Study on the Factors Influencing the Level of Innovation in Agricultural Science and Technology Projects

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Abstract This paper carries out a questionnaire survey of persons in charge of the agricultural project in the "Eleventh Five-Year National Support Program" on the level of innovation in projects and the factors influencing innovation. After the linear regression analysis of the survey data, it is found that the factors influencing the innovation in agricultural science and technology projects include the level of innovation in scientific achievements, efficiency of research methods and creation of innovation environment. Through the variance analysis of the level of innovation and its influencing factors related to different innovators, it is found that there are differences in the statistical significance of level of innovation in projects among universities, research institutes, research and extension departments directly under the government, and enterprises; there are no significant differences in the understanding of factors influencing innovation, that is, different innovators basically have the same understanding of factors influencing innovation, but the assessment on level of innovation in projects completed is different to some extent. On this basis, this paper proposes the recommendations for further strengthening the level of innovation in agricultural science and technology projects in order to provide a theoretical reference and practical basis for the project managers to effectively improve the level of agricultural science and technology project management, and enhance the level of innovation in projects.

Key words Agricultural science and technology innovation, Influencing factors, Level of innovation, Innovators

1 Introduction

Agricultural technology innovation is a process of research and development of new agricultural technologies or experimental development; and a process of introducing, absorbing, imitating, improving and promoting new agricultural technology, and re-combining the original agricultural technology[1]. It is also a way to apply material equipment and resources for reasonably efficient allocation[2]. Agricultural science and technology innovation is a social activity that humans participate in, and people's innovation values and innovative atmosphere of society are important external conditions for the technological innovation[3]. The effective supply of agricultural science and technology innovation is insufficient in China, largely due to long-term insufficient investment in agricultural technology innovation[4]. By comparing the development of agricultural science and technology between Eastern and Western countries, we believe that the main reason for high level of research and numerous agricultural science and technology achievements in Western countries lies in the large number of outstanding talents of agricultural science and technology[2]. Colleges and universities, engaged in teaching and basic agricultural research and high-tech research, play a unique role in the process of China's agricultural science and technology innovation. Research institute is an important part of national agricultural science and technology innovation system, and it aims to solve the critical and strategic issues concerning agricultural science and technology[5]. There are also the research and promotion agencies directly under the government, responsible for the welfare function for agricultural and rural development[6]. The enterprises also play an important role in promoting R & D of agricultural technology. From the current development situation, the enterprises still do not have the same status of R & D compared with research institutes or universities[3]. In the literature, it mainly performs the qualitative analysis of innovators, but lacks the differentiation analysis of different innovators' innovation activities based on quantification.

2 Evaluation of level of innovation in projects

The object of this survey includes the leaders of agricultural sector support program started from 2006 and concluded in 2010. The survey was conducted in June 2012 - September 2012, and most of the questionnaires were sent to the project undertakers by mail. A total of about 1000 questionnaires were distributed and 322 valid questionnaires were returned. Using questionnaire and statistical analysis, this paper collates and summarizes the finished agricultural sector projects concerning the "Eleventh Five-Year Plan", in order to provide a reference for the effective application of innovative approaches in agricultural research and improvement of research project management level.

2.1 Project undertakers' self-evaluation of level of innovation in projects Most of the project teams select "very innovative" in the self-evaluation of level of innovation (202 persons), followed by "comparatively innovative" (65 persons) and "most innovative" (46 persons). There are 9 project teams choosing "generally innovative" and "slightly innovative", as shown in Fig. 1.

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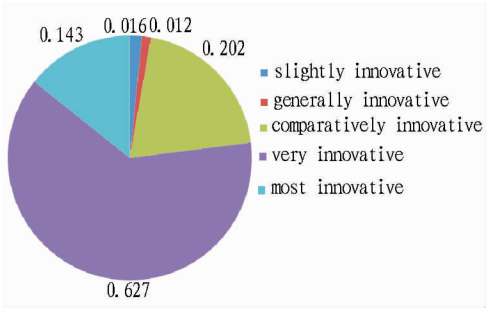

Fig. 1 Project undertakers' self-evaluation of level of innovation in projects

2.2 The difference in the innovators' self-evaluation of level of innovation In the questionnaire, we divide the units undertaking projects into universities, research institutes, extension departments, and enterprises. These units constitute the main body of agricultural science and technology innovation. By the statistical analysis, it is found that there are differences in the evaluation of overall level of innovation between units of different nature, and the contingency table and descriptive statistics[7] are shown in Table 1, 2, respectively.

Now we perform the variance test on different innovators' overall level of innovation, in order to get the differences in the level of innovation in projects between different units, and the results are shown in Table 3. The significance level is 0.1, indicating that there are generally significant differences in the evaluation of overall level of innovation in project between different units. It can be inferred that among the innovators of agricultural science and technology projects, enterprises' self-evaluated level of innovation is high, followed by extension departments, universities, and research institutes.

Table 1 Contingency table of different units' evaluation score on overall level of innovation in the project

Units of different nature	Please evaluate the overall level of innovation in this project					Total
	Slightly innovative	Generally innovative	Comparatively innovative	Very innovative	Most innovative	
Universities	2	0	25	77	14	118
Research institutes	3	4	37	111	23	178
Extension departments	0	0	1	2	2	5
Enterprises	0	0	1	10	5	16
Total	5	4	64	200	44	317

Table 2 Descriptive statistics on different units' evaluation score of overall level of innovation in the project

Units of different nature	The number of samples	Mean	Standard deviation	Standard error	Maximum	Minimum
Universities	118	3.86	0.683	0.063	1	5
Research institutes	178	3.83	0.743	0.056	1	5
Extension departments	5	4.20	0.837	0.374	3	5
Enterprises	16	4.25	0.577	0.144	3	5
Total	317	3.86	0.719	0.040	1	5

Note: In the questionnaire, "slightly innovative" is assigned 1; "generally innovative" is assigned 2; "comparatively innovative" is assigned 3; "very innovative" is assigned 4; "most innovative" is assigned 5.

Table 3 Variance analysis of different units' evaluation score on overall level of innovation in the project

Units	Sum of variance	DOF	The average variance	F value	Significance
Between groups	3.215	3	1.072	2.097	0.100
Within groups	159.952	313	0.511		
Total	163.167	316			

3 Study on the factors influencing the level of innovation in projects

3.1 Analysis of the factors which can improve the level of innovation in projects In the questionnaire, project undertakers set forth the recommendations for better improving the level of innovation in the project (Fig. 2). From the frequency of descriptive statistics, 67% of undertakers believe that giving adequate research funding will help improve the level of innovation in the project, and more than 40% of undertakers believe that building efficient research personnel, exploring research ideas and using scientific research method can improve the level of innovation in projects. About 30% of undertakers believe that the level of scientific research of the project can be also improved from the way of organization and management, and advanced research tools. Adequate funding can not only ensure the successful completion of the project, but also ensure the improvement of innovation in projects.

3.2 Regression analysis of the factors which can improve the level of innovation in project and self-evaluation of level of innovation From the statistical description, although there are a lot of project undertakers who opt for research funding from the key factors influencing the level of innovation in projects, it is found that the results are not in line with facts after the regression analysis of the factors which can improve the level of innovation in project and self-evaluation of innovation. The regression coefficients and significance can be shown in Table 4. In Table 4, the factors with significance level of less than 0.05 include "advanced and efficient research methods", "rational and efficient way of organization and management", and "innovative research results".

"Reasonable and practicable research idea" is only marginally significant. The standardized coefficient of innovative research results is 0.309, and it can be said that the impact of innovative research results on evaluation of level of innovation is greater than the positive impact of advanced and efficient research methods (standardized coefficient of 0.155) on evaluation of level of innovation, and also greater than the negative impact of rational and efficient way of organization and management on evaluation of level of innovation. In contrast, we can see that the project team pays more attention to the pursuit of innovation in scientific research achievements but ignore "clear and appropriate research goal", "reasonable and practicable research idea" and "advanced and efficient research tool" based on process.

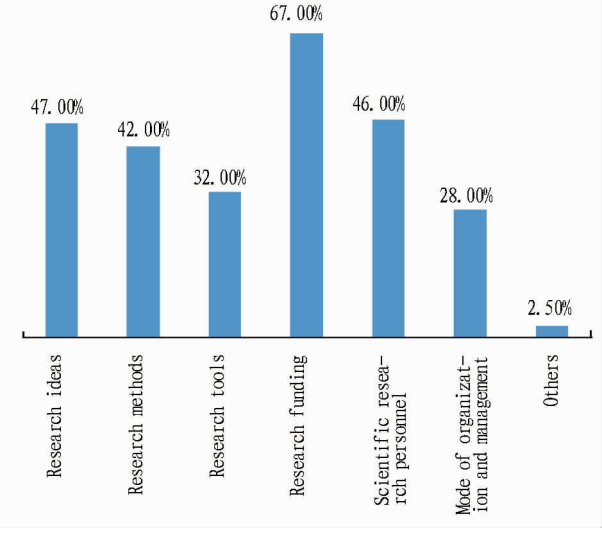

Fig. 2 Statistical description of how to improve the level of innovation in projects

3.3 The differences in different innovators' evaluation of level of innovation in projects Now we'll discuss the differences in different innovators' evaluation under the above three significant influencing factors, and the average value of factors influencing different innovators' innovation can be shown in Fig. 3.

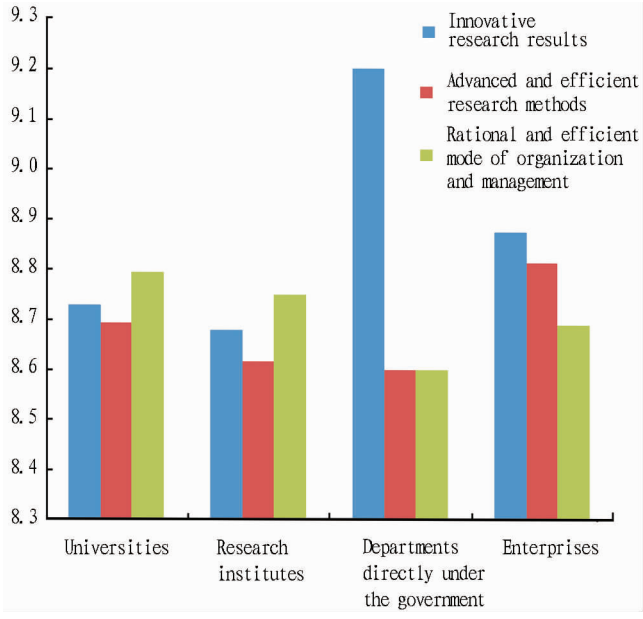

Fig. 3 The average value of factors influencing different innovators' innovation

3.3.1 Focusing on the innovation in research results. In the regression analysis, the innovation in research results is significantly correlated with project undertakers' overall evaluation of innovation in the projects, indicating that the researchers lay more emphasis on innovation in the research results and believe that the innovative research results are largely tantamount to the innovation of the projects. For the innovators of different nature, we perform the analysis on whether there is a difference in the innovative research results (Table 5, 6). From the average value of innovation in research results, it is high in the extension departments, followed by enterprises, universities and research institutes. However, after the analysis of variance, it is found that there are no significant differences for the four kinds of innovators' scores of "innovative research results", and we cannot conclude that the innovation results of enterprises is necessarily higher than the innovation in the research results of other units.

Table 4 Regression coefficients

Factors	Non-stand-ardized coefficients	Standardized coefficients	T value Significance B	Standard error	Beta value
Clear and appropriate research goal	−0.028	0.067	−0.028	−0.421	0.674
Reasonable and practicable research idea	0.112	0.070	0.115	1.612	0.108
Advanced and efficient research methods	0.133	0.055	0.155	2.398	0.017
Advanced and efficient research tool	−0.054	0.058	−0.068	−0.923	0.357
Adequate research funding	0.031	0.030	0.059	1.009	0.314
Sound personnel	−0.062	0.048	−0.084	−1.295	0.196
Rational and efficient mode of organization and management	−0.112	0.050	−0.134	−2.252	0.025
Innovative research results	0.283	0.063	0.309	4.477	0.000
Social, economic and ecological benefits	0.006	0.053	0.007	0.108	0.914

3.3.2 Paying increasing attention to the research methods. After the innovative approaches are promoted in the field of agricultural science and technology, through the significant influence of "advanced and efficient research methods" in the regression analysis, we can see that "independent innovation, method first" has been widely accepted. For the innovators, we perform the analysis on whether there is difference in "advanced and efficient research methods", as shown in Table 7, 8. In terms of the average value

of "advanced and efficient research methods", it is high for enterprises, and there are minor differences among universities, research institutes and extension departments. According to analysis of variance, there is no significant difference in scores of "advanced and efficient research methods" among different innovators.

Table 5 Statistical description of different innovators' scores of "innovative research results"

Units of different nature	Number of samples	Mean	Standard deviation	Standard error	Minimum	Maximum
Universities	118	8.7288	0.75142	0.06917	7	10
Research institutes	178	8.6787	0.80549	0.06037	4	10
Extension departments	5	9.2000	1.30384	0.58310	7	10
Enterprises	16	8.8750	0.61914	0.15478	8	10
Total	317	8.7155	0.78614	0.04415	4	10

Table 6 Variance analysis of different innovators' scores of "innovative research results"

Units of different nature	Sum of variance	DOF	The average variance	F value	Significance
Between groups	1.843	3	0.614	0.994	0.396
Within groups	193.451	313	0.618		
Total	195.294	316			

Table 7 Statistical description of different innovators' scores of "advanced and efficient research methods"

Units of different nature	Number of samples	Mean	Standard deviation	Standard error	Minimum	Maximum
Universities	118	8.6915	0.78496	0.07226	7	10
Research institutes	178	8.6157	0.87248	0.06540	4	10
Extension departments	5	8.6000	1.14018	0.50990	7	10
Enterprises	16	8.8125	0.83417	0.20854	7	10
Total	317	8.6536	0.84064	0.04721	4	10

Table 8 Variance analysis of different innovators' scores of "advanced and efficient research methods"

Units of different nature	Sum of variance	DOF	The average variance	F value	Significance
Between groups	0.843	3	0.281	0.396	0.756
Within groups	222.465	313	0.711		
Total	223.308	316			

Table 9 Statistical description of different innovators' scores of "rational and efficient mode of organization and management"

Units of different nature	Number of samples	Mean	Standard deviation	Standard error	Minimum	Maximum
Universities	118	8.7932	0.83510	0.07688	6	10
Research institutes	178	8.7483	0.89709	0.06724	6	10
Extension departments	5	8.6000	0.54772	0.24495	8	9
Enterprises	16	8.6875	0.70415	0.17604	8	10
Total	317	8.7596	0.85877	0.04823	6	10

Table 10 Variance analysis of different innovators' scores of "rational and efficient mode of organization and management"

Units of different nature	Sum of variance	DOF	The average variance	F value	Significance
Between groups	0.367	3	0.122	0.164	0.920
Within groups	232.677	313	0.743		
Total	233.043	316			

3.3.3 Changing the mode of organization and management. The "rational and efficient way of organization and management" has a negative impact in the regression analysis of level of innovation in projects. Obviously, the project undertakers urgently need to create the environment and atmosphere for innovation, and the management departments only need to provide necessary material conditions and relatively relaxing regulation and management. We do research work on whether there is a difference in the "rational and efficient way of organization and management" between different innovators, as shown in Table 9 and 10. In terms of the average value of "rational and efficient way of organization and management", it is high for enterprises, and there are no large differ-

ences among universities, research institutes, and departments directly under the government. According to the analysis of variance, there is no significant difference in scores of "innovative research results" among the different innovators.

4 Recommendations for improving the level of innovation in agricultural science and technology projects

4.1 Gradually forming the enterprise-led innovation mechanism In recent years, China's agricultural enterprises have made great progress, and the enterprises' innovation ability has been constantly enhanced. They gradually become important forces in agricultural production and operation activities. Chinese enterprises should enhance the ability of agricultural science and technology innovation, pay more attention to scientific and technological resources and human resources, and improve new product development capability, in order to gradually become an important innovation force in the agricultural technology field.

4.2 Creating a research atmosphere conducive to innovation Project managers should loose control over the original innovation, without specifying mandatory targets. For the project management, it is urgently needed to continue weakening the "administration" effect on project management and reasonably allocate project resources. It is necessary to simplify the declaration and reporting procedures to avoid spending more energy on something related to research[7], and set up scientific and objective evaluation criteria for fair and impartial review.

4.3 Strengthening the evaluation of innovation in the projects During the establishment of agricultural projects, it is necessary to strengthen the evaluation of project research methods, institution's innovation conditions and level of innovation in the achievements, foster the innovative projects, and better give play to the role of support project and other projects in breaking through the bottleneck constraints and enhancing the agricultural competitiveness.

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they cling to old practices and refuse to accept new things and the internal pressure of development is transferred to local government and competent agricultural authorities. The innovation cost is high, so enterprises are unwilling to make innovation. Accordingly the marketing channel innovation lags behind.

4.2.2 Issuing relevant innovation guiding policy to encourage reform of seed industry marketing channel. As an attempt, innovation needs cost and also risks. The overall strength of China's enterprises is limited and internal strength is weak. To catch up with trans-national seed enterprises, China's enterprises need drawing support of certain external force. Government should issue relevant support policy to promote innovation incentive mechanism for seed industry marketing channel and boost rapid development of seed industry.

4.2.3 Setting foot on industry development trend, invigorating large enterprises while relaxing control over small ones, and shortening the seed industry reorganization process.

From the development trend of seed industry, the present seed industry is realizing capital reorganization and resource integration. Some weak entities or individuals with small contribution to society are gradually exiting from the seed industry market. This is a mark of an industry entering the high end and also the inevitable trend of the seed industry realizing reasonable and sustainable survival and development. China should go with this trend, support powerful and high potential seed enterprises to make channel innovation, widen the gap with those weak entities, but narrow the gap with trans-national seed enterprises. For example, it is feasible to support those seed enterprises with integrated capacity of breeding, reproduction and promotion, and ability of conducting international trade.

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