21

Table 7. Correlation measures between independent and dependent variables.

Independent variable	Depndent variable	R	Significance
Infrastructral Challenges	Technical Dimensions	0.240	0.131
Economic Challenges	Technical Dimensions	0.019	0.908
Social Challenges	Technical Dimensions	0.403*	0.030
Managerail Challenges	Technical Dimensions	0.241	0.115
Infrastructral Challenges	Business Dimensions	0.411**	0.008
Economic Challenges	Business Dimensions	0.211	0.216
Social Challenges	Business Dimensions	0.640*	0.000
Managerail Challenges	Business Dimensions	0.244	0.119
Infrastructral Challenges	Production Dimensions	0.530**	0.001
Economic Challenges	Production Dimensions	0.337	0.051
Social Challenges	Production Dimensions	0.624**	0.000
Managerail Challenges	Production Dimensions	0.278	0.083

** P≤0.01 * P≤0.05.

Table 8. Multivariate regression analysis.

Parameter	B	Beta	T	Significance
Constant	2.500	--------	4.255	0.000
Social challenges	0.500	0.628	3.790	0.001

R^2=0.0.39; $Y=0.628X_1$.

influence the commercialization of modern technologies, a result that echoes the findings of Oriakhi (2004) and Droby et al., (2009).

It is becoming increasingly clear that commercialization of modern technologies such as nano 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).

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. The absent, incomplete, or nascent character of many regulatory regimes means that very few GM crops have moved onwards to efficacy and performance trials, testing for human and environmental safety, commercialization, marketing, or distribution.

It 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 and D and legislation (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).

It is important to point out that application of new and modern technologies would have negative impacts on the small resource poor farmers and would increase the risk associated with these technologies. On the other hand, the major beneficiaries of new and modern technologies at the earlier stage are large farmers which have the resources to absorb the risks.

The regulatory environment would certainly have impact on the development of these new technologies by the private sector. The supportive policies such as intellectual property rights would encourage involvement of private sector in the development of modern technologies.

The results of this study showed that lack of investment would have impact on commercialization of modern technologies. Nano and biotechnologies are intensive research areas which need appropriate financial resources to achieve substantial benefits.

Overall, these findings suggest the commercialization of nano and biotechnologies in Iran faces challenges and obstacles and one of the indicators of selecting appropriate technology is the adaptability of technoplogies. In order to make a technology adaptable to different condition, it is important to look at location-specific approaches for developing modern technology.

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