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Translating science and technology policies and programs into grassroots innovations in China

A case study

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Abstract

Purpose – Grassroots innovations (GRIs) can contribute greatly to inclusive development and reach out populations and areas not reached by or ignored by the formal sector. The purpose of the paper is to study how China's science and technology (S&T) policies and programs are translated into GRIs.

Design/methodology/approach – A case study of the grassroots organizations of farmer Chen Guangxing, of Baodi County, Tianjin City, is applied.

Findings – Government S&T policies and programs do transfer to the grassroots innovators; the government support is continuous and all-round; the grassroots innovators' leadership is important to get the support; the research and diffusion projects that grassroots innovators received are integrated in some cases; and the S&T training contributes to farmers' research and project application.

Practical implications – There is a need to increase financial support to the grassroots innovators, provide guidance to them and set up a GRI reporting mechanism.

Originality/value – The paper gives an insight into the synergies and illustrates how and why the grassroots innovators benefit from the laws, policies and ensuing programs that are not directly meant for them.

Keywords China, Grassroots innovation, Science and technology policy

Paper type Research paper

1. Introduction

The phenomenal transformation of agricultural economy and rural areas over the last 30 years in China, registering an economic growth rate of about 5 percent per annum (p.a.) since early 1980s (Huang *et al.*, 2001), as compared to 2.7 percent p.a. during the 1970-1978 period (Huang *et al.*, 2001), is based on two pillars – modernization of agriculture and expansion of non-farm activities, both based on application of science and technology (S&T) at the grassroots. The agriculture sector has experienced

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a tremendous increase in crop yield and diversification from food grains to high value and commercial crop (vegetables and fruits) cultivation (Huang *et al.*, 2012). The farmers' income from non-farm activities crossed the 50 percent mark in 2000 (Huang *et al.*, 2011). Consequently, the number of rural poor declined from 260 million (36 percent of rural population) in 1978 to 26.9 million (2.8 percent of rural population) in 2010 (China, National Bureau of Statistics, 2012). Recent (November 2011) revision in poverty line per capita income from RMB 1,196 to RMB 2,300 (US$360 at 2010 constant prices or about US$ 1 per capita per day) by national government has increased the estimate of rural poor to 128 million[1], about a 100 million more than the earlier estimates and the incidence of rural poverty to 13.4 percent. Even then, the decline in the incidence of rural poverty is significant. Another dimension of rural poverty decline is migration of rural poor to urban areas, resulting in the total population living in urban areas crossing 52 percent in 2012[2]. There has also been shifting out of workers from agriculture to other sectors; agriculture's share in total employment declined from 69 percent in 1980 to 37 percent in 2010 and its share in total GDP declined from 30 to 10 percent in the same period.

Such remarkable achievements hide the fact that the per capita incomes in rural areas are still lower than the urban areas at RMB 6,977, which was one-third that of RMB 21,810 in the urban areas[3] in 2011. The rural-urban inequalities are of concern because still 48 percent of the population is living in rural areas[4] with 13.4 percent among them living below the official poverty line. Hence, there is still a huge rural development task and within that improvement in agriculture productivity to be accomplished. Further, the rural poor tend to live in harsh conditions, sometimes in inaccessible areas and with poor infrastructure and support services. Hence, in such situations, they tend to rely on grassroots innovations (GRIs), which build on local resources, knowledge base, skills, culture and creativity. One important way to improve rural productivity and bring the population out of poverty is to support the farmers' own efforts in GRIs in agricultural technology, production organization and institutional development[5]. GRIs can contribute greatly to inclusive development and reach out populations and areas not reached by or ignored by the formal sector.

This paper focuses on translation of the existing S&T policies into the GRI initiatives of the farmers. It shows how various government organizations actively support the farmers in applying S&T for agriculture. Section 2 presents the conceptual framework of the paper. Section 3 presents the institutional structure through which the grassroots innovators can benefit from the existing S&T policies and programs, along with an example of policy-making hierarchies. Section 4 is a case study of farmer Chen Guangxing of Baodi County, Tianjin, which shows the synergies of the efforts of the government policy and program framework with individual efforts. This case also explains the quick learning by the official policy making body from the GRIs to spread them across the nation. There are still some issues that remain in bringing the S&T efforts to the grassroots and also support individual efforts of GRIs wherever these exist. These are discussed in the last section.

2. Conceptual framework: a closed loop of training, research and diffusion

Globally, throughout the long history of agriculture, farmers have developed many technologies and built specific knowledge bases for their respective local environments (Reijnties *et al.*, 1992):

> Many rural poor live in marginal and diverse environments for which blanket technical solutions do not work. The diversity of ecological and social conditions indicate the need for multiple innovations and local adaptation of farming practices (Waters-Bayer and Bayer, 2005).

Therefore, the countries and firms must be open to new ideas, have multiple sources of new ideas, and see that ideas are diffused if they are to achieve economic development and growth (Arrow, 1999). The informal research by farmers can be a major source of agricultural innovations (Biggs, 1992; Hippel, 1988; Reijnties *et al.*, 1992). Local people are knowledgeable about their own situations, their resources, what works and what does not work, and how one change impacts on other parts of their system (Gupta, 2003; Rajasekaran, 1993; The World Bank, 2011). Therefore, increasingly, scientists throughout the world are starting to acknowledge farmers' capacity to experiment and innovate, stressing the importance of participatory approaches for agricultural research and development (R&D) (Hellin *et al.*, 2008; Hoffman *et al.*, 2007; Gonsalves *et al.*, 2005; Reece and Sumberg, 2003; Thrupp, 1996). As Chambers *et al.* (1989) and Richards (1985) have forcefully argued in the 1980s, experimentation is part of the farming practices and partnerships between extension services, formal research and farmers in improving rural livelihoods hold far more promise than the conventional top-down approach to R&D. A genuine partnership is possible only when the external actors can appreciate local creativity (Waters-Bayer and Bayer, 2005). Different agro-ecological and market conditions require not only different technologies but also different providers of technology across the public, private, and civil society sectors (Byerlee and Alex, 1998):

> Because of the changes surrounding and affecting them, the rural areas of the developing world nowadays resemble a gigantic laboratory, with new initiatives taking place everywhere and across a range of issues and objectives (Berdegué, 2005).

This is the case even in China, where examples abound of farmers' own innovations that have led to local, even national, economic development. For example, the over-the-winter greenhouses for vegetable production developed by the farmers in Wafangdian, Liaoning province have resulted in cultivation of vegetables and hence increase in the vegetable choice available to the people in winter (Wu and Zhang, 2013). Chen Guangxing, whose case is discussed in this paper, has developed new varieties of Chinese onion and garlic, through which there have been significant increases in local agricultural production.

Poole and Buckley (2006) drew attention to agricultural development that results:

- from innovation as a response to changing incentives in public sector organizations induced by changing resource endowments and economic change; as well as
- the response by individual firms – or farmers – to changing market signals.

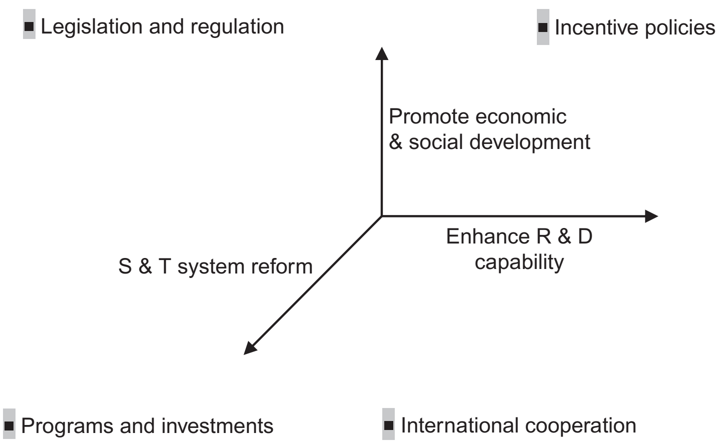
"Poor people's innovative ability is constrained by insufficiently developed skills, inadequate public services, and an inability to access markets and assets on fair terms and handle associated risks" (Utz and Dahlman, 2007). Thus, incentives for the GRIs, accountability towards these innovators and opportunities for these individual or collective innovations to generate more efficient and competitive livelihood support measures are necessary (Gupta *et al.*, 2003). Enhancing skills through better delivery of basic training for the informal sector is important. In addition to strengthening poor people's capabilities, solutions will involve strengthening incentives, policies, and institutions. Part of the solution will be in stronger institutional infrastructure:

> The innovation and rural development processes are complex by nature: they result from the interaction of many diversified and complementary actions, coordinated by different actors. Innovation processes must be flexible, and solutions may often be specific to the local contextual factors: political, economic, geographic, social, cultural.

A complex framework of underlying conditions (e.g. political, administrative, economic) determines the very nature of farmers' experiments and innovations. Thus, decision makers hold crucial power shaping favoring conditions to support farmers' experimental activities and to facilitate the spread of informal research results through social networks (Kummer and Vogl, 2009). Innovation policy and strategy dialogue should shift from undermining the importance of GRI and focus on ways of formulating national systems of innovation and remove bottlenecks that prevent innovators and innovations in rural spaces to become part of the mainstream R&D effort (Ashok and Verloop, 2012).

A distinguishing feature in China from the general global historical and contemporary trends of farmers' GRIs is strong government support in the form of funds for research and its demonstration and diffusion, technology transfer, and application for patents. Different organs and levels of the governments are engaged in this. A study of nearly 2,000 GRI cases in China shows that the interaction between the grassroots innovators and local government at the GRI diffusion stage is strong (Zhang and Liu, 2012). Hua County study by Zhang and Mahadevia (2012) shows that the local government support mechanism to grassroots innovators is very flexible and a leading grassroots innovator has been critical to the utilization of government S&T policies. The overall outcome of the synergies between the GRIs and the government policies has been advancement of farm production and local economic development, which benefits the farmers themselves and the local area.

This specific S&T policy-making and its implementation context is explained by Shang[6] through Figure 1, which shows that the basic structure of S&T policy design in China has 3D objectives and four policy instruments. The three objectives are to:



Source: Yong and Shang (2005)

Figure 1. Basic structure of S&T policy design

(1) promote economic and social development;
(2) enhance R&D capability; and
(3) reform of S&T system.

The four instruments in S&T policy design are:

(1) legislation and regulation;
(2) incentives;
(3) programs and investments; and
(4) international cooperation.

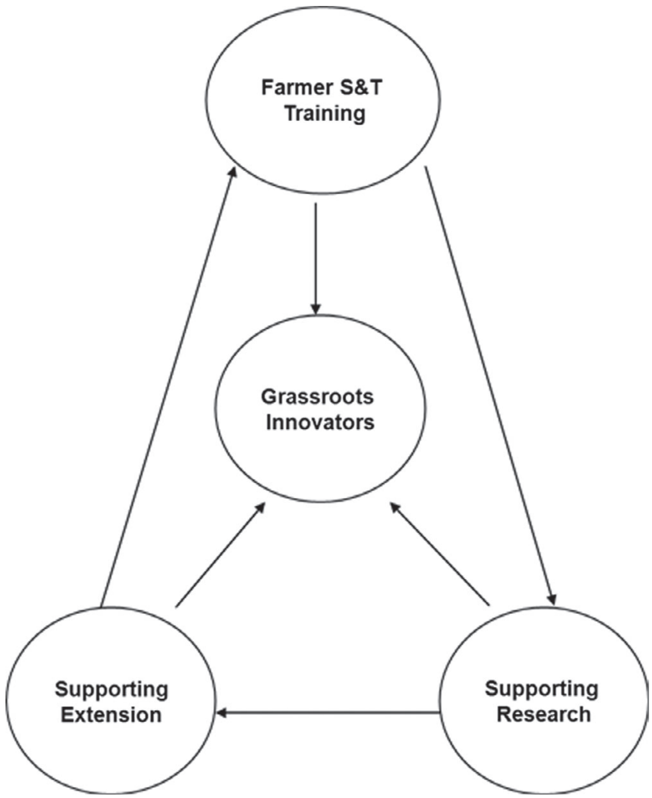
In China, the implementing participants in its rural S&T policies and programs are diversified and the role of government weakens (Liu and Qiang, 2013). Unfortunately, the efficiency and effectiveness of policy and program implementation are impeded due to information asymmetry (Zhao and Lingzhou, 2013).

The core of the S&T application is a closed loop of three pillars, "S&T education and training – research support – diffusion support". The logical starting point of promoting S&T at the grassroots is education and training, followed by support to research and diffusion of its achievements. The diffusion process involves the component of farmers' S&T training as well because the successful application of an agricultural achievement needs to train the farmers. Thus, a closed loop is formed. These linkages in case of grassroots innovators is presented in Figure 2, which in essence is the institutional framework of translating policies and programs into grassroots innovators.

Multiple organizations support each of the three pillars of the GRI promotion depicted in Figure 2, namely research, research extension (diffusion) and farmers' S&T training and each one of them have their own policies and programs to accomplish their designated tasks. For example, the research is mainly coordinated by the Ministry of Science and Technology (MOST) system and its achievement diffusion is mainly managed by the Ministry of Agriculture (MOA). The training and education of farmers – however, involves two institutions: China Association for Science and Technology (CAST), and the MOA. The existing S&T policy and institutional framework in China does not have any separate program or mechanism for the grassroots innovators who are encouraged and enabled to access the existing mechanism to receive training, undertake research and then diffuse the research.

The CAST has branches up to the local level coordinate the popularization of science in China. CAST is the largest national non-governmental organization of scientific and technological workers in China. It:

- devotes itself to boosting the development of S&T in China and enhancing science literacy of the whole nation;
- encourages scientists and engineers of the country through its affiliated organizations to conduct academic exchange, science popularization and scientific and technological consulting;
- firmly safeguards the legitimate rights of scientific and technological workers; and
- acts as the bridge linking Chinese science and technology community with the Communist Party of China (CPC) and the Chinese Government.



Source: By the authors

Figure 2. Institutional framework of translating policies and programs into GRIs

2.1 Hierarchy of policy making – an example

Before discussing the system of training and educating farmers, we explain the policy-making hierarchy in China. The policies and legislation made at the national level, flows down through a system of government organizations up to the town level. However, the programs based on the national level policies and laws get adapted to suit the local conditions. Thus, although there is a top-down approach to law, policy and program implementation, Chinese system is marked by flexibility in their implementation, as the local levels have been conferred wide discretionary powers to implement them. This sub-section illustrates this hierarchical policy making system in China with the example of inculcating scientific literacy of the farmers as depicted in Figure 3. This activity is part of one of the three pillars of GRI promotion, as depicted in Figure 2.

In the unitary state of China, the National People's Congress (NPC) and its Standing Committee frame legislation in accordance with the Constitution of the PRC. The State Council, which is the national government appointed by the NPC, makes policies to implement the legislation. Thus, the NPC makes law, for example, law related to education in S&T, which then gets converted into a policy outline at the State Council level. The policies framed by the State Council are overarching and broad and give

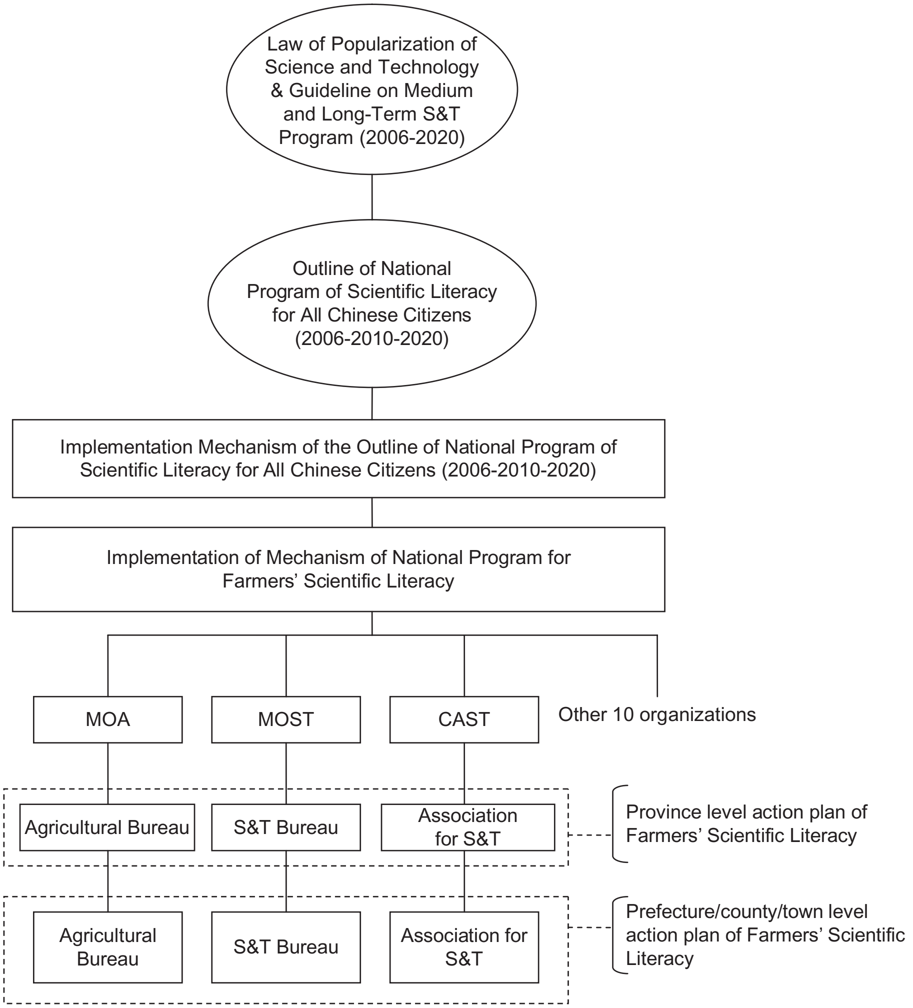


Figure 3.
Policy-making hierarchy for S&T popularization among farmers

Source: By the authors

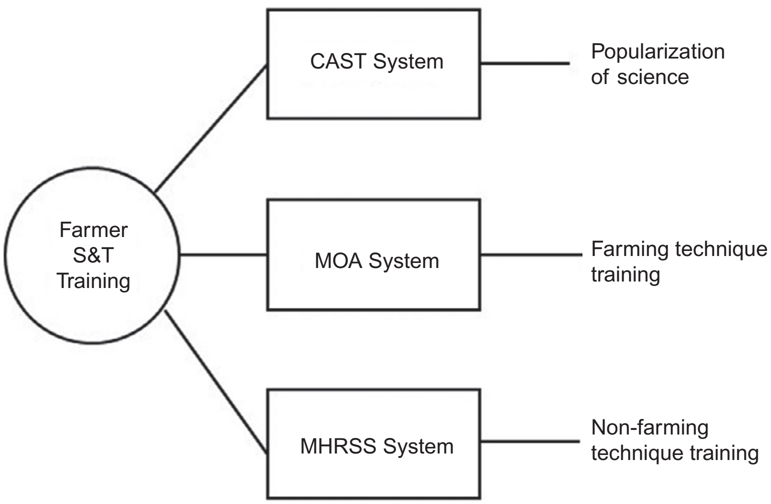
policy direction as well as set the development paradigm. But, the laws are legally enforceable policies. These policies, rules and regulations get implemented down through the state organs at the provincial and local government levels.

At the national level, there is the "law of the People's Republic of China on popularization of science and technology", 2002, derived from which are the "National Guidelines on Medium and Long-Term Program for Science and Technology Development (2006-2020)", leading to the State Council's "Outline of national action scheme of scientific literacy for all Chinese citizens (2006-2010-2020)" in 2006. A national coordinating group is set up to carry out this action scheme, which has identified four target groups: the farmers, the urban workforce, the minors, and the government officials. The leading group's office is in CAST, which then coordinates the functioning of the leading group's activities. Hence, for farmers, there is a "national program for farmers' scientific literacy" which is implemented through 13 government organizations, including the CAST, the MOST and the MOA. Each of these organizations prepares its own action plan, which is implemented through the respective bureaus at its subordinate units. The action plans are in accordance with their superior government bodies. Through this hierarchical mechanism, the national-level laws/regulations/policies/programs get implemented at the local level. This will be seen later in the case study of Chen Guangxing, who has received funds from different levels of government institutions.

2.2 Elaboration of the closed loop

Farmers' education and training for S&T. Although there are 13 government organizations or the organizations under the party, such as the CAST and the All-China Women's Federation (ACWF), working together on farmers' S&T education and training (as we explained in Figure 3), among them, three organizations play the leading roles. They are the CAST system, the MOA system and the Ministry of Human Resources and Social Security (MHRSS) system (Figure 4). The CAST system educates the farmers in basic S&T knowledge. The central government invested 50 million RMB in 2006 in efforts to popularize science in rural areas. It was the first time that the central government had earmarked funds specifically for rural science literacy. Unlike before when CAST and its branches used funds to build science popularization facilities and organize related activities, the new money was disbursed as a fund to support grassroots science communicators. In 2007, the amount was doubled.

The MOA system educates and trains the farmers in improving farming techniques, such as how to grow new crops, how to apply new techniques in breeding and so on. Each year, the government allocates funds for various programs. For example, under the "Sunshine Project" started in 2004 by the MOA, 2.4 million farmers were trained through support of RMB 250 million from the central government and RMB 500 million as local



Source: By the authors

Figure 4. Institutional architecture for farmers' S&T training

supporting funds[7]. In 2012, 1.4 million were trained for vocational training in farming, such as agricultural production and management skills, agricultural machine repairing, etc. 1.88 million were trained in specific agricultural techniques, and 20,000 farmers participated in entrepreneurship training. For the three components, the central government financial support for one person was RMB 600, 100 and 3,000, respectively[8]. Usually, the key farmers are trained and then the fellow farmers learn from them.

Due to urbanization and industrialization, many farmers shift to the non-farming areas. The MHRSS system takes the responsibility of training the farmers who are looking for jobs in the non-agricultural industries both in the city and rural areas. The farmers are trained with new occupational skills such as computer operating skills, software design, vehicle repairing, etc. For example, the total training budget in China was over 6 billion RMB in 2010[9].

Supporting research. The research projects are mainly supported by the MOST system, which goes down all the way to the prefecture level. Each year, a certain percentage of the GDP, which varies at different levels in different areas, is allocated to R&D. This is as truer at the national level as at the local level. The S&T bureaus at the county level, even at the town level may support research as well based on their economic situation. At the national level, for example, in 2012, the total R&D expense in China was RMB 1,024 billion, which was 1.97 percent of the national GDP[10]. The grassroots innovators' research institutes may apply for the research grants at the county, prefecture or provincial levels. There is a little chance for them to be supported directly from the MOST, instead, they can be sub-contracted a project supported by the MOST.

Among the MOST programs, three are related to GRIs:

(1) the transformation fund for agricultural S&T achievement;
(2) the special action plan on enriching the people and strong county through S&T; and
(3) the plan for benefiting the people through S&T.

All the S&T programs are jointly triggered and administered by the MOST and the Ministry of Finance (MOF).

The first one was introduced in 2001, supporting the transfer of research achievements, which is the intermediate link between research and marketing. The second one was started in 2005, aiming at supporting the county's key industries through the application of the integrated advanced and applicable technologies. While in implementation, the grassroots innovators' organizations may be granted sub-contracts by the county S&T bureaus who undertake the projects of the MOST. The last one started in 2012, bridging the demand side of the research achievements with the suppliers. It supports the demonstration and application of the advanced and applicable technologies at the grassroots level.

In the program implementation, the MOA and other related ministries/departments cooperate with the MOST. The MOST money acts as seed capital to leverage investments from enterprises, research institutes, financial institutions and local governments. Each provincial government sets up funds to support its own projects and match the funds of the MOST.

The MOST system regularly publishes call for proposals for S&T programs along with guidelines that mention the application categories, priority areas, number of applications, the application procedures and so on. There is an elaborate process of assessing and selecting the proposals for funding. Each level of government receiving the proposal organizes an expert evaluation team, which recommends the proposal to move up to the higher level of government. At the end, the proposals selected are presented at the expert evaluation meeting held in conjunction with the financial sector. In general, the applications for the government S&T projects need matching grant either from the lower government organizations and/or the applying organizations.

The grassroots innovators, if organized and qualified, can apply for research projects. They can either apply individually or in partnership with other research organizations. In many cases, the grassroots innovators as individuals are invited to be research team members.

Supporting research achievement diffusion. In the context of agriculture, the diffusion projects are mainly supported by the MOA system. Similar to the research projects supported by the MOST system, the provincial-level agricultural committee also sets up its own diffusion fund to support diffusion projects and match the financial support to the diffusion projects which are supported by the national funds as well. It has its own diffusion program. For example, Tianjin Agriculture Committee planned to transfer and apply 100 key agriculture research achievements and train 1,000 extension experts between 2012 and 2015, in which grassroots organizations and grassroots innovators may play an active role. Regarding the agriculture achievement extension, the farmers' cooperatives are important carriers.

3. Case study illustrating the synergies[11]

The grassroots organizations initiated by farmer Chen Guangxing in Baodi County, Tianjin, has received many research and diffusion projects from different government organizations both at the national as well as local levels, as evident in the tables in this section. This farmer has researched, developed and diffused across the country new varieties of Chinese onion and garlic. The entire case of farmer Chen is of how the institutional support for the formal sector has helped GRIs and their diffusion in the country.

3.1 Developing a new Chinese onion variety of "Wu Yeqi"

In 1983, farmer Chen Guangxing, Yuanluo Town, Baodi County, Tianjin, successfully developed a new Chinese onion variety, named "Wu Yeqi". In that year, the Yuanluo town grew 1,200 μ (80 hectares) of "Wu Yeqi". Its average yield was 3,400 kg/μ, while other varieties were only 1,500-2,000 kg. This achievement attracted the attention of the Baodi Agricultural Bureau.

Since then, "Wu Yeqi" has been widely diffused throughout China, which has brought significant economic and social benefits to the local community. Taking 1992 as a benchmark, the economic benefits of "Wu Yeqi" seeds and products are shown below:

> In 1992, there were 2,500 μ of Wu Yeqi seed-production areas nationwide, producing 125,000 kg of seeds. There were 625,000 μ of cultivated Chinese onion, covering 25 provinces. The average yield per μ was 3,750-4,000 kg, 1,300 kg more than the traditional local Chinese onion variety, "Gao Jiaobai"[12].

The seed yield was 50 kg/μ, increasing income by RMB 5,000 (RMB 100 per kg of seed). Thus, 2,500 μ would have brought RMB 12.5 million to the seed growers. The "seeds produced above could be used to produce 625,000 μ of "Wu Yeqi" (200 gram of seeds per μ)". The average increase in production was 1,300 kg/μ, which brought RMB 162.5 million profit (RMB 0.2 per kg).

3.2 Improving planting techniques among farmers

There was no research on Chinese onion and garlic in the formal sector, therefore, in early 1983, Chen set up the Yuanluo Chinese Onion and Garlic Research Association (hereafter the Association), aiming at learning from each other and share the best practices among themselves[13]. In the first few years, they successfully worked out solutions to several difficulties that had worried them for a long time. Below are several examples.

Increasing the germination rate. This was the first research topic selected by the association. They organized a meeting to find out how to increase the germination rate of onion seeds:

> Farmer Chen Weifang, the best among the members at raising seedlings, shared his experience. First, he soaked the seeds for a day in warm water then he sowed them four to five days later than the other farmers, using about a finger's width of covering soil. After that, Chen guided the farmers in discussing why Chen Weifang's germination rate was so high[14].

Protecting "Wu Yeqi" from floods. Yuanluo township is at a low elevation which meant that it is often flooded, ruining the onion harvest. The association decided to research the solutions. Having worked in the fields, they devised a technique to manage the effects of flooding. This had four elements: draining the fields in time, removing residue in time, re-dressing the topsoil in time and re-watering in time. In 1995, this was demonstrated at the "high-yield demonstration project of Chinese onion, garlic and chilli of Baodi" under the Tianjin Spark Programme. In the same year, it received the third prize for Diffusion in the Tianjin S&T Progress Awards by the Tianjin Municipal People's Government.

Counting the seeding rate. The seeding rate needs to be scientific. If too many seeds are sown, the sprouts would be thin and would fall all over. This would be a waste of seeds that could be sown elsewhere. On the other hand, if too few seeds were sown, the sprouts would die and there would be a waste of land. Chen decided to count the exact seeding rate. One day in 1984, Chen carefully counted how number of seeds in half a kilogram, which came to 12,546. According to his farming experience, Chen allowed for one sprout per cm^2. The national standard set for the normal germination rate of Chinese onion is 85 percent, which means that it would be acceptable if 85 percent of the seeds sown sprout. Taking into account the need to weed out weak sprouts, Chen calculated that the germination rate would actually be closer to 70 percent. He came to conclusion that sowing 0.15 kg of seeds per μ would be ideal. To be on the safe side, he suggested to sow 0.2 kg of onion seed per μ.

Calculating ditching depth and line spacing. When "Wu Yeqi" was first developed, it was relatively low yielding. Through careful observation, he noticed that the stems grew stronger when the earthing ridges were higher. This led him to experiment with different heights of ridge. In the winter of 1987, Chen worked out the formula of calculating ditching depth and line spacing for the farmers to follow. The optimal ridge height was half the height of the stem and the optimal line spacing was equal to one and half times the length of the stem. In 1988, this formula won third prize at the Tianjin S&T Progress Awards by the Tianjin Municipal People's Government.

Growing wheat and Chinese onions in rotation. Traditionally Chinese onions were only produced once a year in Baodi, or in rotation with garlic. Limiting production to one crop wasted land but rotating Chinese onion with garlic often resulted in diseases because they belonged to the same family and required the same nutrients.

As the production of "Wu Yeqi" increased, it began to squeeze out the production of wheat and they both needed to be grown close to water. To promote the production of "Wu Yeqi", Chen and his fellow farmers spent two years attempting to grow Chinese onions and wheat in rotation, sowing Chinese onions as soon as the wheat was harvested. This saved land and reduced diseases. In 1998, this technology innovation received the third prize for diffusion at the Tianjin S&T Progress Awards by the Tianjin Municipal People's Government.

Improving the plough. The traditional ploughs used in Baodi tended to damage the Chinese onion plants. With help from technicians at the Baodi Agricultural Machinery Bureau, the association attempted to improve the plough, but had little success. In 2005, the Baodi Agricultural Machinery Bureau received a project from the Baodi S&T Bureau to improve the plough. Chen and the technicians visited several places in China and finally found a suitable plough in Pinggu county, Beijing. They bought one and brought it back to Baodi. The association members made suggestions for improvement and the technicians made modifications. The farmers found that the new tool greatly increased their productivity. The modified version is still in use today.

Flies replacing honey bees. The wide use of chemical pesticides had destroyed the local bee population. This meant that farmers had to artificially pollinate their crops. Chen called the members of the Association together for ideas. One female member, named Zhang Weifeng, mentioned that she had never used artificial pollination. The members visited Zhang's field and found that it was next to her chicken farm. They realized that the flies were pollinating her crop instead of the bees. They started to put leftovers and animal waste in their fields to attract their own flies. This technique has been widely used since then[15]. In 2008, Zhang was appointed as a Special Commissioner for S&T by the Baodi S&T Bureau. In 2009, she became the Special Commissioner for the Tianjin S&T Committee.

It needs to be stated that initially, the association followed tradition and did not invite any women members. In 1989, the ACWF mobilized women all over the country to participate in "learning S&T knowledge and competing in performance and contribution". To better organize the contest, the Yuanluo Women's Federation asked the Yuanluo associtiion for help. The association obliged by taking on 11 women members; Zhang Weifeng was one of them. Chen later received several awards from the Women's Federation.

3.3 Receiving research/diffusion project grants

In 2005, Chen set up the Jinbao Chinese Onion and Garlic Research Institute (hereafter the Institute) to continue research. The Institute's research team was made up of farmer experts from the association, technicians from the Tianjin Academy of Agricultural Sciences and the teachers of a local agriculture school. Chen and his farmers' research association already had a good research background and Chinese onion and garlic had become important to the local rural economy, therefore, the Institute received several research grants. These projects were applied individually or jointly from the local S&T bodies, such as the Tianjin S&T Committee, Baodi S&T

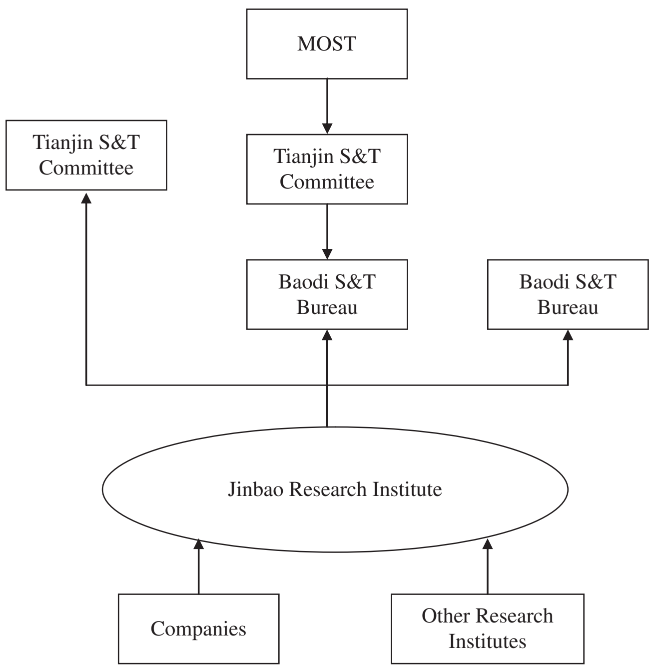
Bureau and Agricultural Bureau. In 2008, the Baodi S&T Bureau was supported by the special action plan on enriching the people and strong county through S&T of the MOST via Tianjin S&T Committee, the institute was subcontracted from the Baodi S&T Bureau. Sometimes, the eternal organizations, such as companies or research institutes came to the Institute for cooperation (Figure 5).

In 2008, Chen set up the Guangxing Chinese Onion and Garlic Cooperative (hereafter the Cooperative). The members of the Association became the members of the Cooperative. After its establishment, the Cooperative was granted three demonstration projects. Table I is the research and diffusion grants received by Chen's organizations for Chinese onion and garlic.

3.4 Awards received[22]

The association has received more than ten recognized titles/awards from the government, as an encouragement. For example, in 1994, the association was designated as a Star Association for Vegetable Diversity, with a supporting fund of RMB 50,000 from the Tianjin Municipal Government. In 2001, winning the title of ten best service organizations in rural economic development brought the Association RMB 100,000. In 2007, the CAST and the MOF awarded the association RMB 200,000 supporting fund because it was named an "advanced association for popularizing science among farmers".

This fund is under the program for "benefiting farmers and revitalizing countryside by means of science popularization", which was jointly set forth by the CAST and the MOF during the 11th Five-Year Plan period (2001-2005). The purpose of the program is



Source: By the authors

Figure 5.
Project application procedure of the Institute

Title	Sponsor	Undertaking unit	Support (in RMB '000)	Project period
Breeding and diffusion of "Wu Yeqi"[16]	Tianjin S&T Bureau	Seed company of Baodi Agricultural Bureau	100	1993-1994
Technique research and application of chemical weeding in Chinese onion production	Baodi S&T Committee	Association	30	2003
Technique research and application of chemical weeding in garlic production			Approved but no funds	2005
Ditching tool for Chinese onion planting (cooperating with Baodi Agricultural Machinery Bureau)		Institute	10	2005
Research of high yield planting technique for Chinese onion, garlic and chilli			10	2006
Sub-project of the Baodi S&T enrich people project				
Experiment of nationwide comparing and selecting high quality Chinese onion seeds[17]	MOST		10	2008-2012
Demonstration and application of planting techniques for "Shuangwei"[18] Chinese onion			20	2008-2012
Garlic rejuvenation experiment			20	2008-2012
New variety breeding and diffusion of "Shuangwei" Chinese onion	Tianjin S&T Bureau		200	2005-2009
Introduction of Gansu garlic, comparison experiment with Baodi garlic, demonstration and diffusion	Baodi S&T Bureau		25	2006-2008
Experiment and demonstration construction of high quality and yield and green production of Baodi Chinese onion		Cooperative[19]	10	2008-2009
Experiment and demonstration zone for construction of high quality and yield and green production of Baodi Chinese onion	Tianjin Agricultural Committee		300	2008-2009
Technology integration and demonstration zone construction for green and high yield planting of Baodi garlic	Tianjin S&T Committee	Baodi S&T Committee[20]	200	2011-2013
"Double smell" Chinese onion variety breeding and high-yield planting technique diffusion[21]	Tianjin S&T Committee	Cooperative	200	2010-2012

Source: Compiled from original documents of Chen Guangxing

Table I. Research and diffusion grants received for Chinese onions and garlic

to promote the implementation of "the outline of action plan for improving the Nation's Science Literacy". It aims to promote the enhancement of science literacy of more farmers, develop their practical skills, and help them adopt scientific and healthy style of work and life[23].

The Cooperative has been recognized as a model "specialized cooperative" by CAST in 2008. In the same year, the Cooperative was listed as a "green farming demonstration base" by the Office of Agricultural Projects under the Chinese Academy of Sciences. This led Chen's Chinese onion to be selected for use in the 2008 Beijing Olympics.

3.5 Summing up

Government S&T policies and programs do transfer to the grassroots innovators. Although there are no policies or programs directly focusing on GRI promotion, Chen's case shows that grassroots innovators benefit from the government S&T policies and programs. Tables I and II explain this. Chen could get support due to certain comparative advantages, such as a good research record, a leading role in achievement diffusion locally and high relevance to the local economic development.

Support is continuous and all-round. Government S&T officials are constantly looking for good locally relevant projects of grassroots organizations and are willing to continuously support them for the purpose of promoting local economic development. Therefore, the different organizations under them would support the GRIs. The rationale for continuous and long-term support is that in the agricultural production process, new problems always crop in the way and invite solutions. Thus, Chen's orgnizations received continuous financial support and honorable titles. Continuous and all-round support prods grassroots innovators to do research and diffuse their achievements.

Grassroots innovators' leadership is important. To get government support, leadership is more important for the farmers' organizations than it is for competing organizations in the formal sector because the former have less access to support from governmental institutions and lack personnel and internal support structure. Chen was persistent in farming innovation and was able to identify research topics and integrate available resources to carry out various activities. His key intelligence was to set up multiple organizations, each one obtaining some grant from different government agencies. But, since Chen himself was involved with each of the organizations set up, he could synergize their activities and utilize the funds available with each organization judiciously. Thus, Chen's leadership played an important role in the process and contributed to his and organizations' success.

Project title	Sponsor	Undertaking unit	Support (in RMB '000)	Project period
Variety comparative test of carrots	An enterprise	Institute	20	2005
Gourd introduction, demonstration and diffusion	Baodi S&T Bureau		20	2006
Survey and utilization of special local plants in Baodi	Baodi S&T Bureau		10	2010
Variety comparative test of fruit radish	Baodi S&T Bureau	Cooperative	20	2011
Gourd introduction, demonstration and diffusion	Baodi S&T Bureau	Cooperative	50	2012

Source: Compiled from original documents of Chen Guangxing

Table II.
Research and diffusion projects for other crops

Research and diffusion projects are integrated in some cases. From a micro sense, the implementation of China's S&T policies and programs is clearly managed by different government bodies, although there are some overlaps and a need for coordination. In addition, the diffusion projects follow research projects logically. At the local level, many research projects have the components of demonstration and diffusion. Chen's case illustrates it. Farmers' research projects are usually in the applied-research category. They have the characteristics of localization and the process of research is the same as demonstration because many farmers can observe the research process.

S&T training contributes to farmers' research and project application. Logically, farmers' S&T training, supporting their research projects and then diffusion projects are sequential activities. The Association and later on the Cooperative provided S&T training to farmers and grassroots innovators. Scientific training helps them in research. Good research is the precondition for grassroots organizations to be supported by national S&T policies and programs. Chen's case shows that grassroots innovators are not only trainees but are also trainers. Meanwhile, farmers' mutual learning is encouraged and supported by the government. This is achieved through the government's guidance and support to organize farmers' research associations and cooperatives, which are the mechanisms of farmers' initiative for training themselves.

4. Policy implications

This paper is about the partnership between government and grassroots innovators, wherein the government provides facilitative support to the latter to extend S&T in farming in China. But, if the grassroots innovators are not well organized or receptive, the government on its own is unable to push the change from the top. The specific discussion in this paper is about the diffusion of scientific thinking and technology at the grassroots for meeting both economic and social goals. In this process, the grassroots innovators and their organizations can play a very important role. These energies at the grassroots have to be harnessed through institutional mechanisms and facilitation by the local government bodies. This paper through a case study demonstrates the dynamics of this partnership. Interestingly, in this dynamic partnership, it is not just the grassroots that benefit but also the government, which learns something new. For example, the government learnt from Chen Guangxing's local achievements that his idea of farmers' research organization could be a model for institutional development all over China. The story of Chen leads us to a few policy recommendations.

More support should come to grassroots innovators

According to Mr Wan Gang, the minister of MOST, China's S&T investment has increased 20 percent annually in recent years. The MOST no longer suffers from shortage of funds. However, a CAST survey shows that only about 40 percent of the project funds are spent on project implementation. Moreover, the government programs do not support many grassroots innovators. When they do support, the money is insignificant. The support Chen received from various government agencies, for example, was very small (Tables I and II) although his contribution to the local economic development was huge[24]. There is a need to increase support in general to the grassroots innovators.

Grassroots innovators need to be guided

In China, many farmers do research in their own interest, but they may not be aligned with the local development priorities and therefore may not qualify for government support. Grassroots innovators should be trained to identify relevant research projects and utilize government policies and programs. This kind of training can be integrated into the farmers' S&T training programs mentioned in the loop of three pillars, "S&T education and training – research support – diffusion support".

A GRI reporting mechanism is needed

Although Chen's "Wu Yeqi" Chinese onion had already been widely diffused nationwide, it is quite by chance that the local government officials noticed it and encouraged Chen to apply for project support. In China, many GRIs are untapped treasures. A reporting system is needed so that more grassroots innovators can be benefited through the S&T policies and programs.

Notes

1. www.guardian.co.uk/world/2011/nov/30/china-raises-rural-poverty-line (accessed 7 June 2012).
2. As per the NBS data, http://news.xinhuanet.com/english/china/2013-03/06/c_132212601.htm (accessed 3 May).
3. http://news.xinhuanet.com/english/china/2012-01/20/c_131371091.htm (accessed 7 June 2012).
4. As per the 6th National Population Census, 2010. Communique No. 1 of the 6th National Population Census, www.stats.gov.cn/tjdt/gjtjjdt/t20110429_402722652.htm (accessed 21 May 2011).
5. There are many political GRIs as well. For example, the major political innovations since late 1970s in rural China were all triggered by the grassroots (Zhang, 2012).
6. At the time, Shang Yong was the vice minister of the MOST, China.
7. http://news.xinhuanet.com/newscenter/2005-01/14/content_2460334.htm (accessed 12 May 2013).
8. www.moa.gov.cn/govpublic/CWS/201206/t20120606_2751138.htm (accessed 12 May 2013).
9. http://ms.nvq.net.cn/nvqdbApp/htm/zhengcefagui/ecFwDownloadForView-1411.html (accessed 10 May 2013).
10. Source: www.022net.com/2013/3-8/426045182467387.html (accessed 20 June 2013).
11. All the information in this section is based on discussions with Chen and his original documents.
12. Cited from the "report of the economic benefit analysis of 'Wu Yeqi'", the Baodi Seed Company, 1993.
13. It was the first farmers' research association in China. Later on, this organizational innovation was institutionalized by the CAST.
14. Cited form the Work Summary of the Association, 1988.
15. The flowering period of "Wu Yeqi" was only about ten days and it produced a large amount of seeds. Therefore, the local farmers applied artificial pollination as before.

16. This was the first research project that Chen received. When "Wu Yeqi" was diffused throughout China and featured in national media, Chen and his fellows did not know they could apply for projects from the government. In 1992, the Tianjin S&T Committee officials came to the Baodi S&T Bureau and suggested that the association applied for a research project from them. At the time, only research institutes at the county level were qualified to apply for the research projects. Thus, the Seed Company of Baodi agricultural bureau applied for the project. The Association was the project participant. The support to this project was fully transferred to the association later on. In 1993, the breeding and diffusion of "Wu Yeqi" won the Second Prize at the Tianjin S&T Progress Awards.
17. There is a nationwide competition of different onion seeds to find which ones give highest yields.
18. It is one variety of Chinese onion, which is also called double-smell Chinese onion.
19. In this case, the Tianjin Jialian agricultural production material trading company is the project leader and the Cooperative is the participant. While doing the project, the Cooperative did not receive financial support from the project. Instead, the Cooperative used 100 μ land of Jialian for free. Chen often provided technical support to the project implementation.
20. The Cooperative is the project participant.
21. In 1998, an agricultural delegation from Baodi visiting Romania bought garlic bolts in the supermarket to eat. They gave Chen some of these that they had brought home. He used them to develop a new variety of leek in China. He named it the "double smell Chinese onion" since it smelled of both Chinese onion and garlic. Flies replacing honey bees was applied in this project.
22. Data in this paragraph is compiled from documents with Chen Guangxing.
23. Source: http://english.cast.org.cn/n1181872/n1182063/n1182081/47754.html (accessed 15 June 2013).
24. Taking the application of Wu Yeqi as an example, "In 1992, there were 2,500 μ of Wu Yeqi seed-production areas nationwide, producing 125,000 kg of seeds. There were 625,000 μ of cultivated Chinese onion, covering 25 provinces. The average yield per μ was 3,750-4,000 kg, 1,300 kg more than the traditional local Chinese onion variety, "Gao Jiaobai". Taking 1992 as a benchmark, the seed yield was 50 kg/μ, increasing income by RMB 5,000 (RMB 100 per kg of seed). Thus, 2,500 μ would have brought RMB 12.5 million to the seed growers. The seeds produced above could be used to produce 625,000 μ of "Wu Yeqi" (200 gram of seeds per μ). The average increase in production was 1,300 kg/μ, which brought RMB 162.5 million profit (RMB 0.2 per kg). Source: Cited from the "report of the economic benefit analysis of 'Wu Yeqi'", the Baodi Seed Company, 1993.

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