BARRIERS AND SOLUTIONS TO COMMERCIALIZATION OF RESEARCH FINDINGS IN SCHOOLS OF AGRICULTURE IN IRAN: A QUALITATIVE APPROACH

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ABSTRACT

The transformation process from idea to product and finally to wealth creation is one of the major problems in the agriculture sector in Iran. This study used a qualitative-exploratory approach to investigate the barriers and the solutions, which were derived from the interview results of our study, to commercialization of research findings in Iranian schools of agriculture. The data was collected through in-depth semi-structured interviews. The results showed that the highest ranking barriers to commercialization were inappropriate perspectives and policy-making, financial-investment barriers, mistrust, and poor communication; the barriers related to the participation of the private sector were among the lowest ranking items. The top ranking solutions for commercialization were related to planning, legislation, policy-making, needs assessment, goal setting, and prioritization. The technical-specialized solutions were the lowest ranking items.

Keywords: Agricultural research; Barriers to commercialization; Coding method and ranking; Schools of agriculture; Solution for commercialization

1. INTRODUCTION

In the past few years, Iran has seen a remarkable progress in research activity at universities and research development centers. For example, one of the main indicators in research activity progress is the R&D expenditure relative to GDP. According to the latest available data, the amount of the aforementioned indicator for Iran was 0.55 percent in 2001, which has increased to 0.65 percent in 2010 (Abbasi, 2013).

The role and importance of knowledge transfer and the utilization of research results for decision-makers in both developed and developing countries can play a significant role in improving the quality of life and the prosperity of the community. However, these findings will not bear fruit until they are put into practice, commercialized, and accessed by the users (Seddighi et al., 2007; Santesso & Tugwell, 2006). To convert knowledge to wealth, the universities and research institutes should concentrate on conducting applied projects with industries as well as compiling technical knowledge and replicable documentation. This study was conducted to investigate the barriers and difficulties facing the agricultural sector and to identify solutions for commercialization of the research findings from the schools of

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agriculture. The results of "the qualitative method part" are presented in this paper.

1.1. Theoretical Foundations and Literature Review

At the global level, the dependence of the developing countries on agricultural exports creates many problems. The efforts of diversification and commodity stabilization can be successful only if undertaken under viable international agreements. The empirical findings concerning the terms of trade of developing countries vis-à-vis the developed countries leads to the presumption that the trade agreements are not improving (Dethier & Effenberge, 2012). The evidence suggests that although many of the technological development research in Iran have been successful, only a small percentage, about 5 percent, have been commercialized. This shows the complexity of the process of the commercialization of technology (Bandarian, 2007).

In general, the macro process of commercialization consists of five main steps. The first three steps are developing commercialization strategies, interacting with research team(s) to find the technical specifications of the project, and studying the market. In step four, the manufacturing products are based on technology (laboratory manufacturing, benchmark manufacturing, semi-industrial manufacturing, and industrial manufacturing). Finally, achievements are assessed and changes in the technology are made in order to optimize various stages of production to predict the future developments in technology and product markets (Musayi et al., 2008). In another study, components of the commercialization process included technology development and technical documentation, marketing and market research, coordination and decision making, and technical economic assessment. Other components were the provision and allocation of resources and the outsourcing of a portion of the technology development. The protection of intellectual property, executing legal affairs, negotiation, and lobbying are also components of this process (Goodarzi et al., 2011). The expectations of industry and society in regard to the universities are becoming more important because of the acceleration of knowledge-based advancement in Iran. The more the universities are supported for the commercialization of ideas and the transfer of developed technologies[1], the more successful they will be in carrying out their mission (Fakour & Haji-hosseini, 2008). Commercialization requires serious interaction by higher education institutions with government research organizations, industrial companies, financial and investment institutions, entrepreneurs, and academic staff. In addition, various factors affect the successful commercialization of technology in universities. One of these factors includes the availability of the necessary prerequisites in the universities and industries; the socio-economic environment governing these sectors can also affect the process (Fakour, 2005). However, there are challenges in the way of commercialization of the research findings. The success of this task depends on identifying and eliminating these challenges. Several studies have been conducted regarding the barriers to commercialization of university research findings in Iran and abroad. It was found that when compared to other countries, less attention has been paid to the area of agriculture and agricultural higher education in Iran. The research review with this reference in mind is given in following part of this paper.

Fakour and Haji-Hosseini (2008) concluded that the universities had a stable situation concerning conducting joint research and making contracts with industries, but other activities, such as licensing, assigning the intellectual rights of research findings and creation of spin offs, are not yet prevalent. Hashemnia et al. (2009) worked on educational and fundamental research

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[1] For example: Iranian Research Organization for Science and Technology (IROST) is one of the Iranian research organizations which has successful commercialization in agricultural and biotechnological research in Iran. One of these researches is about know-how of *Microalgae products* which has been realized for the first time by IROST. This knowledge could be used in pharmaceutical products, fuel of aircraft as well ac cars. In May 2014, the know-how of this project was transferred to an Iranian private enterprise and established in 1000 hectares in Queshm Island, Persian Gulf in IRAN. This is the first industrial scale of Microalgae bio-Fuel Production and first in the Middle East (International workshop on *Technology-Based Entrepreneurship*, held 27 and 28 October 2015, IROST, Tehran, Iran)

on commercialization in higher education and identified two challenges: i) inadequate attention to the entrepreneurship culture and ii) a conflict between commercialization and the traditional functions of the university. Pour-ezzat et al. (2010) found that bureaucracy, inflexibility of university management, weak communication, as well as a lack of communication networks between investors, industry practitioners, and academics were among the most important barriers of knowledge commercialization in the University of Tehran, Iran. The findings of a study by Moghimi et al. (2010) showed significant correlation between organizational factors and the commercialization of research findings. According to Pour-ezzat and Heidari (2011), the lack of links between the government, industry, and university sectors is one barrier facing the commercialization of knowledge.

The findings of Jahed et al. (2011) concluded that personal factors played a role in the commercialization of research findings. These factors included self-efficacy, seeking success, seeking power, creativity and innovation, and competitiveness. Hossein-gholipour et al. (2011) identified several items as the main barriers to the commercialization of knowledge: lack of a competitive environment in universities, a negative attitude towards business planning at universities, ineffectiveness of laws and regulations, and a weak educational system. In addition, the financial problems, lack of skilled and expert manpower, unfamiliarity with the real environment, and the lack of a research strategy document are considered as barriers. The findings of a study conducted by Mirghafouri et al. (2011) showed that market, financial and administrative-legal variables contribute in the success of commercialization. Zahedi-anbardan (2011) declared that institutional factors, the researcher, technology, market, intellectual property, and industry structure together compose the requirements and prerequisites of academic research commercialization. Borzouei et al. (2011) stated the factors influencing the commercialization of nanotechnology in the agricultural sector and concluded that foundational, economic, educational, financial and cultural factors had the greatest impact on the issue. Lacy (2000) reported that in order to facilitate and expand the process of commercialization of agricultural research, there must be appropriate policy making and monitoring by the government. The findings of Debackere and Veugelers (2005) showed the lack of understanding on both sides concerning cultural differences; these conflicting goals may also hinder the development of an effective relationship. In particular, a conflict may emerge between an academic's inclination to publish the new scientific findings as opposed to the industry's inclination to make commercial use of the new knowledge. Also, the researchers reported no motivation to disclose their inventions and further development them through transfer of patent rights as one of the barriers facing commercialization of academic research. Siegel et al. (2007) enumerated the registration of intellectual property, licensing, joint research collaborations with businesses, and creation of spin offs as methods of knowledge commercialization in universities. Siegel and Wright (2007) deduced that lack of confidence for full protection of intellectual property rights in the industrial sector is a major obstacle to motivate the creators to take advantage of innovations resulting from academic research. Decter et al. (2007) named communication problems, the need for technical support, cultural differences between universities and industry, and lack of entrepreneurship in universities as major barriers to commercialization of knowledge. Chen (2009) stated that success of commercialization depends on factors such as capacity for foreign investment, ownership of research findings, entrepreneurial skills, and governmental future plans and policies. The findings of Wan Hussain's (2012) showed that a strong and effective relationship between education and research can be an effective solution for commercialization of agricultural academic research. Summing up these findings, we can categorize the barriers to commercialization of university research findings as follows: lack of joint research projects, failure to protect intellectual property rights, absence of entrepreneurial culture, bureaucracy, weak communication and interaction, financial constraints, distrust between industry and

university as well as cultural differences between the two entities, weak management and manpower, laws and regulations, lack of motivation, and poor planning. The literature reviews also showed that the indicators, methods and models used to analyze the barriers to commercialization were often quantitative in nature. Meanwhile, qualitative methods are recommended for deeper and more accurate analysis of social phenomena (Ezzati, 2012). Therefore, in this study we attempted to investigate the barriers and solutions for commercialization of research findings in schools of agriculture with a qualitative approach in order to achieve more accurate and in-depth results for future research and development in Iran. The main question in our research was: what are the challenges in the commercialization of research results in Iranian schools of agriculture? This question leads us to ask two following questions in our interviews:

1.2. Areas Covered by this Research

The interviewees were asked the following two main questions: 1- In your opinion, what are the barriers to commercialize the findings of research in the schools of agriculture in Iran? 2- In your opinion, what solutions are there to overcome each of the barriers facing commercialization of research findings in schools of agriculture?

2. METHODOLOGY

The present study was conducted using an exploratory qualitative research method such as the one used by Bazargan (2008). In this type of analysis, the text of the respondents was encrypted, counted, and recorded in a frequency distribution table (due to its great length, this table could not be printed in this paper). Subsequently, this information was analyzed by using descriptive statistics and the stated objectives of the study. The researcher could calculate the statistical indicators such as the percentage of the distribution and frequency (Hafez-nia, 1998). The selection of a sample is realized by using Typical Case Sampling. In this method, the researcher studies an individual, group, or a series to determine the average score. The researcher should consult one or more experts in the field in order to achieve the objective of a study. One current approach in sampling is snowball sampling. This type of sampling is based on random selection. This method will be used when members of a group or society cannot be easily determined (e.g. illegal immigrants). In this method, the researcher first identifies certain individuals. After requesting the necessary information from these individuals, the researcher will ask them to introduce a new person to be interviewed (Ranjbar et al., 2012). This study was conducted to investigate the barriers and solutions for the commercialization of research findings in schools of agriculture with a detailed insight and in-depth analysis. To collect the data, qualitative and in-depth interviews were used in order to understand the phenomenon from the point of view of the participants and their particular socio-institutional position. For this study, 15 subjects were chosen by the researchers and 3 were recommended by the interviewees. The total population chosen consisted of 18 people, which included academic staff, managers of commercial offices, and offices with similar activities, such as the technology transfer office, industry relations offices of the schools of agriculture, and agricultural research centers in Tehran, Iran. All of the interviewees were males with a Ph.D. The characteristics depicting this sample population are shown in Tables 1 and 2.

The optimal sample was selected through a purposive-typical case sampling and a snowball sampling method. In the typical case sampling, a group of professionals conducted the interviews until obtained the needed data (Bazargan, 2008). Purposive sampling is a judgmental or selective sampling technique. The mixed purposive sampling techniques of typical case sampling were used in the interviews. In the snowball sampling method, the interviews were conducted with those introduced by the sample subjects.

Table 1 Executive experience for the sample population

	Executive Position	Number
1	Head of agricultural faculty	2
2	Head of agricultural research department	2
3	Director of commercialization office	4
4	Director of industry- university relation office	2
5	Director of intellectual property office	2
6	Head of science and technology park	1
7	Head of technology incubator	1
8	Academic staff without executive position	4
	Total	18

Table 2 Years of executive experience for the sample population

Years of experience	Number
10-15	1
15-20	2
20-25	11
25-30	4
Total	18

In this method, the sampling will continue until we no longer obtain more information[2] (Ranjbar et al., 2012). Therefore, the interview was continued as long as was needed. In this regard, interviews were conducted with this population of 18 subjects. All these people participated in the interviews in order to answer the researcher's questions. The interviews were done in two months during 2014. The procedure for conducting the interviews followed all standard procedures. In addition to purposive selection of samples for interviews, the questions or the intended topics for the interviews were submitted to the interviewers in a complete and clear format in order to ensure the validity and reliability of the research. During the interviews we tried to raise relevant concepts and examples using the interviewer's questions to guide the conversation in the intended direction and to prevent deviation of the responses related to the technical area, irrelevant issues, and to conduct an in-depth examination of our questions. For example, it was demonstrated in the literature review that financial factors, bureaucracy and miscommunication can be an obstacle in agricultural commercialization. In addition to that, we tried to study the details and instances of these factors from the point of view of those being interviewed. Finally, the interviews were summed up with the respondents' collaboration. Furthermore, the interviews were conducted in the conditions intended by the respondents. The questions were revised and repeated, and the respondents were ensured that the information they provided will be kept confidential. Regarding the responses to the questions, the indicators of the study under "Barriers and Challenges Facing Commercialization of Research Findings in Schools of Agriculture" and "Solutions for Removing These Barriers" were defined; the data collected from the interviews were analyzed using content analysis and open codifying. In this context, the summarized propositions obtained from the interviews and the relevant codes were expressed. For coding and grouping the propositions, the topics and concepts existing in the literature were mainly used, in addition to the topics used by the researchers and/or the respondents. Subsequently, the frequencies of the propositions were determined; finally, the barriers and solutions were accordingly ranked.

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[2] Banning EB. (2002), Archaeological survey. New York ; London: Kluwer Academic/Plenum Publishers. cited In Ranjbar et al.

3. RESULTS

In this study, two general indicators, namely "barriers to commercialization" and "solutions for commercialization" were defined, based on the answers given by the respondents in the conducted interviews. First, the propositions related to the indicators of "Barriers Facing Commercialization of Research Findings in Schools of Agriculture" were summarized and codified. Accordingly, a total of 17 propositions were identified and classified as barriers to commercialization. The frequency of extracted codes related to the commercialization barriers and the ranking of the propositions are presented in Table 3 and Table 4, respectively.

Table 3 Frequency of extracted codes related to commercialization barriers

No.	Barriers' Statement	Code	Frequency	Percentage
1	Financial-investment	1	13	10.23
2	Infrastructure	2	9	7.08
3	Educational-cultural barriers	3	11	8.66
4	Needs assessment, problem identification and statement	4	8	6.29
5	Perspective and inappropriate policy making	5	18	14.17
6	Distrust and weak communication	6	13	10.23
7	Technical-specialized	12	10	7.87
8	Skill-related	13	3	2.36
9	Advertisement and marketing	14	3	2.36
10	Presence of private sector	18	2	1.57
11	Intellectual property	19	7	5.51
12	Paper orientation in universities	20	5	3.93
13	Market instability	21	6	4.72
14	Lengthy time of agricultural research	28	4	3.14
15	Motivational barriers	28	4	3.14
16	Competition and competitive environment	32	3	2.36
17	Support	33	8	6.29
	Total		127	100

Table 4 Ranking of propositions as commercialization barriers

Rank	Code	Barriers' Statement
1	5	Perspective & inappropriate policy making
2	6 & 1	Financial-investment distrust & weak communication
3	3	Education & culture creation
4	12	Technical-specialized
5	2	Infrastructural
6	4 & 33	Needs assessment, problem identification & statement supportive
7	19	Intellectual property
8	25	Market instability
9	20	Paper orientation of universities
10	27 & 28	Agricultural research taking long time motivational barriers
11	13, 14 & 32	Skills related advertisement & marketing competition & competitive environment
12	18	Presence of private sector

In the second part of the research, the opinions of the respondents concerning the solutions for removing the existing obstacles to commercialize research findings were examined. The propositions related to the indicator of "solutions for removing the barriers to commercializing research findings at schools of agriculture" were summarized and codified. Accordingly, a total of 16 propositions were identified and categorized as solutions. The distribution of extracted codes related to the solutions for commercialization and the ranking of these propositions are given in Table 5.

Table 5 Distribution of extracted codes related to commercialization solutions

No.	Solutions	Code	Frequency	Percentage
1	Planning, legislation & policy making	7	18	15.25
2	Needs assessment, goal setting, & prioritizing	8	16	13.56
3	Investment and attracting outside resources	9	7	5.93
4	Incubators and science & technology parks	10	8	6.78
5	Communication	11	6	5.08
6	Technical-specialized	15	1	0.85
7	Business skills	16	2	1.69
8	Education and culture creation	17	13	11.02
9	Infrastructural	21	5	4.24
10	Supportive	22	10	8.47
11	Advertisement and marketing	23	5	4.24
12	Presence of other sectors (as private sector)	24	6	5.08
13	Spinoffs and academic firms	26	8	6.78
14	Team work	29	3	2.54
15	Consulting	30	2	1.69
16	Intellectual property	31	8	6.78
	Total		118	100

4. DISCUSSION

Research and development are the most important tools in the advancement of science and industry, especially when it leads to commercialization. Furthermore, universities play an important role in conducting research in various scientific fields by utilizing their human and non-human resources. Today, many problems have plagued commercialization of academic research findings including the absence of appropriate policies and lack of perspective, to name a few. Thus, a large number of academic research does not reach the production and the commercialization stage, which results in a loss of a substantial part of the resources. In this regard, the studies show that although the research centers in Iran have been in a good situation in terms of allocated human and financial resources, they were unsuccessful in the conversion of research findings and commercialization of technology. This is reflected in the low percentage of exportation of high-tech products in comparison to industrial products. Iran has been ranked 117th among 175 countries (Abbasi, 2013). Therefore, given the importance of this issue, the barriers to and the solutions for commercialization were investigated from the point of view of experts adopting a qualitative approach and an in-depth insight into the problem. There are also political issues outside of the scope of this research, which may be contributing factors.

According to the results, the foremost barrier to commercialization was inappropriate **attitude and policy making**. Although financial support is considered as a commercialization requirement, all 18 respondents viewed the lack of vision and appropriate policies, programs, and models as the most important barriers to commercialization. These results are shown in Table 4. Therefore, instead of having limited and short-term views, the issue of commercialization of research findings should be considered as one of the fundamental policies in agricultural education. The interviewees were asked to suggest practical solutions in respect to the discussed obstacle. One suggestion was to define intellectual property values, which in turn would support the establishment of knowledge-based firms. In addition, reducing administrative bureaucracy may facilitate the granting of credit, which can reduce the obstacles in the commercialization process. As shown in Table 5, all 18 interviewees cited the above mentioned solutions in order to realize and facilitate the commercialization of research findings in agricultural schools. Planning and cooperation in the commercialization of research results should be announced as an academic goal. Then, proper processes and standards should be developed in accordance with the requirements of higher education in order to achieve this goal.

Although higher education in agriculture is education-oriented, developing regulations for encouraging commercialization could promote an active presence of faculty members in this field.

Additional barriers included the **lack of financial-investment, distrust,** and **weak communication**. According to Table 4, 13 out of 18 respondents placed financial barriers after policy making. The respondents concluded that there is a lack of adequate investments and funding in agricultural research. Usually, when universities are faced with a lack of funding, less money is allocated to the research programs. The lack of appropriate policies in favor of the commercialization of research in the universities results in insufficient budget allocation and investment in this filed. On the other hand, banks are reluctant to get involved due to high interest rates and high investment risk in this sector. It is also very difficult for researchers to guarantee their commercialization projects.

The **educational-cultural barriers** had the lowest ranking. In Table 4, distrust and weak communication are in the same level as financial investment impediments. One of the problems of the agricultural sector is the lack of interaction between Iranian universities and agricultural entities. They usually do not perform research together. Therefore, neither party can benefit from such cooperation. This is why research in the university is not consistent with the real needs of the agriculture industry. As shown in Table 3, 11 interviewees mentioned educational-cultural factors as the third important obstacle to commercialization. According to the interviewees, creating the proper culture and providing necessary training in this field is essential for the development of commercialization. In fact, agricultural schools are based on training and teaching and there is less support for doing research. The commercialization of research results has not been defined as a requirement to faculty members. Also, according to the respondents, a solution to lifting this barrier consists of holding conferences and workshops on commercialization, its regulations, and guidelines. In addition, the knowledge of the target market could also contribute to the development of commercialization.

5. CONCLUSION

The overall conclusion is that the value-added agricultural stimulates the economy in the long-run through an increase in aggregate demand. There is a relationship between economic growth and in agricultural value-added along with gross capital formation, labor force, and real exports. In most cases, university research continues to operate independently with little involvement of stakeholders in the identification of research priorities, implementation, testing, and evaluating the impact of the technologies. Often technologies have not been adequately tested under producer circumstances so as to assess their suitability and performance. Further, the technology delivery mechanisms have often been ineffective and at times non-existent or not linked with the technology generation process. The links to a complementary input supply system for the packages that are essential to exploit the benefits arising from any given technology have also been at best weak. A technology policy that addresses these weaknesses would include a focus on scientific and socioeconomic issues, including adaptation and adoption of improved high yielding agro-processing technologies to increase productivity, reduce losses, add value, and improve quality. The following suggestions are derived from the research results of this study: (1) The needed structure for commercialization should be established in the organization of the schools; (2) The relevant rules and regulations should be drawn and notified concerning school policies on the division of the benefits obtained from transferring technical knowledge, commercialization of research findings, establishing spin-offs and knowledge-based firms, protecting intellectual property, etc.; (3) Considerations related to the commercialization potential of the research findings should be considered upon approval of proposals as a policy with notification to the faculty and the students.

The role of markets in the process of economic development and the steps the Iranian government must take to foster that role. There is now a general agreement that agricultural development requires a market-oriented strategy capable of stimulating rapid technological change in the agricultural sector and related industries for commercialization.

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