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The Levels Formed Commercialization of Agricultural Biotechnology in Researchers' Opinion

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Abstract: Biotechnology is the application of biology to improve quality of life via the innovation use of cellular and molecular processes to develop beneficial technologies and products. While agricultural biotechnology research findings don't apply to eliminate needs, resources will waste. Despite of applying findings' researches on biotechnology in agriculture, most of them just are published in scientific journals but they aren't accessible to utilizers, due to the fact that these findings require converting to applied products. So, the major purpose of this study was to identify the levels formed commercialization of biotechnology's findings by agricultural biotechnology researchers of Iran. The population for the study was 170 biotechnology researchers engaged in governmental agricultural research institutions of Iran and data collected by using a questionnaire. In this study, an exploratory factor analysis technique in $SPSS_{Win16}$ was used to summarize and sort many variables in some factors. The results of factor analysis were shown that five latent factors including idea creation, development of technology, Business opportunity searching, entering to the market and expanding the business and commercialization continuing formed the levels of agricultural biotechnology's findings commercialization. Among those factors idea creation factor with 3.43 eigenvalue was in the first.

Key words: Commercialization levels, exploratory factor analysis technique, Biology and Biotechnology, Agriculture, Iran

INTRODUCTION

Over the past three decades, the biotechnology industry has emerged as a critical and dynamic source of new technologies for the agricultural industries (Gans and Stern, 2002). Emerging agricultural biotechnology leads to economic growth and improvements in life quality, environment and industrial productivity. Governments in developing countries and investors intend to increase bio entrepreneurship.

James (2009) declares that during 1996-2012 millions of farmers in 30 countries, adopting biotechnology products. Because biotechnology products cause considerable and sustainable economic, social and environmental benefits, they trust on biotechnology. Agricultural biotechnology creates great expectations about food production, livestock and fishery. In spite of that biotechnology is entering into Industrializing phase.

So, adapting biotechnology products to environment and their effects requires considering. Commercialization of university's research related to roles and functions of the office technology transfer, incentives for researchers, licensing procedures, mechanism of commercialization such as spin-offs and start-ups (Hussain *et al*., 2011).

According to Kapeleris, commercialization is defined as the process of taking an idea to successful results in the market, that it's a product, service, process or organizational system. Commercialization should also include knowledge diffusion, advising services and contract research. Maarse and Bogers (2012) stated that while some innovation projects are driven by latent and unsatisfied customer needs (market-driven innovation), others are driven by the creation of a new technology or scientific advance (technology-driven innovation).

Public acceptance of crop biotechnology has been a lingering concern in Asia. So, the benefits of biotech crops still require to be communicated to the public. Neglecting to identify the needs, interests and concerns of the primary stakeholders or publics in the biotechnology has been a major factor in the emergence of argument (Navarro and Hautea, 2011).

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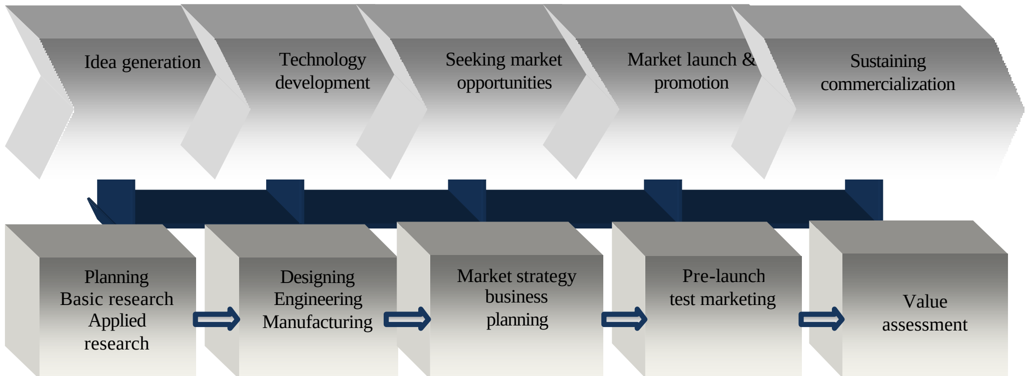

Fig. 1: Preliminary framework for technology commercialization

Some key factors enhance biotechnology commercialization that including an entrepreneurial environment, adequate services on law issues and patent, biotechnology services and sufficient management expertise. Among Asian, African and Middle East countries, Iran has a superior occasion on agricultural biotechnology and 13 technologies have commercialized.

In the other hand, one of the problems in agriculture is that researches aren't targeted and research findings aren't commercialized. As well as, Qasem Sharbiani remarks privatization, supportive laws, creating and transfering of technology, marketing and cultural issues as biotechnology production constrains in Iran.

Kajanus *et al.* (2011) declared that restricts of innovation commercialization are including finance, networking, marketing, and business environment which effect on commercialization process.

As some authors such as Kajanus *et al.* (2011) and Obiora (2013) emphasized on the roll of information in commercialization process, awareness of the commercialization levels' biotechnology findings crucial for bio entrepreneurs.

Valadan stated the commercialization levels of researches on agricultural and natural resources, respectively as need assessment, studding of market, idea generation, research, IP, technology assessment and development, technology marketing, transfer of technology, new enterprise establishing, marketing for new products.

Also, Goudarzi declared innovation, research, commercialization strategy, new service/product development, launch to the market respectively as the commercialization levels.

The commercialization levels by Goldsmith (1999) model as well, included research, feasibility, development, introduce, growth and maturity, respectively. Moreover, the commercialization levels in Jolly model, respectively included idea imagination, benefits mobilization, growth, resources mobilization, exposure, market mobilization, expanse, property mobilization, commercialization sustaining and understanding of long-time value. In addition, Maattanen emphasized on idea generation, technology development, seeking market opportunity, launch to the market, sustaining of commercialization as the commercialization levels in sequence (Fig. 1).

MATERIALS AND METHODS

The research type was applied, descriptive and quantitative method. In this study, stratification sampling was applied and population for the study was 170 biotechnology researchers engaged in governmental agricultural research institutions of Iran. Data collected by using a questionnaire and the reliability of the questionnaire was measured by using a Pilot test and Cronbach's alpha method and the reliability for the overall instruments was estimated 0.85 and for the commercialization levels was estimated 0.88. The levels formed commercialization of biotechnology's findings was identified by using exploratory factor analysis technique and the data was analyzed by using statistical methods in $SPSS_{Win16}$. Items of levels were obtained through a comprehensive literature review.

The major purpose of this study was to identify the levels formed commercialization of agricultural biotechnology findings' researches by agricultural biotechnology researchers and its objectives were:

- Awareness of some personal and professional characteristics of this research's respondents
- To identify the levels formed commercialization of biotechnology's research findings
- To summarize items formed each level of biotechnology's findings commercialization
- To sort the levels formed commercialization of biotechnology's findings

- To determine influence of each item on forming each level by biotechnology researchers in governmental agricultural research institutions of Iran

RESULTS AND DISCUSSION

Findings of researches showed that approximately, 80% of researchers as respondents had PhD degree and 20% had master degree. According of findings of the research, 80% of researchers had studied agricultural engineering and only 3% had studied natural resources. Also, findings of research showed that the average of research articles' number in the case of agricultural biotechnology is 27 articles that 55.5% of researchers as respondents have 1-20 published articles and 0.6% (one researcher) has 120 articles. Finally, based on the results of the study, the average of respondents' research background is 19 years.

In this study, significance of Bartlet test and KMO score were respectively 99 and 0.84% which showed that variables were suitable for factor analysis. According to Kaiser Criterion, five factors with >1 eigenvalue were extracted (Table 1).

After factors' varimax rotation as shown in Table 2, variables sorted in five factors and only factor loadings than are >0.50 were reported. These five factors (commercialization's levels) were named based on variables loaded on each of them. The first factor was named idea creation with 3.43 eigenvalue and explained 68.67% of the total variance of variables. The second factors named development of technology which eigenvalue for this factor was 0.64 and explained 12.85% of the total variance of variables. Also, the third factor identified as business opportunity searching with 0.38 and explained 7.64% of the total variance of variables. The forth factor named entering to the market and business extending which its eigenvalue was 0.30 and explained 6.03% of the total variance of variables. Ultimately, the fifth factor identified as commercialization continuing which eigenvalue for this factor was 0.24 and explained 4.80% of the total variance of variables.

Variables loaded on each factor along with their factor loadings have shown in Table 3-7. In order of priority based on factor loading, need assessment of agricultural sector (0.945) is the most important activity in the first level and feasibility of basic and initial agricultural biotechnology researches (0.941) is an important activity in forming of idea creation level as shown in Table 3.

According to priority based on factor loading, intellectual property creation in biotechnology industry (0.945) is the most important activity in the first level and Feasibility of basic and initial agricultural biotechnology researches (0.965) is the most significant activity in technology development level. Then, applied biotechnology research (0.950) is an important activity in the second level as shown in Table 4.

Based on factor loadings on the third factor as shown in Table 5, designing and performance of a biotechnology business model (0.925) and limited sale of the agricultural biotechnology production (0.925) are the most important activities to form business opportunities searching level.

According to the factor loadings on the forth factor as shown in Table 6, Share information through communicational channels (0.922) is the most significant activity to constitute entering to the market and expanding the business level. Also, set regulation on biotechnology commercialization (0.920) is necessary to form the forth level.

Based on factor loadings on the last factor as shown in Table 7, Long time profit warranty for the biotechnology researcher as inventor (0.924) is the most significant activity to form commercialization continuing level. Then, changing production through applications improvement or continues use by utilizers (0.910) is an important activity in the fifth level.

Table 1: Summery of literature on commercialization

Levels	Authors 1
Idea creation	Cybrary Manage, Kainuma, BarZakay, Hashemi and Shabanali Fami
Development of technology	Maattanen, Enzing, Visalakshi and Khilji
Business opportunity searching	Maattanen, Ferguson, Hashemi, Valadan and Goudarzi
Entering to the market and expanding the business	Maattanen, IBIA, Ferguson and Goudarzi
Commercialization continuing	Kajanus *et al*. (2011)

Table 2: Factors extracted, eigenvalue and variance after factor rotation

No. of factor	Eigenvalue	Variance (%)
1	3.43	68.67
2	0.64	12.85
3	0.38	7.64
4	0.30	6.03
5	0.24	4.80

Table 3: Variables loaded on the first factor

Factors	Variables	Factor loading
Idea creation	Need assessment of agricultural sector	0.945
	Feasibility of basic and initial agricultural biotechnology researches	0.941
	Examination possibility of new biotechnology production technically	0.922
	Manner of the technology response to the needs	0.920
	Resources and expenditures prediction	0.917
	Prediction of applying new biotechnology products effects	0.892
	Benefits prediction of new biotechnology products commercialization	0.885

Table 4: Variables loaded on the second factor 2

Factors	Variables	Factor loading
Development of technology	Intellectual property creation in biotechnology industry	0.965
	Applied biotechnology researches	0.950
	Technology variation and modification indigenously	0.947
	Technical support with new biotechnology production	0.925
	Allocation resources for preliminary commercialization decision	0.919
	Preliminary identifying of the agricultural biotechnology market	0.900
	Conversion new idea to applied biotechnology production	0.897

Table 5: Variables loaded on the third factor

Factors	Variables	Factor loading
Business opportunity searching	Designing and performance of a biotechnology business model	0.925
	Limited sale of the agricultural biotechnology production	0.925
	Demand creation and resistance reduction to the new agricultural biotechnology product	0.922
	Assessment of new biotechnology production to final manufacture	0.923
	Identifying business opportunities for commercialization	0.913
	Biotechnology production prototype manufacturing	0.876
	Final deciding for the new biotechnology commercialization	0.858

Table 6: Variables loaded on the forth factor 4

Factors	Variables	Factor loading
Manufacturing and commercialization the new biotechnology	Share information through communicational channels	0.922
	Set regulations on biotechnology commercialization	0.920
	Mobilization assets for new biotechnology production delivery	0.915
	Conversion new biotechnology to commerciality feasible and large scale manufacturing and commercialization the new biotechnology	0.912
	Finding appropriate market of biotechnology production	0.901
	Adopting and entering the new agricultural biotechnology production by utilizers	0.879
	Marketing expanding of the new agricultural biotechnology production	0.808

Table 7: Variables loaded on the fifth factor

Factors	Variables	Factor loading
Commercialization continuing	Long time profit warranty for the biotechnology researcher as inventor	0.924
	Changing production through applications improvement or continues use by utilizers	0.910
	Commercialization stability through maintaining the new biotechnology production dominance long time	0.886
	Comprehending the new biotechnology production advantages by users and its effects appearance	0.884
	Expanding the new biotechnology production use	0.881
	Supporting the new biotechnology production manufacture	0.878
	Assessment of users satisfaction and feedback	0.847

CONCLUSION

In this study, the levels formed commercialization of biotechnology's findings were summarized in five factors as idea creation, development of technology, business opportunity searching, entering to the market and expanding the business and commercialization continuing. According to the results, idea creation explained 68.67% of the total variance of the levels formed commercialization of biotechnology's findings and became the firs factor. Based on the results of exploratory factor analysis, need assessment of agricultural sector was the most important activity in the first level. Because biotechnology requires be adapted and modified to needs in which it will be invented to eliminate. These findings were verified by researchers such as Maattanen, IL Small Business Development Center, Maarse and Bogers, Olsen, AIC and Ferguson (2008).

Also, IP creation in biotechnology industry was the most influential activity in the second level. Due to the fact that intellectual property creates worth and benefit. These results were verified by researchers such as Gans and Stern (2002), Boehlje (2004), Indarti and Wahid (2013) and Haeussler (2011).

As well as, designing and performance of a biotechnology business model was the most important activity in the third level. Designing a business model is necessary for investors or factory owners and it's a path plan to develop strategic programs and actions. This finding was verified by researchers such as IL Small Business Development Center, Valadan, Mozenter and Berger, Olsen, Ferguson.

In addition, in the forth level, set regulations on biotechnology commercialization was influential. This result was verified by researchers such as Gans and Stern (2002), Newell (2007) and Indarti and Wahid (2013). And also in market and expanding the business phase, large scale manufacturing and in fact, commercialization occurred. Due to the fact that information about economic resources, expendituresa and target market make industry capable of assessing opportunities reliably. This finding was verified by researchers such as Kajanus *et al.* (2011).

RECOMMENDATIONS

Finally, long time profit secure for the inventors in the fifth level was the most influential activity. In order to motive the researchers to commercialize their achievements. This finding was verified by researchers such as Olsen, Goudarzi and Ferguson. Eventually, findings of this study, suggest some recommendations as bellow:

- Allocating certain share of biotechnology license sale or assignment's income to the innovator researchers as royalty to protect their right
- Registering patent on biotechnology for the researches as innovators but not the research institute
- Providing credit facilities to operate and develop small and medium enterprises to researchers and entrepreneurs on agricultural biotechnology
- Set regulations to allotment of benefits from commercialization researchers' inventions fairly
- Providing agricultural extension system with educational extension workers to assess farmers' needs and problems about agricultural inputs such as bio fertilizer, bio pesticide
- Determining researches priorities at the extension-research committee jointly and transferring feedback of the farmers' needs to research institutes by extension workers

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