The Role of Agribusiness Firms in Agricultural Research
The Case of China

Huijie Zhang
Institute of Agricultural Economics and Development, CAAS

Shenggen Fan
International Food Policy Research Institute

Keming Qian
Institute of Agricultural Economics and Development, CAAS

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Huijie Zhang[1]
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I. Introduction

Despite the efforts of various economists and agricultural scientists in calling for more investments, funding for agricultural R&D has stagnated for the last two decades in China. This will pose a great challenge for the China's agricultural sector. Productivity has leveled off, and farmers' income has been flat. As a result, poverty reduction in recent years has also not shown any significant progress.

On the other hand, agribusiness firms have emerged rapidly since the rural reforms initiated in 1978. Emerging of these firms has fundamentally changed the landscape of Chinese agriculture. In 2002, they account for a significant share of agricultural GDP (7%), and agricultural employment. Many of these firms are also engaged in high value production, offering new opportunities for farmers to increase productivity and income given the limited land resources. More importantly, it is their role in agricultural research and development (R&D) that will drastically affect the Chinese agricultural research system. In 2002, these firms invested more than 10% equivalence of public spending in agricultural research. If their spending on technology-intensive capital is included, the percentage rose to 30%. Back in mid-1990s, these shares are minimal. It is obvious that these firms will play an even larger role in investing in agricultural R&D in China. But this increase didn't come automatically. It is the change in the investment environment and government policies that have led to such a rapid increase.

There is a large body of literature on public agricultural R&D in China. However, few studies have attempted to analyze the role of private agricultural R&D. This study will use a recent survey on agribusiness firms to analyze the magnitude and their distribution among sectors and regions in their investment and to determine the factors affecting the investment behavior in agricultural R&D of these firms. The data used are from a firm survey conducted by the Ministry of Science and Technology, P.R of China in 2003. More than 500 leading firms (based on sales) were

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[1] Huijie Zhang is an Associate Professor of Institute of Agricultural Economics and Development, CAAS, and a Post Doctor in the International Food Policy Research Institute (IFPRI). Keming Qian is a professor and the Director General of Institute of Agricultural Economics and Development, CAAS. [2] Shenggen Fan is a Senior Research Fellow and the incoming Director of Development Strategy and Governance Division (DSGD) of the International Food Policy Research Institute (IFPRI)

surveyed. They are located in different parts of China: coastal, central and western. They also represent different sectors, for example, crop production, livestock, feed processing and supply, vegetables/fruits/tree, tea, fishery, seed development/sales and biotechnology/medicine. There firms also vary by their ownership, for example state-, private-, and collective-owned, shareholding, and multinational companies.

This paper is organized as follows: Section two describes the development and current situation of agribusiness firms and the related government support policies. Section three analyzes the investment behavior of agribusiness firms in agricultural research and development. Section four concludes the paper.

II. Development of Agribusiness Firms

Emerging of Agribusiness Firms

Agriculture is currently facing new challenges after the successful reform starting from 1978 in China. These challenges include increasing competition from both domestic and international markets, particularly in traditional products likes grains; emerging issues in food safety, increased insecurity in farmers incomes and employment, mounting environmental pressures associated with population growth, and widening overall inequality between urban and rural areas. Therefore, there is a need of new engine of growth for the agricultural sector.

Agribusiness firms have emerged rapidly since the rural reforms initiated in 1978 and future development of these firms may offer a new opportunity for the Chinese agriculture sector. Taking Sichuan province as an example (according to a survey conducted by the Census Center, National Statistic Bureau in 2003), the number of agribusiness companies opened was only 387 before 1978, but this figure went up by 331 in the period of 1978-1991, 204 in the period of 1992-1995 , and 860 in the period of 1996-2001. There is a rapid growth in agricultural enterprises after 1978, especially after 1993.

Farmers and agribusiness are linked in mutually beneficial forms of "company plus farmers" or "company plus base plus farmers" in the forms of contract or shareholding. In order to procure standard products, most agribusiness companies provide a wide range of extension services to farmers. They provide funds, new technologies and market information to producers by reducing their market risk, providing knowledge on using new varieties/technologies, and improving their access to inputs and financing services. Emerging of these firms has fundamentally changed the landscape of Chinese agriculture, and plays a crucial role in improving labor productivity, crop and animal yields, products safety and the commercialization level, and eventually their income. In 2002, they account for a significant share in agricultural GDP (7%), (see table 1). More importantly, it is their role in agricultural research and technology adoption that will drastically affect the Chinese agricultural research system.

Table 1. Agribusiness firm and Agriculture

	Sales（million yuan）	Employee（thousand）	Taxes（million yuan）
Agribusiness firm	74952	518	3930
Agriculture	1611700	368700	71700
Share（%）	4.7	0.1	5.5

Notes: one yuan is about 0.12 dollar.

Policy Support

Numerous policies have been introduced by the government to support the development of these firms. These policies include two aspects. One is centered on the promotion of agribusiness firms such as exemption or reduction of value added tax, rebates of export tax, exemption or reduction of special agricultural or forest products taxes, and discount loans for exported-oriented products or special loans for agribusiness firms. The key policy document for such support is titled "Supporting Guidelines on Leading Agribusiness Firms", which was issued jointly by eight ministries in November, 2000. According to this document, certain leading agribusiness companies will be chosen to give financial aid for further development in the next five years.

Another aspect focuses on supporting key sectors related to agriculture. For example, in order to promote the key sectors related to agriculture, some enterprises could receive financial subsidies from the government. In 2002, Beijing Sunxing Agricultural Shareholding Limited Company successfully obtained the special funds for storing frozen pork products from Beijing City. Jiangxi Gannan Fruit Shareholding Limited Company received the financial allowances for developing new products. Anhui Fengyuan Bio-Chemistry Shareholding Limited Company received a special fund for controlling sewage.[3]

To attract more enterprises to enter into the agriculture sector and to improve their competition under the free market, government institutions gradually abandoned controlling distribution and marketing of most agricultural inputs by direct administration intervention. Instead, input supplies are now regulated by the government through the legal framework. For example, it was only the state-owned seed companies that had the right to supply hybrid seeds of staple crops before 2000. After the new seed law was implemented in 2000, private seed companies and shareholding companies can also enter the hybrid market to compete with state-owned companies if their conditions meet the requirement of the law.

In addition, fostering a beneficial linkage between firms and farmers is a vital consideration of government support. Agribusiness should not only raise shareholders' profit, but also bring high income to farmers. Many challenges still exist. For example, the legal enforcement of contracts between firms and farmers is difficult considering the existing legal framework and system.

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[3] Information resource:http://www.agri.gov.cn/jjps/t20041129_278899.htm

A Snapshot of Agribusiness Firms

We use the MOST (Ministry of Science and Technology, P.R of China) 2003 survey to give a snapshot overview of the current situation of the agribusiness firms in China. Based on their sales, more than 500 leading firms were surveyed. They are located in different parts of China: coastal, central and western. They also represent different sectors, for example, crop production, livestock, feed processing and supply, vegetables/fruits/tree, tea, fishery, seed development/sales and biotechnology/medicine. There firms also vary by their ownership, for example state-, private-, and collective-owned, shareholding, and multinational companies.

Based on this survey, a firm has an average level of capital of 200 million yuan with fixed capital of 86 million yuan, annual sale and profit of 170 million yuan and 13 million yuan respectively, turning over taxes of 11 million yuan, and 1159 employees.

More specifically, the capital of majority companies is between 100~500 million yuan, and the biggest size is over 6 billion yuan; the fixed capital is between 10~50 million yuan, and the largest is around 2 billion yuan; the proportion of annual sale over 1 billion is only 2.2%, and the largest sale is over10 billion yuan, which shows the huge gap when comparing with the top 50 world food companies having several hundreds billion dollars sales per year. Most of agribusiness firms are profitable, only 4.8% are in deficit, the highest figure of profit is 1.2 billion yuan, and the largest tax contribution is around 1.4 billion yuan. In terms of ownership, private company is the dominant model in eastern and central areas, whereas the state-owned ownership is more common in western area.

The enterprises in eastern area have of higher sales, profitability and tax, absorbing more rural labors, and the most outstanding province is Shandong. In terms of ownership, the shareholding companies performed the best in the size of sales, profitability and number of employee. The enterprises in processing sector are the best in attracting capital, executing sales, obtaining profitability, and creating employment opportunities.

In 2002, these firms invested more than 10% equivalence of public spending in agricultural research. If their spending on technology-intensive capital is included, the percentage rose to 30%. Back in the mid-1990s, these shares are minimal[4]. It is obvious that these firms will play an even larger role in investing in agricultural research and development, and in creating an integrated framework of agricultural scientific and technological system in China. There are several features of these investments.

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[4] According to the research of USDA in 2001，in 1995, the amount of private agricultural R&D expenditure was around 83~133 million yuan in China, which is equivalent to 2.3%~3.3% of public agricultural, and mostly come from the foreign companies. See Carl E.Pray and Keith Fuglie, *Private Investment in Agricultural Research and International Technology Transfer in Asia---China*, USDA ERS, Agricultural Economic Report No.805, page 137.

Table 2. Expenditure of Agribusiness Firms in Agricultural R&D

Unit : million yuan, %

Expenditure	Amount	Expenditure /sales	Expenditure/ profitability	Expenditure/ public agri R&D
R&D Related Spending	2149	2.7	38.1	34.3
R&D spending	601	0.8	10.7	9.6
New products development	611	0.8	10.8	9.7

First, only about one fifth of the surveyed firms invested in agricultural R&D in 2002, the proportion is quite small. There exist large differences in terms of ownership, regions, and sectors. , Companies in western area have higher investment ratios than those in eastern and central areas; but all the expenditure maintained about 3% of their sales among different regions.

Second, state-own enterprises have higher spending in agricultural research and development than other types of ownerships. As a matter of fact, in the planning economic era, all the agricultural research was carried out by government arrangement. Now the state-owned unit is still the main body in agricultural research and development. However, in terms of the share of sales, it is the private company that has the largest investment in agricultural R&D. Their expenditure in agricultural R&D was accounted for 4.7% of total annual sales, and it was 1.7 percentages higher than those of state-owned and shareholding companies.

Third, R&D investment in processing sector was larger than any other sectors in terms of total expenditure. Following were the sectors in livestock, feed, vegetables/fruit/fruit tree, seed and biotechnology.

III. Conceptual Framework and Model

Conceptual Framework

Agribusiness firms are currently operating in a competitive market without much government interference. China officially acknowledged that the country will implement a market-driven economy in 1992. As a result, business and investment environment has improved and business firms have been increasingly operated based on the market and their profitability. China's entry into WTO in 2001 further accelerated this process. The law, regulations and the enforcement of intellectual property rights have also improved substantially. Therefore, investment in agricultrual R&D is considered as a business decision for a firm in order to maximize its future profit. Under this principle, there are several factors that may affect the R&D investment behavior. First, the size of the firm or the market share of its products. The level of private research investment is determined by the degree to which reasonable market portion then profit may be generated (Derek

Byerlee, Ruben G. Echeverria 2001).

Second, it is the government policies. China adopted the preferential policy of letting the eastern areas develop first, and then the strategies for developing Western China. Therefore, some favorable policies are discrepant among various locations in affecting the development of agribusiness and their investment in agricultural R&D. Under this conceptual framework, we first analyze the factors that determine sales, then the elements that determine profit and tax, and finally the behavior of firm's investment in agricultural research and development.

The total sales of an agribusiness firm are determined by its capital, location, ownership, investment in agricultural R&D, and spending on sales promotion. The specification of the equation is specified in equation (1).

Sales

= f (capital, location, ownership, type of business, tax policy, R&D investment, promotion investment)   (1)

Similarly, we can model the determination of profit and tax as the same set of the variables.

Whether an agribusiness firm invests in R&D is determined by the following factors. First, if the firm can increase its expected market proportion through the new technology. Second, the price effects of using new technology or products. Third, government policies on fiscal capital, tax and credit and the intellectual property right regime etc. All these have direct impacts on the return of private investment in agricultural research and development. Thus, the level of private research and development spending is specified as:

Expenditure of agribusiness firms in R&D

= f (size, location, ownership, IPR, type of business, tax policy, capital/credit limit)   (2)

We estimated the expenditure of agribusiness firms in agricultural research and development in two steps using the Heckman model. The first step is to model whether the firm will invest, and the second is to determine how much the firm will invest if it decided to invest. Some of the variables on the right hand side of the equation may also be endogenous, therefore, in one of the specifications, we also attempt to endogenize some independent variables.

IV. Data, Model Estimation and Results

Data

The data used was based on a firm survey conducted by the Ministry of Science and Technology, P.R of China in 2003. 1000 questionnaires were sent to large agribusiness firms (based on their scale), and 457 available forms were returned. The data have been selectively examined in certain companies and by some managers in agribusiness firms[5]. Among the 457 companies, 20 are national leading agribusiness firms while 151 companies were certificated to be titled national leading agribusiness firms by the central government in 2000. They are located in 19 provinces including Beijing, Tianjin, Shan'xi, Inner Mongolia, Liaoning, Jilin, Zhejiang, Anhui, Fujian, Shandong, Henan, Hubei, Guangdong, Guangxi, Hainan, Sichuan, Yunan, Shann'xi and Xinjiang, accounting for 62.5% among the overall provinces, being located in different parts of China: coastal, central and western. They also represent different sectors, for example, crop production, livestock, feed processing and supply, vegetables/fruits/tree, tea, fishery, seed development/sales and biotechnology/medicine. There firms also vary by their ownership, for example state-, private-, and collective-owned, shareholding, and multinational companies.

Model Estimation and Results

Estimated Equations for Sales, Profit, and Tax

The findings form the estimated equations for sales, profit and tax are:

1、Firms locating in coastal area have more sales, whereas the firms in western area have higher profit and tax. The ratio of sales to capital increases (declines) by 1%, the ratio of profit/capital will increase (decline) by 2.5% correspondingly.

2. The capital has positive impact on the sales. If one more yuan is added to capital, 0.64 and 0.043 yuan are added in profit and tax respectively.

3、The firms in processing industry have more 12.23 million yuan profit than those in the other sectors, meanwhile the firms in crop industry have 16.24 million yuan less profit than those in the other sectors. With the same profitability, the firms in processing, crop and vegetable/fruit sectors contribute more tax to the national economy.

4、The profit has negative impact on the tax. If one more yuan profit is added in firm, the tax will be down by 0.127 yuan. If the firms are state- or collective-owned, they have higher ratio of tax to profit, which means they contribute more to the overall economy.

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[5] For instance, Wang Weizhong , General Director, Delong Seed Co.Ltd, helped to check the data when he visited IFPRI in 2004.

5. Expenditure in agricultural R&D does benefit to the sales. One more yuan invest in agricultural R%D lead to 17 more yuan in sales, and 9.15 more yuan in tax. But the higher level of sales to capital is harmful to ratio of expenditure in agricultural R&D to capital, 1% higher in this ratio will lead to 1.4% reduction of the ratio of expenditure in agricultural R&D to capital. The more investment in agricultural R&D from tax has positive role in raising the ratio of tax to profitability.

Estimated R&D Investment Equation

The results from the estimated R&D investment equation can be summarized as:

1、The firms in Western China invest the highest amount in agricultural R&D, followed by the firms in coastal China. However the firms in central area have the highest ratio of spending in agricultural R&D to tax. This implies that tax policy may not be favorable to R&D investment in central China.

2. Tax plays a positive role to spending in agricultural research activities. If one more yuan is added in tax, then R&D investment will increase by 0.295 yuan.

3. State- or collective-ownership companies, and the firms transformed from research units and private companies have higher proportion of expenditure in agricultural R&D to tax.

4. The firms of processing industry have the highest amount of R&D investment among all firms, followed by firms in fishery, feed, livestock and seed industries.

5. The firms in biotechnology/pharmacy have the higher ratio of investment in agricultural R&D than others.

V. Conclusions

Agribusiness firms are in the period of fast development. This has been a result of good investment and business environment. The firms are entering into a period of fast growing, and become a main force in upgrading agricultural structure, improving farmer income. However they still have more room to further expand. Raising and enhancing the capability of core competition is a long term goal. Government should take more efficient measures to build better circumstances for their development and innovation activities.

It is necessary to strengthen their capability building innovation, and reform the system of agricultural science and technology in China. It is no doubt that the agribusiness firms are becoming the main body in agricultural R&D. For example, the agribusiness firms involved in the national agricultural products processing project, focusing on staple grain, oil, vegetable, animal products and forest products, and invested about 580 million

yuan in research and development activities like deep processing, equipments, standard system and quality controlling[6]。On the other hand, generally speaking, the enterprises in China spent 57.6% of their capital on R&D in 2000，and 60.1% in 2004（Ministry of Science and Technology, the science and technology statistics in China, 2005），while as the proportion for agribusiness firms is much more less, and they still lack strong capacity in R&D activities.

More favorable policies are needed to support, induce and encourage the firms spending more in agricultural R&D. From the point of economics, agricultural research outcomes can be divided into two kinds, one is has the feature of public goods , that is non-exclusiveness, non-competition and non-separation, for example seed resources, diseases and insect pests prediction, cultivation technique. The other is belonging to private goods, such as seed (especially hybrid seed), pesticide, fertilizer, machinery, food processing and vaccines, this kind of technology has the features of exclusiveness, competition and separation, and could be commercialized by private firms. In developed countries, private is the major investor in agricultural biotechnology; form 1987 to 1994，There are 84％of the total new varieties enrolled by private companies, and hybrid corn seed are completely enrolled by private firms[7]；in the industries of processing, input and biotechnology, there are many extra huge companies. In China, measures should be taken for private agricultural research activities to set up encouragement mechanism, to enhance the protection of intellectual property, to have more cooperation with research institutes, to raise the capability of private research and make up the insufficient of public agricultural research.

It is important to study more on the benefit allocation and safeguarding lawful rights and interests of farmers. More study is necessary to explore the firms' role in upgrading agricultural and promoting farmer income. Although this kind of benefit distribution is always an focus, but there has no clear answer, which should be study deeply to get the win-win among state, firms and farmers.

Appendix: Relative Results

Table A-1 Variables and Definitions

Variable	Definition
Central	Represent agribusiness firm in central area
west	Represent agribusiness firm in western area
rde	Represent firm expenditure in agricultural R&D

[6] Resource: http://www.gongguan.most.gov.cn/info/showinfo.asp?id=3210
[7] Bonwoo Koo, Philip G Pardey, Keming Qian and Yi Zhang, *The Economics of Generating and Maintaining Plant Variety Rights in China*, Page 21-22, EPTD, discussion paper No.100, IFPRI, 2003。

government	Represent the firm is state or collective ownership
rdi	Represent the firm is shifted from research institute
private	Represent ownership of the firm is private
foreign	Represent ownership of the firm is joint
otherown	Represent ownership of the firm is others
process	Represent the firm belongs to the industry of process
crop	Represent the firm belongs to the industry of crop
live	Represent the firm belongs to the industry of livestock
feed	Represent the firm belongs to the industry of feed
vegfru	Represent the firm belongs to the industry of vegetable/fruit
tea	Represent the firm belongs to the industry of tea
fish	Represent the firm belongs to the industry of fishery
input	Represent the firm belongs to the industry of input
biotec	Represent the firm belongs to the industry of biotechnology
capital	Represent the firm's capital
tprofit	Represent the firm's total profit
tax	Represent the firm's tax
debtp	Represent the firm's ratio of debt to capital
salecap	Represent the firm's ratio of sales to capital
profcap	Represent the firm's ratio of total profit to capital
taxcap	Represent the firm's ratio of tax to capital
profsle	Represent the firm's ratio of total profit to sales
taxsale	Represent the firm's ratio of tax to sales
taxprof	Represent the firm's ratio of tax to profit
rdecap	Represent the firm's ratio of R&D expenditure to capital
rdeprof	Represent the firm's ratio of R&D expenditure to profit
rdetax	Represent the firm's ratio of R&D expenditure to tax

TableA-2 Results of Sales, Profitability and Tax

Variables	Sales		Profitability		tax	
	coefficient	t	coefficient	T	coefficient	T
central	-4601.126*	-1.71	-78.12888	-0.26	198.9143	0.68
west	-20103.68*	-2.17	2628.704*	2.56	884.5989	0.89
rde	17.28458*	3.13	.122115	0.20	9.146876*	15.43
government	102.3226	0.53	-26.10803*	-1.20	75.53748*	3.83
rdi	19.6176	0.08	8.845528	0.32	68.90252*	2.28
private	81.05134	0.45	-3.142843	-0.16	85.30137*	4.69
foreign	100.6295	0.35	-16.71194	-0.50	83.18598*	2.77
otherown	2.490492	0.01	-12.20376*	-0.60	88.79132*	4.79
process	-6063.436	-1.12	1223.169*	1.98	64.49345	0.11
crop	-11138.62	1.54	-1624.583	1.99	-21.7768	-0.03
live	-5847.551	-0.91	-471.6761	-0.65	492.8323	0.70
feed	-3761.572	-0.40	-313.0086	-0.30	-11.76737	-0.01

vegfru	-12378.78	-1.84	402.7186	0.53	914.3562*	1.25
tea	-9358.527	-0.45	394.1977	0.16	1762.049	0.83
fish	-21190.83*	-2.15	-138.2822	-0.12	984.8374	0.89
input	-3741.635	-0.28	-233.1462	-0.15	1420.357*	1.04
biotec	-18064.02*	-2.10	-458.6152*	-0.46	900.4355	0.99
capital	.6403617*	14.05	.0478216	9.40	.0431293*	4.96
debtp	7.852047	0.17	-3.022213	-0.59	.6743845	0.15
sales					.0040619	0.83
tprofit					-.1273712*	-2.72
_cons	12630.87	0.66	977.8497	0.45	-10368.02	-5.27

Note:*indicate that the result has significant feature at the level of 10%.

Table A-3 Regression Results with the Factors Related to Salecap,Profcap,Taxcap and Taxprof

Variable	Salecap		profcap		Taxcap		Taxprof		taxsales		taxprof	
Result	Coefficient	T	coefficient	t	coefficient	T	coefficient	T	coefficient	t	coefficient	t
Central	.0645286*	-1.71	.000441	0.05	-.0018294	-0.30	.0511769	0.66	.0329346	1.19	.0724146	0.71
west	-.9150517*	-2.17	.0149488	0.52	.0072692	0.37	.1266338	0.49	-.0551644	-0.60	-.0576545	-0.17
rde	.0001619*	3.13	2.57e-06	0.16	3.97e-06	0.35	2.73e-07	0.00	.000022	0.42	.000391*	2.01
government	.0044839	0.53	-.0010171*	-1.72	-.000458	-1.12	-.0022966	-0.43	-.0004558	-0.24	.0147122*	2.09
rdi	.0026333	0.08	.0001023	0.11	.0001237	0.20	-.0016819	-0.21	-.0011359	-0.40	.0103874	0.98
private	.0025814	0.45	-.0002864	-0.53	-.0003129	-0.83	.0011939	0.24	-.0000117	-0.01	.009952	1.52
foreign	.009559	0.35	.0000487	0.06	-.0003775	0.61	-.000358	-0.04	.0003815	0.13	-.0025019	-0.24
otherown	-.0019934	0.01	-.0005989	-1.09	-.0002786	-0.73	-.0005057	-0.10	.0005719	0.32	.0114483*	1.74
process	.0351772	-1.12	-.010474	-0.62	.0073396	0.62	-.0779693	-0.51	-.0549286	-1.01	.4728348*	2.38
crop	.4416141	1.54	-.0425619*	-1.85	-.0210383	-1.31	.1862685	0.90	.1169676	1.58	-.4630927*	-1.71
live	.2877706	-0.91	.0003343	0.02	-.0042555	0.29	-.0012754	-0.01	.0084341	0.13	-.2067258	-0.84
feed	.0843975	-0.40	-.011362	-0.37	-.0185177	-0.87	.1293075	0.47	-.0139567	-0.14	-.0368226	-0.10
vegfru	.1686719*	-1.84	.0136003	0.63	-.0050962*	1.86	.1474206	0.76	.0104075	0.15	.4924061*	1.96
tea	-.0375602	-0.45	.0847358	1.36	.0811255	-0.34	.0232235	0.04	.0541586	0.27	.3336775	0.45
fish	-.2562547*	-2.15	.0134709	0.42	.004598	0.20	.0383125	0.13	.1228032	1.19	.121585	0.32
input	.7423316	-0.28	-.0431773	-1.07	-.0263991	-0.94	-.0287152	-0.08	.0450947	0.35	.5675467	1.18
biotec	-.2109239*	-2.10	.0013599	0.05	.0134741	0.73	-.1062598	-0.44	.059096	0.69	.2224022	0.71
profcap	2.507134*	14.05									-1.323314*	-2.04
rdesale	-1.467836	0.17									-.1706786	-0.20
debtp	-.0007874	-0.60	-.000084	-0.62	-.0000658	-0.70	9.16e-07	0.00	-.0001139	-0.26	.0001139	0.07
salecap					.0161237*	4.08	-.0807769*	1.58	-.0314888*	-1.73	.1306902*	1.89
taxsale	-.2036467	0.66	.0301304*	5.31	.0314739*	2.53						
profsle			.0306956*	4.85								
rdeprof			.0003344	0.03			-.0196568	-0.17	.0301972	-0.64	.3472242*	2.07
taxprof			-.009998*	-2.07	.0350281*	10.38	-.0097332	-0.22	-.0293773*	1.93	-.035018*	-1.86
rdetax					-.0004133	-0.44			-.0008844	-0.19		
_cons	.6016197	1.02	.1296724	2.23	.0451376	1.11	.2049196	0.39	.0777624	0.41	-.7021818	-0.99

Note:*indicate that the result has significant feature at the level of 10%.

Table A-4 Regression Results with the factors related to rde

Variable	rde 1		rde 2-1 (judge rde>0 or =0)		Variable	rde 2-2 when rde>0	
Result	Coefficient	T	Coefficient	t	Result	coefficient	T
Central	.0175328	0.22	-20.81002	-0.61	rde		
west	.381449*	1.32	122.5889	1.10	central	-12.48529	-0.61
government	-.0059108	-1.02	-1.967105	-0.85	west	63.37854	0.92
rdi	.010008	1.00	4.28257	1.27	government	-.6146545	-0.44
private	-.0056969	-1.05	-2.03703	-0.93	rdi	2.710692	1.31
foreign	-.0024535	-0.28	-3.237866	-0.93	private	-.5945925	-0.46
otherown	-.0045766	-0.84	-1.784578	-0.80	foreign	-2.171055-.-.6	-1.04
process	.0104631	0.06	85.45798	1.29	otherown	486745	-0.49
crop	-.3510915*	-1.61	-166.0539*	-1.81	live	24.25039	0.38
live	.0146685	0.07	.0579674	0.00	feed	32.03678	0.29
feed	.0053136	0.02	-47.73472	-0.40	vegfru	-44.05708	-0.64
vegfru	.2450492	1.20	-70.17809	-0.85	tea	-40.95643	-0.20
tea	-.31475	-0.53	-240.8569	-0.90	fish	50.57649	0.35
fish	.0998796	0.32	-91.16326	-0.73	input	-79.23655	-0.84
input	.2509788	0.65	-40.66025	-0.26	biotec	-64.81832	-1.02
biotec	.0287731	0.11	-54.65653	-0.53	capital	.0003144	0.49
capital	-1.72e-06	-0.67	.0005357	0.54	sales	.0001118	0.33
debtp	-.001869	-1.46	-.6772247	-1.27	tprofit	.0015059	0.46
sales	5.98e-07	0.42	.0001955	0.37	tax	.0480102*	16.26
tprofit	.0001*	1.97	.0023927	0.47	process	696.1626	1.34
tax	5.86e-07	0.04	.0486604*	10.65	_cons	-153.2304	-0.54
_cons	.578172	0.97	140.0733	0.59	-----------process		
					crop	-.3415587*	-1.84
					live	-.129382	-0.72
					feed	-.3381243	-1.17
					vegfru	-.2001994	-1.13
					tea	-.3150416	-0.54
					fish	-.6475863*	-2.15
					cons	.0616945	0.51
_se			478.598	(Ancillary parameter)	Hazard lambda	-398.393	-1.23

Note：rde1,suppose Z is the only external variable, and others are the results calculated by the model；rde2-1 and red 2-2,suppose Z is an external variable, meanwhile not all the factors having impact on Z are calculated by the model.

*: indicates that the result has significant feature at the level of 10%.

Table A-5 Regression Results with the factors related to rdecap,rdeprof and rdetax

variable	Rdecap		Rdeprof		Rdetax	
result	Coefficient	T	Coefficient	T	Coefficient	T
Central	.0006146	0.19	.0193706	0.52	-.2384984	-0.68
west	-.0220398*	-2.05	-.2083285*	-1.67	-.7678871	-0.66
rde	.0000331*	5.62	.0003026*	4.36	.0019475*	2.96
government	-.0003381	-1.56	.0058486*	2.27	-.0260118	-1.08
rdi	-.0002682	-0.81	.0083016*	2.14	-.0040343	-0.11
private	-.0003643*	-1.82	.0045643*	1.94	-.0366431*	-1.65
foreign	-.0001042	-0.32	.0057802	1.50	-.0341624	-0.96
otherown	-.0005019*	-2.47	.0025779	1.08	-.0416772*	-1.85
process	-.0075906	-1.22	-.0728365	-0.99	-.6749085	-0.98
crop	.0049831	0.58	.0237809	0.24	.8585483	0.90
live	-.0055775	-0.72	-.0808639	-0.89	.3538591	0.42
feed	.014425	1.26	.083201	0.62	-.3334151	-0.26
vegfru	-.0019661	-0.25	.0125615	0.13	-.1587645	-0.18
tea	-.0034296	-0.15	-.1472879	-0.54	-.5552201	-0.23
fish	-.0003679	-0.03	-.0725545	-0.52	-.6117122	-0.46
input	.0194516	1.29	-.0726188	-0.41	.3282901	0.20
biotec	-.002149	-0.21	-.2145972*	-1.84	-.3764179	-0.35
salecap	-.0001494	-0.07	-.0281507	-1.10		
profcap			-.0047918	-0.02		
profsle	.004141	0.90				
taxsale	-.0118063	-0.92			-.2613902	-0.35
debtp	-.0000388	-0.77	-.0003566	-0.60	-.0061851	-1.10
taxprof			.0294262	1.39		
taxcap					-3.605467	-1.27
_cons	.0562073	2.60	-.2173112	-0.85	5.376627	2.25

note：*indicates that the result has significant feature at the level of 10%.

Reference：

1. Anwar Shah, *Do tax policies stimulate investment in physical and R&D capital?*, chapter 16 of "Fisacl Incentives for Investment and Innovation", page 617-634, published by the World Bank,Oxford University Press,1995;
2. Bonwoo Koo, Philip G Pardey, Keming Qian and Yi Zhang, *The Economics of Generating and Maintaining Plant Variety Rights in China*, Discussion Paper No.100, IFPRI, University of Minnesota and IAE,CAAS,2003;
3. Carl E.Pray and Keith Fuglie, *Private Investment in Agricultural Research and International Technology Transfer in Asia*, USDA, Agricultural Economic Report No.805,2001;
4. Clive James, *Agricultural Research and Development:The Need for Public- Private Sector Partnerships*, Issues in Agriculture 9,Consultative Group on International Agricultural Research,1996;
5. Derek Byerlee and Ruben G.Echeverria, *Agricultural Research Policy in an Era of Privatization,* Rural Development Department, the World Bank; Sustainable Development Department, Inter-American Development Bank; CABI publishing 2002;
6. Department of Middle and small enterprises, National development and reform Committiee, the situation of middle and small enterprise in 2004；
7. Frank Hartwich,Jaime Tola and Willem Janssen, *Public-private Partnerships for Agroindustrial Research Fostering agroindustrial development in Latin America and the Caribbean*, Draft, ISNAR,2001;
8. General Survey Center, National statistics bureau , paper 24, *the Development of Private Enterprises: Situation, Issues and Countermeasures*, 2003；
9. General Survey Center, National statistics bureau , paper 21, *The Analysis of Agibusiness firms in Sichuan Province ,*2003；
10. Jikun Huang, Ruifa Hu and Scott Rozelle, *China Agricultural Research Investment: Challenge and Hope,* China Finance and Economy Press,2003；
11. Julian M.Alston and Philip G.P ardey, *Making Science Pay :the Economics of Agricultural R & D Policy*, AEI Studies in Agricultural Policy,1996;
12. Kemin Qian, How to Overcome the Difficulties for Private Firms Entering Agricultural R&D, China Industry and Business Times, January 6,2003；
13. Li Jianmin and Wang Lanying, *Agricultural Comprehensive Development Strategy and its Impacts on Rural Development in Western China*, Ministry of Finance, P.R,China, paper, International Food Policy Research Institute, 2003.12;
14. Li Liu, The factors of Firms Invest in R&D：A Theory Analysis Based on the View of Resource;
15. Pingqing Liu, the Evaluation and Thinking of Private Capital Investing in Agriculture, Chinese Rural Economics, 6,2004;
16. QingLin Du, the Situation of National Agricultural Industrialization,2003；
17. Ruben D.Estrada, Rafael Posada and Federico Holmann, *Agricultural Research Private Funding: the Colombian Experience,* COL 014/2000;
18. Scott Waldron, *Models of Agro-industrialisation in China: the Case of the Cattle and Beef Industry*, School of Nature and Rural Systems Management, the University of Queensland, Agricultural and Natural Resource Economics Discussion Paper 7/99;
19. Shenggen Fan , Peter Hazell and Sukhadeo Thorat, *Linkages between Government Spending, Growth, and Poverty in Rural India*, Research report 110,IFPRI,1999;
20. Shenggen Fan,Linxiu zhang，*WTO and Public Investment in Rural Areas in China*，China Agricultural Press, 2003；
21. Shenggen Fan and Keming Qian, *Agricultural Research and Poverty*, China Agricultural Press,2005；
22. S.W.Omamo, J.K.Lynam, *Agricultural Science and Technology Policy In Africa*, Research Policy 32(2003)1681-1694;
23. T.C.Tso(USA), He Kang(China), Chief editors, *Dare to Dream Vision of 2050 Agriculture in China,* China Agricultural University Press,2004;
24. Xiaobo Zhang, Shenggen Fan, Linxu Zhang, Jikun Huang, *Local governance and public goods provision in rural China*, Journal of Public Economics 88 (2004) 2857-2871;
25. Xiaobo Zhang, Shenggen Fan, Linxiu Zhang, Jikun huang, *Local Governance and Public Goods Provision in Rural China*, Journal of Public Economics 88(2004)2857-2871,2003.