# Implementation Mechanism Research of Scientific Institutions Involved in Crop Breeding Cooperation — Evidence from Western China

Ying Feng [1], Dongmei Li [2], Xiaolei Xiong [3]

[1] Sichuan Agricultural University, Chengdu, China

**Abstract - The establishment of enterprises as the mainstay of commercial breeding mechanism is the inevitable choice of China's seed industry modernization and food security. But the R&D strength of Chinese seed enterprise is still weak; they need to cooperate with scientific institutions. This paper aims to investigate scientific institutions' [1] willingness to participate in science-enterprise cooperation [2] and the factors influencing their selection. The Logistic model was used to analyze the impact factors of scientific institutions' willingness.365 respondents from 53 units of four major agricultural province in western China were surveyed. The results indicate that the factors such as technology transfer mode, the cooperation enterprise' ability to accept and recreate, leaders' recognition degree, personnel regulation, incentive regulation, distribution of benefit and risk regulation, support from the government's policy and law guarantee have positive effect on scientific institutions' selection. It first analyzes the scientific institutions' selection of choosing cooperative breed enterprises in transition period, and investigates the commercial breeding mechanism more scientifically.**

**Keywords - commercial breeding, food security, science-enterprise cooperation, scientific institutions, western China**

## I. INTRODUCTION

Seed industry is located in the upstream of the agricultural industry chain, which is to ensure food security and basic industry of effective supply of major agricultural products, and which is also involved in a strategic industry of the national security. For a long time, breeding of crop seed industry had taken the conventional breeding mechanism which was to take the agricultural scientific research institutions and agricultural colleges and universities as the main body, enterprise was mainly responsible for sales. This way of breeding ignored the market demand, and research achievements conversion rate was low, which could not adapt to market competition. The cooperation level between scientific institutions and enterprises was low, such as short cooperation, single simple way, loose relationship, low credibility, and high default rates, which leaded to seriously disconnect phenomenon among production, study and research, so that the "first-class seed" would only get the lowest price (Changyun Jang, Mingxuan Liu, 2010). Conventional breeding mechanism could not have any competitive ability in a highly open globalization seed market, and domestic breeding towards commercialization would be the inevitable choice for China. Building the cooperation mechanism between scientific institutions and seed enterprises, promoting factors of scientific institutions to flow to the enterprises, and realizing complementary advantages of science-enterprise is the key to the development of Chinese modern commercialized breeding system.

## II. RESEARCH FRAMEWORK

Foreign scholars researched on industry-university-institute cooperation which started in the eighties of the last century, and focused on cooperation theory basis, collaborative agent and so on to analysis. Transaction costs theory (R.H. Coase, 1933), the incentive theory and synergetics theory (Hawking, 1977), Triple Helix Model Theory (Leydesdorff and Etzkowitz, 2001), the model of knowledge production mode (Gibons.M., 1994) are the theoretical basis of industry-university-institute cooperative innovation. Bothwell (1979), Rothberg (1980) etc. realized a breakthrough of innovating main body category in the study, and Davies (1983), Eveland and Gidley (1986), Feeman. C (1987) and Curien (1989) focused on the main body such as functions of the government in cooperation and mechanism structure. Domestic scholars started to study industry-university-institute relatively late, mainly concentrated in the industry-university-institute cooperation mode (Wenyan Wang, 2008; Jinghui Chen, 2011), the influence factors (Aixiang Tao, 2011; Shuojun Su, Shiming Zhong, 2012; Yijia Zhu, 2012) as well as performance evaluation, operation mechanism (Kaiyong Xie, 2002; Xueyuan Wang, Hongqi Wang, 2008) and other aspects.

In terms of industry-university-institute cooperation mechanism, Wenming You(2004), Tingxun Zu (2006), Guichun Li (2008) studied the dynamic mechanism of industry-university-institute , and summarized the cause of the lack of motivation of industry-university-institute cooperation in our country. And some other scholars' studies focused on the industry-university-institute cooperation about knowledge management mechanism (ZuYing Weng, 2012), interest distribution mechanism

(Wenhua Wang, Henglong Ding, 2008), and risk sharing mechanism (Fangyuan Chen, 2008). The researches to the industry-university-institute cooperation discussion were elaborated to the understanding of a specific operation system, their study has a certain depth, but they have failed to fully hold the constituent elements and the mutual relations of the industry-university-institute cooperation mechanism. Another kind of researches angle was to the level of organization mode analyzed the operation mechanism of a certain specific cooperation mode (Jingbo Zhao, 2012; Xueyuan Wang, Hongqi Wang, 2008), and such researches could be controlled to a certain extent for the elements involved in the cooperation mechanism, but the classification methods from scholars were not comprehensive, or reflective of the relationship between the elements as well. Science-enterprise cooperation as a newer and higher form of industry-university-institute, the studies from domestic scholars were less, and they mainly focused on the meanings and functions of science-enterprise cooperation (Hongfei Zheng, 2013; Liwei Xiao, 2013) and the preliminary ideas and discusses of the implementation mechanism (Heping Liu, Jichun Luo, 2011; Xuanli Li, Guobao Yuan, 2013; Liqiu Li, 2013), while they neither proposed any specific operational methods from the level of the co-working functions, nor used any mathematical analysis models to test.

This article learning from synergetic theory, key elements related to the construction department Enterprise Cooperation implementation mechanism of the theoretical framework of cooperation systems from both internal and external. In cooperation system body connection, referencing Etzkowitz and Leydesdorff's triple helix model and the main body division method of Huoxue Shi(2001), Jiaojie Cheng and Wenhua Zhao(2011), and delimiting the the main body of seed industry by enterprise cooperation for business, science, education, government and the market. The key elements of internal and external cooperation system referenced from Gang Zheng's $C^3IS$ model (2004), based on the key elements of a comprehensive collaboration in technical innovation of technology, strategy, organization, culture, institutions, markets. And the seven elements model of Jun Zhang and Jun Cao (2008) as follows, the talent, technology, capital, market, institutional, cultural and environmental combination. In this paper, the internal system key elements to the implementation mechanism is set to intelligence elements, the strategic elements, the institutional factors, organizational elements, and the external system elements as market factors and governmental factors, and makes the 5 hypothesis of this paper as follows:

Hypothesis 1: The transfer mode and business-to-secondary technical ability of technology significantly affects the willingness to cooperate of scientific institutions

Hypothesis 2: Bilateral strategic synergy of cooperation significantly affects the willingness to cooperate of scientific institutions

Hypothesis 3: The synergy degree of cooperative internal institution significantly affects the willingness to cooperate of scientific institutions

Hypothesis 4: The synergy degree of cooperative organization significantly affects the willingness to cooperate of scientific institutions

Hypothesis 5: The demand orientation of seed market and government actions significantly affects the willingness to cooperate of scientific institutions

DATA

This paper is supported by the National Social Science Fund Project "implementation mechanism research of science-enterprise cooperation in crop seed industry---based on the perspective of commercial breeding", and the data is from field survey by students from college of management, Sichuan agricultural university, august 2014 to June 2015. The surveyed objects are breeding relevant agriculture universities and research institutions around the municipal, the respondents include leaders and relevant breeding researchers. And this survey covers Sichuan, Chongqing, Yunnan, Guizhou provinces. Through the collecting of questionnaire, get 356 valid questionnaires from 53 scientific institutions in western four provinces.

In the survey of 53 institutes, there are 32 already in cooperation with seed enterprises, accounting for 60.38% of the total. In terms of the current model of cooperation, cooperation between the investigative units and companies mainly includes the outright sale of varieties, licensing and the joint development, building an entity and so on. The most common forms of cooperation the is still the outright sale of varieties, there are 84.62 percent of such transfers are taken in the surveyed institutes.

TABLE 1. THE CURRENT SITUATION STATISTICS OF SURVEYED UNITS INVOLVED IN COOPERATION OF SEED INDUSTRY

| | YES | NO |
|---|---|---|
| Number | 32 | 21 |
| Proportion | 60.38% | 39.62% |

Due to the limited number of surveyed breeding-related research institutions and agricultural universities, this paper will comprehensively consider the views of management and researchers as the unit's willingness to cooperate. 356 respondents indicate their views on whether the units involved in science-enterprise cooperation according to their understanding of the breed industry and their working units. Of these, 232 respondents expressed support for the units involved in science-enterprise cooperation accounted for 65.17%, 124 respondents show negative attitude accounted for 34.63%, the result shows the vast majority of respondents have positive attitude to the cooperation.

In terms of the selection of the cooperation enterprises, the majority of respondents tend to choose the multinational seed enterprises, and large enterprises with capital over 100 million which can achieve the integration of breeding and promotion. These types of enterprises have great strength and competitiveness, and high market share. Little respondents choose to cooperate with small breed enterprises with low registration capital. Visibly, those small and medium breed enterprises is weak, lack of government Support, and difficult to get cooperation opportunities and personnel support from scientific institutions, their living environment will be more difficult (Table 2).

TABLE 2 THE TYPE STATISTICS OF PROPOSED COOPERATIVE ENTERPRISES

| Type of enterprises | Yes | No |
|---|---|---|
| Multinational seed companies | 122 | 234 |
| Breeding and promotion companies | 275 | 81 |
| Registration capital over 100 million | 112 | 244 |
| Registration capital 30 to 100 million | 70 | 286 |
| Registration capital 5 to 30 million | 33 | 323 |
| Registration capital under 5 million | 18 | 338 |

## III. MODEL AND ANALYSIS

### -A. Model selection

Regression models are kind of common used methods for solving factors problem, but the general linear regression model has limitations, the dependent variable is usually required only quantitative variables, not a qualitative variables. Logistic model is to solve the qualitative dependent variable, early used in medical field to determine the risk factors for the disease, but now widely used in economics and other areas. To the willingness of participating in science-enterprise cooperation of seed industry, there a "YES" and "NO" two endpoints, it is a typical problem of binary decision. Therefore, in this paper, the logistic binary choice model is selected to analysis the factors of breeding-related universities and research institutes' willingness to cooperate with seed enterprises. So, establishing the following logistic regression model:

$$Ln(\frac{P}{1-P}) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k$$

Among them, $P = P(Y = 1)$ represents the probability of the scientific institutions' willingness to be involved in the science-enterprise cooperation. Y=1 expresses willingness to participate in, Y = 0 indicates unwilling to participate, $\beta_0$ is a constant term. Obtaining values of P by regression model:

$$p = \frac{1}{1 + \exp(\beta_0 + \beta_1 x_1 + ... + \beta_k X_k)} \quad \text{or}$$

$$p = \frac{\exp(\beta_0 + \beta_1 x_1 + ... + \beta_k X_k)}{1 + \exp(\beta_0 + \beta_1 x_1 + ... + \beta_k X_k)}$$

### -B. Variables

Dependent variable: in this study, set the "willingness to cooperate" of scientific institutions as the dependent variable, because of the limitation number of the survey unit, expanding the range of Y as each respondent' views on whether the units involved in this cooperation. Data from the questionnaire "If you are a decision-maker of your work unit, whether will you support the unit involved in science-enterprise cooperation". Value Y is set to a given class of dummy variables, Y = 0 expresses reluctance to participate in cooperative, Y = 1 expresses their willingness to participate in cooperative.

Independent variable: according to the article review and the five hypotheses in the front part, proposing 15 factors as the internal and external factors that may affect units' willingness as independent variable. The 15 independent variables are all from the questionnaire Likert 5-point scale (not important = 1; unimportant = 2; important = 3; more important = 4; 5 = very important). According to 356 questionnaires, the statistical characteristics of the variables as Table 3.

## IV. RESULTS AND ANALYSIS

Using econometric analysis software SPSS20.0 to process data for 356 samples by logistic binary regression. Firstly, taking into account all the variables to obtain the mode l. Then, using inverse filtering method, selecting insignificant variables until all variables are at the 10% level of statistical significance, to obtain the mode 2. Regression coefficients and probability of the variables as

Table 4. The model 2 shows that Pseud $R^2$ value of 0.241, it means that dependent variables have an impact on Independent variable. And the LR chi-square test value of 34.99, the corresponding accompanied probability is much less than 10%. So, the modle2 is statistically significant. In addition, the accuracy of the model estimated percentage of 84.3%, indicating relatively high precision; overall, the model fits well.

TABLE 3 EXPLANATION, STATISTICAL CHARACTERISTICS AND EXPECTED IMPACT DIRECTION OF VARIABLES

| Variable name | Explanation | Average | Standard deviation | Expected impact direction |
|---|---|---|---|---|
| Y | Willingness | 0.6517 | 0.4764 | - |
| X1 | Technology transfer mode | 4.3624 | 0.7580 | + |
| X2 | Re-creation capacity of enterprises | 4.1657 | 0.8412 | + |
| X3 | Degree of leader's emphasis | 4.2135 | 0.7904 | + |
| X4 | Consistency of cooperation goal | 4.2500 | 0.8371 | + |
| X5 | Personnel Security System | 4.2107 | 0.8000 | + |
| X6 | Incentive System | 3.8680 | 0.8637 | + |
| X7 | Intellectual Property System | 4.0590 | 0.8488 | + |
| X8 | Benefit distribution system | 4.3174 | 0.6902 | + |
| X9 | Risk Distribution System | 4.0843 | 0.7755 | + |
| X10 | Organization Construction | 4.4775 | 0.7058 | + |
| X11 | Culture construction | 4.1826 | 0.7748 | + |
| X12 | Communication and exchange | 3.7331 | 0.8970 | + |
| X13 | Demand orientation from market | 4.1292 | 0.8085 | + |
| X14 | Policy support | 4.1489 | 0.8173 | + |
| X15 | Legal Protection | 4.3258 | 0.8053 | + |

TABLE 4 LOGISTIC REGRESSION RESULTS OF INFLUENCING FACTORS OF WILLINGNESS TO COOPERATE

| Variable name | Model 1 | | Model 2 | |
|---|---|---|---|---|
| | Regression coefficients (B) | Significant probability（sig） | Regression coefficients (B) | Significant probability（sig） |
| X1 | 0.395* | 0.081 | 0.426* | 0.073 |
| X2 | 0.380** | 0.029 | 0.403** | 0.014 |
| X3 | 0.448* | 0.073 | 0.486** | 0.040 |
| X4 | 0.303 | 0.114 | - | - |
| X5 | 0.387** | 0.018 | 0.486*** | 0.007 |
| X6 | 0.385** | 0.046 | 0.338* | 0.054 |
| X7 | -0.202 | 0.281 | - | - |
| X8 | 0.600*** | 0.005 | 0.661*** | 0.001 |
| X9 | 0.403** | 0.043 | 0.151* | 0.068 |
| X10 | 0.277 | 0.185 | - | - |
| X11 | 0.269 | 0.142 | - | - |
| X12 | 0.371* | 0.096 | - | - |
| X13 | 0.147 | 0.536 | - | - |
| X14 | 0.559*** | 0.002 | 0.489** | 0.040 |
| X15 | 0.437** | 0.020 | 0.306* | 0.067 |
| Pseude $R^2$ | | 0.241 | | |
| LR | | 34.989*** | | |

Note: *, ** and *** represent the significance level of 10%, 5% and 1%

The results of Model 2 shows that 9 factors passed the regression test: Technology transfer mode, Re-creation capacity of enterprises, Degree of leader's emphasis, Personnel Security System, Incentive System, Benefit distribution system, risk distribution system, Policy support and Legal Protection from government, while the other six factors did not pass regression test. And the following is a explanation of the result combined with previous studies and the hypothesis in this paper.

On the technical impact for Hypothesis 1, the

DOI 10.5013/IJSSST.a.17.36.11  ISSN: 1473-804x online, 1473-8031 print

significance probability of rational way of technology transfer is 0.073; the result is consistent with the study of Cao Xia (2012), Huijing Chen (2011) and other scholars. The significance probability of seed enterprise's ability to absorb and re-create technology is 0.014, the same findings with Yingxiang Deng (2011) and other scholars. It shows that large breed companies usually have better self-R & D capability to achieve the absorption and re-creation; it's easier for them to get opportunities for cooperation with the scientific institutions.

As for the strategic synergy in cooperation, the significance probability of leader's emphasis is 0.04, the result shows that unit leaders play an important role in the determine of science-enterprise cooperation, this is consistent with the findings by Qingfeng Fu(2012). The consistency of cooperation goal did not passed the test,it means that in the current model of cooperation, business and science units focus on different breeding goals, so it's difficult to achieve synergistic of cooperation goals.

In terms of Hypothesis 3, we choosed 5 indicators of institution within the system of cooperation, only the intellectual property system did not pass the test, it shows that currently breeding science units have not paid enough attention to intellectual property protection variety, and this is the cause of a low conversion rate and the loss of outcome, the same as findings from scholars (Shufang Xie, Guanghui Chen, 2008; Wang Min, 2010). The significance probability of benefit and risk distribution system is 0.001 and 0.068 respectively, we can see that science unit think that the distribution of benefits is far importance than risk. According to previous studies, universities and research institutions are often at a disadvantage in the distribution of benefits, while enterprises are relatively weak in risk-sharing, this situation is consistent with previous studies. The other two indicators are personnel system and incentive system for researchers joining into cooperative organizations, the significance probability is 0.007 and 0.054, showing that researchers are more concerned about the indemnification of establishment, welfare benefits and the incentives, and the emphasis on indemnification is greater than the incentive, reflecting the researchers 'mentality of stability.

As for Hypothesis 4, the 3 indicators about organization and cultural construction of within the cooperation system did not pass test, the reasons are as follows, because of the relatively simple forms of cooperation, the unstable of partnership, and the weak awareness of the organization and teamwork. This is consistent with the actual findings; it shows that the current cooperation is still at a relatively low level.

Policy support and legal protection from government have a large influence on scientific institutions' willingness to take part in science-enterprise cooperation, this is because a national supported institution mainly relies on state funding for academic research, and researchers apply for national projects and tasks in line with the government's development plans. Therefore, the government's exhortation and support has a positive effect on r science-enterprise cooperation in seed industry. The market demand-oriented shows no significant effect on the cooperation, this is consistent with Du Qiong's findings(2012),the reason is that science units' main breeding goals is to complete the research project but not the market, leading to the bred products cannot adapt to the market test, and this is the reason of the disjointed phenomenon in Industry-University-Research cooperation of breed industry.

## V. CONCLUSIONS

As the source of seed industry chain, breeding science research and education units concerned act as an important role. The transfer of intellectual factors can promote the transition of commercialized breeding mechanism. In this paper, a cooperative mechanism theory structure of science research units and corporations is constructed in the level of factors. The paper confirms both inner and outside factors involved in the cooperative system, which can lead to the realization of the mechanism. What's more, this paper is based on field investigation and gets the first-hand materials. Making use of the Logistic Model, the paper discusses the effects that key factors of cooperative mechanism have when science research and education units participate in the seed industry. These factors are technology transfer mode, the cooperation enterprise' ability to accept and recreate, leaders' recognition degree, personnel regulation, incentive regulation, distribution of benefit and risk regulation, support from the government's policy and law guarantee. Thus the paper comes to a conclusion that the key to realize the cooperative mechanism is the cooperation of all these factors. On the basis of what has mentioned before, this paper puts forward the following advice that can improve the cooperative mechanism of science research units and corporations in the seed industry.

## ACKNOWLEDGEMENT

This paper is supported by the National Social Science Fund Project( number：13BJY114）.

[1].Scientific institutions means research institutions and universities related to crop breeding.

[2].Science-enterprise cooperation is an innovative model of traditional cooperation, emphasizing the enterprise's dominant position in the commercial breeding.

## REFERENCES

[1] Cohen, W.M. Nelson, R. R. and J. P. Walsw. Links and Impacts: the Influence of Public Research on Industrial R&D [J]. Management Science 2002, 48(1): 1 ~23

[2] Crespo,M,and Dridi,H .Intensification of university industry relationships and its Impact on academic research[J].Higher

Education,2007,54(1):61~84

[3] Eom,B Y,and Lee,K.Determinants of industry academy linkages and their impact on firm performance: The case of Korea as a latecomer in knowledge industrialization [J].Research Policy, 2010, 39(5): 625~639