THE PUBLIC AGRICULTURAL EXTENSION SYSTEM IN CHINA: DEVELOPMENT AND REFORM[1]

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1. Introduction

One of the major ideological debates in development centers on whether the provision of local public goods in developing countries should be made financially self-sustaining, as opposed to relying on international donors or national governments. Should external donors indefinitely fund activities that generate positive externalities, or can they be most effective by establishing institutions that rely on local cost-recovery?

Replacing dependency with self-sufficiency is attractive across the ideological spectrum, but empirical evidence from a number of contexts suggests that local financing may be ineffective in delivering public goods. For example, Kremer and Miguel (2007) find that cost recovery for de-worming drugs in Kenya reduced uptake by 80%, and Meuwissen (2002) found disappointing results from cost recovery for health services in Niger. Morduch (1999) found that microfinance institutions focused less on the poor when asked to be self-sustaining. Few studies of local financing institutions focus specifically on agriculture, which has been newly recognized as crucial to development and poverty alleviation (World Bank 2008), or on China, where fiscal responsibilities have been decentralized on a massive scale (Zhang 2006). A few papers speculate about optimal financing for agricultural extension, a crucial institution for farmers (for example, Anderson, 1999), but to our knowledge none use primary survey data and econometric methods to support their conclusions.

China has established a decentralized public agricultural extension system (PAES) since the end of 1970s (Hu et al., 2009). The inclusive system has contributed great to China's agricultural growth in the early 1980s (Zhu, 1997; Zang, 1989; Wang, 1994).

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However, the financial shortage had made the operation difficult for the huge system (Hu et al., 2009). To reduce the financial burden and improve the operation efficiency of the system, the government made a series reform. This paper will make a review of the development of the PAES next section, then we will review the reform of the system, and the effects of the system reform. Finally, we will give the conclusion and policy recommendation.

2. Development of the public agricultural extension system in China

The rapid expansion of the real output of major food and agricultural products in China ranks as one of the nation's great achievements. Publicly funded agricultural research and extension have been key to the impressive performance (Huang et al., 2003; Fan and Pardey, 1992). Several studies conducted by research economists at the Chinese Academy of Agricultural Sciences find that technology contributed more than 40 percent of agricultural growth (Zhu, 1997). Recent studies on agricultural total factor productivity (TFP) further confirm that agricultural productivity growth has mainly come from technological changes, including high-yielding varieties, other embodied input technology, and farming system improvements (Huang et al, 2000; Fan and Pardey, 1997; Jin et al., 2002; 2009).

China's government re-established its public agricultural extension system (PAES) at the end of the 1970s. By the end of the 1980s, the system employed an extension staff of more than one million (Zang, 1989). More than 70 percent of these staff members have graduated from technical high schools or colleges (Zang, 1989; Lu, 1999). More than 90 percent of them work at PAES stations at the county and township levels, with most agents at the township level (Table 1). By the mid-1980s, China has established stations in every rural county and township, even in remote regions (Hu et al., 2009), and this large and inclusive system provided high-quality agricultural extension services (AES).

PAES stations are organized by agricultural sub-sector. Most agents work at crop or livestock stations, but most counties and townships also have agricultural machinery, aquatic products, and agricultural economics stations (Table 1). Most counties have established specialized stations in addition to the five types listed above, including crop management, plant protection, horticulture, and soil and fertilizer technology, as well as stations corresponding to locally important agricultural products. For example, cotton-growing areas have stations specializing in cotton. By the end of 2000, there are more than one million staff of agricultural extension in each level government of China (Table 1). Among them, 58.1 percent are located in the township government, 34.8 percent are located in the county level government. It means that most of China's public extension agents are work directly for farmers.

The proliferation of specialized stations make the PAES became overstaffed (Hu et al., 2004; Hu and Huang, 2000). Comparing to the 1.01 million of agricultural extension agents, there are only 0.74 million of agricultural administrative villages (Figure 1).

The studies indicated that the public extension agents had provided very good service to farmers in early 1980s In China (Zang, 1989; Wang, 1994). And at that time one extension agent usually tasked to provide technologies services to farmers in 3-5 villages. It explores that the public agricultural extension system is overstaffed in China in 2000.

The overstaffing has created a financial burden for local governments (Hu et al., 2004). Our survey found that funding levels per agent at China's agricultural extension stations are low, and that government-funded operating expenses represent the largest share of station budgets (Table 2, see Hu et al., 2009). In 2002, agricultural extension stations at the township and county levels had an average budget per agent (including salaries and extension expenditures) of only 14,304 *yuan* (approximately US$1,730, Table 2), with county-level stations only a bit higher at 16,496 (approximately USD$1,139). This included 11,197 *yuan* of government funding (13,467 *yuan* for county stations and 6136 for township stations), 78% of the total. Income from commercial activities averaged 3,107 *yuan* (3,029 at the county level and 3,280 at the township level), accounting for 22% of the total. Of the government funding, an average of 8,990 *yuan* was operating budget (OB) and 2,031 *yuan* project grants (PG), 63% and 14% of total funding or 80% and 18% of government funding, respectively. It should indicate that for the agents in township level, our survey found that many of the agents did not receive any budgets from the government (Hu et al., 2004). All their income comes from the commercial activities.

3. The reform of the public agricultural extension system in China

3.1 The commercial and decentralization reform and its effects before 2000

3.1.1 The commercial reform

To overcome the financial burden problem, China's central government has carried out the first round reform for its agricultural extension system since the mid-late 1980's. In 1985, the central government decreed a policy that encouraged PAES to earn their own income through commercial activities (Wang, 1994). Since then, the PAES stations located at every administrative level have gradually begun their own commercial activities. The reforms were originally designed to encourage the stations to earn money to make up for the increasingly tight budgets. PAES agents were encouraged to provide better services to farmers by supplying appropriate input technologies. However, as some studies have shown, AES agents may have conflicts of interest. Because they earn some income from selling fertilizer, pesticides, and seeds to farmers, some studies have shown that some agents recommend more pesticides, fertilizers, or expensive seeds than farmers really need (Huang, 2001).

In the early 1990s, the Chinese government formalized the commercial reforms by classifying stations by their source of funding: fully funded stations, partially funded

stations, and self-funded stations. Counties had flexibility in how to implement the reforms, and in some counties that were less able to finance agricultural extension all the PAES stations have became self-funded stations or partially funded stations. Cuts in funding for PAES affected the day-to-day operations of the system (Ke, 2005; Hu et al. 2004). Several studies have found that services have been greatly reduced since the early 1990's (Hu et al., 2004; Qiao et al., 1999; Sun, 1993).

3.1.2 The administrative decentralization reform

At the end of the 1990s, the Chinese government carried out an administrative decentralization reform to the PAES. This reform shifted the administrative rights (including personnel, finance, and materials, or "three rights") from county agricultural bureaus to township governments. The reform was intended to enhance the capacity of township governments to manage the agents in township agricultural extension stations; to strengthen PAES extension service to farmers (the service had been weakened by the commercial reform); and to reduce the budgetary burden on the county agricultural administration departments, which were responsible for the station budgets. However, several studies have shown that the reform cut the links between the county agricultural extension stations and the township agricultural extension stations, thus interfering with technical services to farmers (Ke, 2003; Hu et al., 2004). The ministry of agriculture (MOA) criticized the reforms, in part because they increased the time agents spent on administration and reduced the time providing AES (Hu et al., 2004).

3.1.3 The effects of commercial and decentralization reform

To access the commercial and decentralization reform, we conducted a nation-wide survey at the end of 2002 and in early 2003. We randomly selected 7 provinces from China's seven major geographic regions (northeast, northwest, north, east, south, central, and southwest. Each region selected one provinces). In each sample province, we randomly selected four counties and in each counties, we randomly selected 3 townships based on farmers' per capita net income. In each county /township, we randomly selected 3 stations (or all stations where there were fewer than three). The sample includes 7 provinces, 28 counties, 84 townships, and 363 extension stations (198 at the county level and 165 at the township level). Extension staff members selected to participate in the survey included the station leader (or deputy leader) and a randomly selected one-third of the agents at each agricultural extension station in the sampled counties and townships[2]. In total, 1245 extension staff members (45 per county on average) were interviewed, including 423 station leaders (239 at the county level and 184 at the township level) and 822 agents (531 at the

[2] The response rate was 100% except for a small number of agents who were traveling in other counties. Sampled agents who were in the field when the survey team arrived were called back to the office.

county level and 291 at the township level).

Our survey provides an empirical proof that the agents spent more their time on office and administration works (see Hu et al., 2009). Agents spent a relatively small share of their time providing AES in 2002 (Table 3). On average, they spent 135 days (37% of the year) in the office; 56 days (15%) on commercial activities; 92 days (25%) on other activities; and only 81 days (22%) on delivering AES to farmers. AES time increased with seniority, from 19% for junior staff, to 26% for mid-level staff, to 29% for senior staff; commercial activities decreased from 17% to 14% to 8%, respectively. More highly educated staff members spent more time on delivering AES than did less educated staff members. Time spent on delivering AES increased from 20% for those with a secondary vocational school or lower education, to 24% for those with two to three years of technical college, to 26% for those with a BS degree or above. Time spent on commercial activities decreased with education, from 21% to 11% to 9% respectively. Time on AES increased with staff position, from 19% for ordinary agents, to 26% for ESC leaders, though it was slightly lower for ESC leaders (24%). But station leaders spent nearly same time on commercial activities as other agents (16% for each group), which is much higher than county agricultural bureaus plan for.

Time allocation differs greatly for agricultural agents at different administrative levels (Table 4). County-level agents spent 86 days on delivering AES, compared to only 73 days for township-level agents. County-level agents spent only 39 days on commercial activities, far less time than did the township agents. This illustrates one of the problems resulting from the reform of agricultural extension stations: the township agents who should provide more AES to farmers actually spend less time on it. This is the main reason why farmers often complain that they have not seen an extension agent for many years (Shi et al., 2003; Cai and Hu, 2009).

Agents in the stations that were fully or partially funded by the government spent more time on delivering AES (85 and 87 days respectively) than did agents at self-funded stations (58 days) (Table 4). As a matter of fact, most of the self-funded extension stations are operating virtually as private enterprises, in which the agents spend an average of 190 days on commercial activities. The comparable figures for the fully funded and partially-funded stations were 25 and 64 days respectively. Office time also varied. The agents in fully funded stations spent more time in the office (160 days) than did the agents in partially funded stations (116 days) and in self-funded stations (48 days). Thus, under current institutional practices, the agents in fully funded stations spent more time in the office, but about the same time on delivering AES as compared to agents in partially funded stations.

Whether a county had implemented the “three rights” reform also affected the time allocation of its township agents. Our survey found that township-level extension agents in counties where the “three rights” reform had been implemented spent 71 days on delivering AES, 25 days fewer than the township agents in counties that had

not implemented the "three rights" reform (see Table 4). Agents at stations that had implemented the reforms spent more time on commercial activities and on private activities (other).

Government investment in agricultural extension includes the OB (core funding), PG, and capital construction (for buildings, instruments, etc.). The OBs are used for staff salaries, office expenses, extension activities, etc. The PGs are used for special technology extension activities. Table 4 suggests that government investment significantly affects agents' time allocation. When per capita OB and per capita PG increased, agents allocated more time to delivering AES and to the office, and less time to commercial activities. When per capita OB was less than 5,000 yuan, agents spent only 74 days on delivering AES and 95 days in the office, but 115 days on commercial activities. When per capita OB was more than 22,000 yuan, agents spent 98 days on delivering AES and 166 days in the office, but only 2 days on commercial activities. It should be noted that when per capita OB increased from 5000 RMB yuan to 22,000 RMB yuan, the time agents spent on delivering AES increased only 7 percentage points (from 20% to 26%). The time spent on commercial activities decreased 32 percentage points (from 32% to less than 0.5%), but the time in the office increased 19 percentage points (from 26% to 46%). Thus, under the current institutional practices, increasing government investment cannot effectively stimulate agents to spend more time delivering AES. It mainly inducesed agents to shift from commercial activities to office work.

The same pattern can be seen in the per capita PG. Of the 1245 extension staff we surveyed, 953 worked at stations with no PG, and these agents spent 77 days delivering AES, 137 days in the office and 60 days on commercial activities. When per capita PG was more than 5,000 yuan, agents spent 100 days on delivering AES, 142 days in the office, and 22 days on commercial activities. As with the OB, raising PG decreases the time spent on commercial activities, but raising PG may be more effective at directing the time savings toward AES, as opposed to additional time in the office.

To access the true effects, we estimated as a cross-sectional[3] tobit (Tobin 1958) model to examine the determinants of the agent's time allocation. The estimation results show that the model generally performed well in explaining agent time allocation (Table 5). The estimations have a relatively high explanatory power, with pseudo-R^2 values of 0.49, reasonably high for cross-sectional data (bottom row). Most of the signs on the estimated coefficients of the control variables representing personal characteristics are as expected. For example, when an agent's specialization does not match his training, he spends less time delivering AES (Row 20, Table 5). Likewise, higher levels of education level and seniority are associated with greater AES delivery (Rows 9-12, Table 5).

[3] A difference-in-difference analysis with panel data is not possible because there was very little variation in time allocation in the 1980's before the reforms. According to a survey the authors conducted at other extension stations in the 1980's, agents spent almost all of their time providing AES.

Most importantly, the coefficients on both government investment variables, per capita OB and per capita PG, are positive (Rows 1 and 2, Table 5). This means that when the government increases its investment in PAES, it stimulates the agents to spend more time delivering AES. However, the magnitude of this impact is small. The coefficient on per capita OB is statistically significant at the 5% level, but the estimated value is only 0.2 (Row 1, Table 5). This means that, controlling for other factors, each 1,000 RMB increase in per capita annual OB will prompt agents to increase their time spent delivering AES by only 0.2% (0.7 days per year). Even at the upper limit of the 95% confidence interval on this coefficient, agents increase their time spent on AES by only 1.3 days annually for every 1000 RMB annual increase in per capita OB. The small magnitude of this coefficient is not a result of attenuation bias; although there may be measurement error in the number of days agents spent on AES, the independent variable is derived from administrative records and not subject to meaningful levels of measurement error.

Thus, under the current institutional practices, government increases in operating investment in PAES are effective, but their impact is very limited. The coefficient on per capita PG is even smaller and not statistically significant, with a small confidence interval around zero (Row 2, Table 5). The results suggest that, under current institutional arrangements, increasing extension project investment will not substantially increase the time agents spend delivering AES.

The coefficients on township-level agricultural agent and “three rights” management reform dummy variables are not statistically significant (Rows 3 and 4, Table 5). This indicates that, controlling for other factors, the time that the agents spend delivering AES is about the same at the township and county levels, and appears to have been little affected by the “three rights” management reform.

The most notable results of the analysis are revealed by the coefficients on the type of government funding (Rows 5 and 6, Table 5). Compared to those at fully funded government stations, controlling for other factors, agents at partially funded government stations or self-funded stations spent less time delivering AES—7.5% (27 days) and 13.5% (49 days) respectively. We see that the PAES commercial reforms significantly reduced the time that agents spent on delivering AES.

Because the above results rely on cross-sectional data, they are subject to the possibility of selection bias, since many of the same unobserved variables are likely to be the underlying factors that explain differences in budgets, institutions, and personnel characteristics. To address this concern, we ran a placebo test by including 1996 funding levels in the regression. If current funding is simply a proxy for unobserved fixed station characteristics, the coefficient on past funding should be similar to that on current funding, and including both variables in the same regression might make both coefficients insignificant due to multicollinearity. Similarly, if past funding is a proxy for unobservable past station characteristics that go into determining present institutions and agent characteristics, past funding

would be expected to have a significant correlation with the time that agents currently spend providing AES. In fact, however, the coefficients on past funding are insignificant, with a small confidence interval around zero, and including past funding in our regressions has no meaningful effect on other coefficients of interest.

3.2 Pilot reform to Improve public extension function

As an attempt to make the extension agents in public sector to spend more their time to work on the AES to farmer, led by the state organization commission (SOC), National Development and Reform Commission (NDRC), Ministry of Finance (MOF), Ministry of Human Resources (MHR), Ministry of Science and Technology (MOST) and Ministry of Agriculture (MOA) launched a nationwide pilot reform in 2003. The pilot reform covered 12 counties in 12 provinces. The reform requires selection of the most suitable format to establish the national extension institutions at the township level, based on local agriculture development and specialty (Huang et al., 2009). Closely-linked extension agencies were merged to form the integrated extension service stations. The extension personnel were optimized by separating the public and non-public functions and by adopting competing mechanism for staffing. All of these have been done to increase local fiscal revenues and improve extension efficiency.

Different reform strategies were adopted across counties, and showing varying effects. Among the 12 counties, the three rights (personnel right, financial right and property right) were shifted upwards to the country level agricultural bureaus in 6 counties, and 4 counties have established agricultural extension regional stations, and 6 counties established integrated service stations. According to our comprehensive survey covering 35 counties and 7 provinces in 2006, among all the pilots, the 4 counties with regional stations have the highest time allocation of extension staff which averages 109 days per year, 32 days higher than non-reform counties. Whether the three rights are shifted or not does not make a difference in terms of time allocation of extension staff. From our recent survey, we also find that the reforms dominated by creating 'regional stations' involve expansion of service areas and higher costs of extension staff, and in addition, it is more suitable for certain production and ecological zones. We also find that in all the pilot reforms the deep-rooted issue of top-down decision making was not resolved, and thus not meeting the diversified needs of farm households.

Based on the experience of the pilot reform, Opinions of the State Council on Deepening Reform and Strengthening the Building of Agricultural Technology Extension System at the Grassroots Level (Guo Fa [2006] No. 30) was promulgated by the State Council. The document requested to push deepening reforms for its PAES nationwide. Although this document clearly defines the public function of extension agencies and pledges increased funding and support in the future, the reforms are currently in the predicament. The finance department holds that there will not be much effect from reforms to increase revenues and efficiency, while the departments

being reformed complain about the debts from previous rounds of reforms and the cost of reform has been too high. Unless there is a huge amount of funding available, any further reforms would be very difficult.

3.3 Inclusive public agricultural extension system reform

3.3.1 Design and Implementation of Inclusive Extension Policy

The authors, cooperated with the National Agricultural Technology Extension Service Center of the Ministry of Agriculture designed and implemented a pilot inclusive public agricultural extension service reform program (called the INC initiative). The program randomly selected technicians to participate in the reform. The selected technicians (responsible agents or RAs) were required to provide extension services to farmers in certain randomly selected villages for which they were responsible (responsible villages or RVs) any time when the farmers need their services. Each RA's responsibility covered a wide range of agricultural extension services, including plant protection; fertilizer use; technology related to seed, irrigation, machinery, and farm management; marketing information; and so on.

The main objective of the INC initiative reform was to encourage RAs from township extension stations to take a more proactive role in meeting the diverse agricultural extension needs of small-scale farmers (Hu et al. 2006, Chen and Shi 2008). One of the main features of the INC initiative was the use of various approaches to identify farmers' extension service needs. The Rapid Rural Assessment (RRA) approach is a participatory method used to identify farmers' technology needs (Hu et al. 2007). During an RRA workshop in the RV, 20 randomly selected farm families completed a workbook that tracked their production practice problems, technology needs, and challenges. Another 20 randomly selected individual farmers in each RV completed a survey of their agricultural production activities. Based on the results from the RRA workshop and the survey, the farmers' technology problems and needs for agricultural extension services were identified. The RAs for each RV constructed a plan for solving these identified problems and providing necessary services to the farmers. This plan was also one of the basic indicators for assessing each RA's performance at the end of each year.

To ensure that the RAs worked toward meeting the farmers' diversified needs for extension services, the INC initiative included an accountability system. First, the RAs were required to provide services to all farmers in their respective RVs. The contact information of the RA was displayed on a banner in the village. Second, the INC initiative included a monitoring and evaluation component. The RA's performance was assessed by an evaluation team that consisted of the pilot project leader and local government officials. The key performance indicators were the RA's door-to-door services for all farmers in his or her RVs, summed up as these "3A indicators": availability, whether the farmers in the RV saw the RA in the past year;

acceptance, whether the farmers in the RV accepted any service from the RA in the past year; and adoption, whether the farmers in the RV adopted the technologies provided by the RA in the past year. In accordance with this assessment, each RA was eligible to receive a bonus of up to CNY 4,000 a year.

The INC initiative reform programs were initially introduced in Pengzhou city (a county-level city) in Sichuan province and Wuchuan county in Inner Mongolia Autonomous Region (IMAR) in 2005. In each county, 5 villages were randomly selected initially in 2005 as pilot RV sites, an additional 5 villages were randomly selected and added to the program in 2006, and 5 more villages were randomly selected and added in 2007. By 2007, then, 15 villages in each county were participating. Five technicians at the township level were also randomly selected as the RAs in each county. As a result, each technician (RA) was responsible for 3 villages (RVs) by 2007.

At the end of each year, a team made up of project members and local officials evaluated each RA. The team interviewed 20 randomly selected farmers in each RV and used the 3A indicators to assess the RA's performance. Based on the survey results and other records, such as farmers' feedback, the evaluation team determined each RA's bonus.

After its successful implementation of the INC reform initiative in the two pilot counties, the Pengzhou government and the Ministry of Agriculture (MOA) initiated similar reform programs with a few modifications as described below.

3.3.2 Pengzhou Government Reform Initiative

Based on the pilot INC initiative, the Pengzhou initiative was introduced in 2006 by the city government. The initiative covered 9 villages in one township in 2006 (villages not involved in the INC pilotprogram) and then expanded to 130 villages, with 65 township agricultural extension technicians participating, in 2007. Each technician was responsible for 2 villages. However, the extension agents were responsible for identifying the farmers' needs based on their own individual informal survey, rather than through RRA as under the INC initiative. Although the agents were also required to provide public agricultural extension services to all farmers in the RVs, the target group was farmers selected for technology demonstration purposes. The maximum year-end bonus was CNY 3,000, as opposed to the CNY 4,000 in the INC initiative.

3.3.3 MOA Pixian and Kalaqin Programs

MOA introduced a similar policy initiative to 25 counties from 25 provinces in 2006 and 2007. By 2009, more than 300 counties had implemented the reform. This study selected two MOA reform pilot sites, Pixian county in Sichuan province and Kalaqin

Qi (a county-level city) in IMAR, to study the impacts of the reform. These two counties both started the reform in 2006. While Pixian implemented the reform program in 2006, Kalaqin implemented in 2007. Unlike the INC initiative and the Pengzhou initiative, MOA's reform program covered all extension staff and all villages in the county. Both Kalaqin and Pixian used service contracts with the extension agents and provided public agricultural extension services to the selected farmers.

The MOA reform differed from the INC initiative in several ways. First, an attempt was made to include the county-level extension agents in the reform initiative. Separate service contracts were designed for the county- and township-level extension agents with the MOA initiative. They were required to work together to provide door-to-door technology services to pilot villages. Second, farmers' technology needs were identified through a questionnaire rather than the RRA method. The results of the questionnaire were incorporated into the services provided by the agents. Third, while the MOA reform also provided services to all farmers, the target group was the model farmers selected for technology demonstration purposes. Fourth, local government provided extra operational funds to encourage agricultural extension agents to go to the villages. In Pixian, for example, an operational fund in the amount of CNY 5,000 per year was provided for each responsible agent. Fifth, extension agents were assessed jointly by their work units and the selected farmers. The performance assessment was linked to agents' promotion.

4. Effects of inclusive public agricultural extension system reform

4.1 Sampling, Data Collection, and Description

In order to examine the effects of INC reform initiatives, we conducted a farmer survey. Because the INC initiative covered 5 RVs in each county in 2005, 10 in 2006, and 15 in 2007, we chose to study all participating RVs for each year of the INC initiative. From the villages that participated in the Pengzhou government's reform initiative, we randomly selected 9 in 2006 and 15 in 2007 for treatment in this study. We also randomly selected 15 reform villages from two counties that were involved in the MOA reform.

For control villages, we randomly selected 15 non-reform villages from each INC county. Because the Pengzhou government reform initiative was also implemented in one of the two INC initiative counties, we use the same control villages for both initiatives that took place in Pengzhou. In the MOA reform initiative counties, Pixian and Kalaqin, all county villages were involved in the reform. Therefore we selected the two neighboring counties (Doujiangyan in Sichuan and Songshan in IMAR) as non-reform or control counties.

From each village (both treatment and control), 10 households were randomly selected to be included in the survey from a list provided by the village leaders. A

survey questionnaire was designed to collect information on the farmers' access to technology services during the years 2005 to 2007. A team of four trained enumerators conducted a random survey in IMAR and Sichuan at the end of 2007 and the beginning of 2008. The sample includes 421 households in 2005, 914 households in 2006, and 1,395 households in 2007.

Backgrounds of studied areas, extension agents' income, and agents' service coverage are presented in Tables 5 and 6. On average, each village has about 400–900 households (column 3, Table 6), which is typical in the studied provinces. All farms are small. Average farm size (measured as arable land per household) ranged from 0.16 to 0.41 hectare in Sichuan in 2007 (last column, Table 6). Although per-household land was larger in IMAR, it was still close to 2.5 hectares in Wuchuan, 0.38 hectare in Kalaqin, and 1.19 hectare in Songshan. The annual basic incomes (without year-end bonus) of the agents ranged from CNY 16,280 (about US$2,400) to CNY 26,420 (about US$3,900) (column 1, Table 7). The variation reflected the differences of local economic situations. Because of variations in the sizes of villages, the responsible number of households per agent also differed among locations (last column, Table 7).

The changes in agricultural extension services are measured by 3A indicators. Availability is measured as the percentage of farmers in the village who saw the RA in the past year. It measures whether or not the reform initiative created more chances for farmers to access the agricultural extension services. Acceptance is represented by two indicators, the percentage of farmers who received the services provided by the RA and the average number of services each farmer received from the RA in the past year. These two indicators measure the efficiency of the reform initiative. Higher efficiency would be indicated if more farmers received services and they received them more frequently. Similarly, adoption is also measured by two indicators, the percentage of farmers in the villages who adopted the RA's services and the average number of services each farmer adopted from the RA in the past year. These two indicators measure the quality of the services. More farmers adopting the services and each farmer adopting more services would indicate that the agent's services met farmers' demand.

Table 8 shows the summary results of the changes in agricultural extension services received by farmers in the reform and non-reform villages. Results indicate that more farmers in each reform village had seen the RAs over the course of a year and had accepted and adopted the RAs' services than in the control villages. For the INC reform initiative, the percentages of farmers who saw extension agents were 91.0 percent and 84.0 percent in Wuchuan and Pengzhou respectively, which were 71.5 percent and 47.4 percent points higher than those who saw their agents in the non-reform villages in the two counties (Wuchuan 19.5 percent and Pengzhou 36.6 percent). In the Pengzhou reform initiative, 68.3 percent of farmers saw the RAs, which was 31.7 percent points higher than in the non-reform villages in the county (36.6 percent). The percentages of farmers who saw the RAs in the MOA reform

initiative were 89.7 percent and 43.4 percent in Kalaqin and Pixian respectively, which were 21.8 percent and 16.4 percent points higher than those in the two control, non-reform villages in Songshan and Doujiangyan (67.9 percent and 27.0 percent).

All reform initiatives increased the chances of farmers' receiving services from the RAs. The percentages of farmers who received services from the RAs in the INC reform initiative were 84.2 percent and 79.0 percent in Wuchuan and Pengzhou respectively, which were much higher than those in the non-reform villages in the same two counties (18.8 percent and 34.6 percent). Similarly, the average numbers of services received per farmer in the INC reform initiative were 1.82 and 2.30 in Wuchuan and Pengzhou respectively, in both instances much higher than in the non-reform villages in the same two counties (0.22 and 0.76). The percentage of farmers receiving services and the number of services received in the Pengzhou local government reform initiative were 57.2 percent and 1.28. These were 22.6 percent and 0.52 more than in the non-reform villages in the county (34.6 percent and 0.76 respectively). On average, percentages of farmers who received services in the MOA reform initiative in Kalaqin and Pixian were 84.5 percent and 36.1 percent, while they were only 64.2 percent and 25.0 percent in the two control, non-reform counties (Songshan and Doujiangyan). Similarly, farmers in the MOA reform initiative in Kalaqin and Pixian received an average of 2.57 and 0.6 services, compared with 1.56 and 0.39 services in the control, non-reform villages in Songshan and Doujiangyan.

All reform initiatives also induced adoption of more agricultural technologies introduced by the RAs. For example, on average, 80.1 percent and 74.3 percent farmers in the INC reform initiative in Wuchuan and Pengzhou adopted the new technologies provided by the RAs. These were 62.2 percent and 40.7 percent points higher than in the non-reform villages in the same two counties (17.9 percent and 35.6 percent). Farmers in the INC reform initiative villages adopted an average of 1.66 (Wuchuan) and 1.93 (Pengzhou) new technologies, while these numbers in the non-reform villages in the same two counties were only 0.22 and 0.73. Similar results were also found for the Pengzhou local government reform and the MOA reform initiative in Kalaqin and Pixian, though their observed impacts were smaller than those found in the INC reform initiative villages.

4.2 Model and estimation

To assess the effectiveness of public extension reforms in China, we used the 3A indicators with the five measures discussed above. The model below is designed to control for the effects of farmer characteristics and allow meaningful comparisons between the effects of different reform initiatives:

$$A_{ijkt} = \alpha_0 + (\beta_0 + \beta_i R_{ikt}) D_j + \gamma X_{ijkt} + \varepsilon_{ijkt} \quad , \tag{1}$$

where A_{ijkt} is the effectiveness indicator variable for the kth farmer in the ith village (i = 1 or 2, indicating reform or non-reform village) in year t; D_j indicates the jth reform initiative: (1) INC initiative, (2) Pengzhou government initiative, or (3) MOA's initiative. R_i is the reform experiment dummy, where $R_i = 0$ is the comparison and $R_i = 1$ is the experiment; X is a vector of the characteristics of farmers and households. Y_t is the year dummy and ε_{ijkt} is the error term. The difference between β_j and β_0 is the effect of the reform i.

Five reform scenarios are included in the model specification of equation (1). These are (1) the INC initiative in Wuchuan, IMAR, and its comparison; (2) the INC initiative and (3) the Pengzhou local government reform initiative in Pengzhou, Sichuan, and their comparison; (4) the MOA reform initiative in Kalaqin, IMAR, and its comparison in Songshan; and (5) the MOA reform initiative in Pixian, Sichuan, and its comparison in Doujiangyan. To avoid the problem of colinearity, a non-reform scenario—Wuchuan, IMAR—is used as a control variable while estimating the model.

Household characteristic variables and year dummies are selected as control variables. Household characteristic variables include characteristics of both the household head and the household. Household head characteristics include age (AGE), years of education (EDU), and off-farm working days (OFFFARM). Household characteristics include whether there is a village cadre in the household (CADRE), household size (HSIZE), proportion of off-farm labor force (LABOR), residential area (HRSIZE), and arable land (LAND). Because the starting years of different reform initiatives are different, we control the starting year while estimating the model. The year dummies are 2005, 2006, and 2007, with 2005 used as the control.

The probit model (Maddala 1983) and zero-inflated Poisson (ZIP) model (Cameron and Trivedi 1996; Cragg 1971; Greene 2002) are used to estimate equation (1). The probit model is used for dependent variables with a 0-1 indicator, the ZIP model for dependent variables with a discrete indicator.

4.3 The Estimation Results

The estimates of the probit model and the marginal effects (Maddala 1983; Greene 2002) are presented in Table 9, and the estimates of the ZIP model (Cameron and Trivedi 1996; Greene 2002) are presented in Table 10. Most coefficients are statistically significant at the 1 percent level, and their signs are as expected. For example, the coefficients of LAND are not statistically different from zero in all models estimated, which implies that the reform programs are size-neutral and therefore inclusive. The coefficients of AGE are not significant in the three probit models, but they are significantly negative in the two ZIP models. This indicates that the services provided by the RAs are the same for farmers with different ages. Compared to younger farmers, older farmers accepted services less often and

adopted fewer new technologies. The positive sign of the coefficient for EDU in the probit model indicates that the higher the educational level of farmers, the more willing they were to accept the services and adopt the technologies that the agents supplied. However, coefficients for EDU in the two ZIP models are not significant. The positive coefficients of HRSIZE in all five models indicate that the larger a farmer's house, the more likely that farmer is to receive and adopt agricultural services. A possible explanation is that a family with a larger house typically is more wealthy and influential. Not only could those wealthier households be more likely to attract more attention from the extension agents, but they may also express more desire for agricultural services. The positive coefficients for variable CADRE indicate that a family with one or more cadres was more likely to receive services from the extension agents and to adopt the new technologies. It is not unusual for a family with a village cadre to be the contact point for the extension agent in the village. The negative coefficient of OFFFARM is expected. It indicates that the more a household head works off farm, the less likely he or she is to get in touch with the extension agent and the fewer chances he or she has to accept and adopt services.

All coefficients of the reform initiatives and non-reform comparisons are statistically significant at the level of 1 percent with the exception of the coefficient of variable Doujiangyan (Tables 9 and 10). Because the impacts are the differences between the coefficients of each policy initiative variable and its control, non-reform variable, Wald tests were conducted (rows 20–23, Tables 9 and 10). These tests show that, compared with the control scenarios, all policy initiatives have significant positive effects on farmers' access to the RAs, likelihood of receiving the RAs' services, and likelihood of adopting the services, after controlling for farmers' characteristics. The impacts of the reform initiatives on access to, acceptance of, and adoption of extension services are presented below.

4.3.1 Impacts of the Reform Initiatives on Availability

The estimated results show that the reform initiatives had significant impacts on availability of the RAs' services to farmers (columns 1 and 4, Table 9). Farmers from the villages with the INC reform initiative in Wuchuan (compared to non-reform, control villages in the same county) were 54 percent more likely to have seen the RAs (row 1, column 4). Pengzhou farmers in the INC reform initiative were also 31 percent more likely to have seen the RAs (50 percent versus 19 percent in the control villages, rows 2 and 3). The impacts of the Pengzhou Government and MOA initiatives were also statistically significant, but the impacts were lower than those found for the INC initiative. For example, farmers in Pengzhou under the Pengzhou government initiative increased their chances to have seen the RAs by 22 percent (41 percent - 19 percent in the control villages, rows 4 and 2), and farmers in IMAR and Sichuan under MOA's initiative increased theirs by only 11 percent (48 percent - 37 percent, rows 6 and 5) and 17 percent (22 percent - 5 percent, rows 8 and 7). These results may reflect differences in efforts and designs among the three initiatives. The greater impact observed in the INC initiative may also be partially due to the pilot

INC initiative receiving more attention than the subsequent scale-up in the Pengzhou government and MOA initiatives.

4.3.2 Impacts of the Reform Initiatives on Acceptance

The estimation results show that the reform initiatives had significant impacts on farmers' acceptance of the agents' services (columns 2 and 5, Table 9; column 1, Table 10). Farmers from the villages with the INC reform initiative in Wuchuan were 56 percent more likely to receive the RA's services relative to the farmers from the control villages (column 5 row 1, Table 9). Farmers from the villages with the INC reform initiative in Wuchuan received services provided by the RAs 1.59 more times per year than did farmers in the control villages (column 1 row 1, Table 10). Farmers from the villages with the INC reform initiative in Pengzhou were 34 percent more likely to receive the agents' services (53 percent - 19 percent, column 5 rows 2 and 3, Table 9), and also received the services more frequently (1.93 times per year as opposed to 1.47 times per year for the control villages, column 1 rows 2 and 3, Table 10).

Similar to the effects of the reform initiatives on farmers' access to the services, the results of Wald tests (rows 22 and 23, column 5, Table 9; rows 22 and 23, column 1, Table 10) show that the reform initiatives also had significant impacts on the farmers' acceptance of services in the Pengzhou government and MOA initiatives (column 5, Table 9; column 1, Table 10). Compared with farmers from non-reform, control villages in Pengzhou, under the Pengzhou government initiative 18 percent more farmers received the RA's services (37 percent - 19 percent, Table 9). They also received services from the RAs about 0.11 (1.58 - 1.47) more times per year. Similar findings are also found in the MOA initiative in Kalaqin and Pixian.

4.3.3 Impacts of the Reform Initiatives on Adoption

The estimation results show that there were also significant impacts on farmers' adoption of technologies offered by the RAs (columns 3 and 6, Table 9; column 2, Table 10). Compared with farmers in the non-reform, control villages in Wuchuan, farmers in the villages with the INC reform initiative in Wuchuan were 56 percent more likely to adopt the agent's services (column 6 row 1, Table 9). They also adopted new technologies from the RA's services 1.37 more times per year than did the farmers in the control villages (row 1, Table 10). Consistent with the findings on service availability and acceptance, we also found that the impact of the INC reform initiative on adoption in Pengzhou was smaller than in Wuchuan. The Wald tests (row 21, column 6, Table 9; row 21, column 2, Table 10) indicate that the INC initiative had significant impacts on farmers' adoption of new services provided by the RAs in Pengzhou; the impact was 32 percent (52 percent-20 percent, Table 9) in percentage of farmers adopting the RA's services and 0.34 (1.64 - 1.30, Table 10) in number of services adopted. While the impacts on adoption were also smaller in the Pengzhou government and MOA initiatives, they were still significant. For example, in Kalaqin, 14 percent (53 percent - 39 percent) more farmers from the MOA initiatives adopted

the RA's services than farmers from control, non-reform county of Songshan. The farmers in Kalaqin also adopted new technologies from the RAs 0.18 more times per year (1.66 - 1.48) than farmers in the control, non-reform county, Songshan.

5. Conclusions and policy implications

The public agricultural extension system has contributed greatly to China's agricultural production growth during 1980s. The government has established inclusive agricultural extension service system in China. The system distributes in each township, even in the most robust township. The system had provided very good service to farmers.

However, the proliferation of the system has made the PAES became overstaffed and for that has created a financial burden for local governments. To overcome the financial burden problem, the government conducted a series of reform in the mid-late 1980s. The reform permits the PAES to earn their own income through commercial activities. The reform did not only make the extension agents reduce their service to farmers. It also made farmers input more pesticides, fertilizers and expensive seeds.

The Chinese government carried out another type of PAES reform at the end of the 1990s. The reform shifted the administrative rights from county agricultural bureaus to township governments. However, the reform cut the links between the county agricultural extension stations and the township agricultural extension stations that makes the agents increased their time on administration and reduced the time providing AES.

To overcome these problems, the authors designed and implemented a pilot inclusive public agricultural extension service reform program - INC initiative. The pilot reform has been adopted by MOA and Pengzhou city governments. The purpose of the INC initiative reform was to encourage RAs from township extension stations to take a more proactive role in meeting the diverse agricultural extension needs of small-scale farmers.

This paper examined the impacts of the recent reform initiatives to promote inclusive public agricultural extension services in rural China. Two major findings for the reforms are reached. First, the introduction of all reform initiatives increased the availability and acceptance of public agricultural extension services for all farmers, and farmers actually adopted more public extension services in the reform villages than in the non-reform villages. Second, the farmers under the initial pilot inclusive reform initiative were more likely to receive, accept, and adopt the agricultural extension services than those under later reform initiatives that used some of the major components of the initial pilot reform.

There are four distinctive features of these reform initiatives: the inclusiveness of all

farmers as targets for public extension service, a systematic approach to identifying local farmers' needs for extension services, accountability of the extension agents for providing services, and incentives provided to the extension agents for their services. Targeting all farmers for the public extension services and taking a systematic approach to identifying the farmers' needs are necessary conditions for inclusive public extension because these features made the service providers (extension agents) understand better what services farmers actually demand. These are not, however, sufficient conditions for a successful inclusive extension reform. Accountability through the extension agent's commitment (or promise) and incentives based on a well-designed annual evaluation method are also critically important in the reform initiatives studied in this paper.

The results of the study have several policy implications. First, China should continue its current agricultural extension reform by scaling up the pilot initiatives to the rest of the country. While China's top-down agricultural extension system played an important role in its agricultural development under the planned economy and in the early reform period of the 1980s, the traditional top-down extension model can hardly meet diversified demand for agricultural extension services by millions of small farmers.

Second, it should be recognized that a shift from a top-down to a bottom-up approach is challenging and requires strong political commitment from the local government. It is common sense that attention from leaders and extension agents during the pilot reform period often diminishes during the scale-up period. Our analyses provide some indirect evidence of this phenomenon: The impacts of the initial, pilot inclusive reform in Wuchuan and Pengzhou were much larger than those in other counties where the reform was implemented on a larger scale.

Third, reform requires substantial effort in improving the human capital of extension staff (agents). As mentioned earlier, in the introduction and problem statements, many township-level extension organizations have either disappeared or ceased to function well. Hiring new extension staff and improving their skill for inclusive public extension service should be carefully considered when reform is implemented.

Finally, reform requires substantial investment. While this study does not examine the cost of the reform initiatives, which is also one major limitation of the study, providing an incentive (monetary bonus) and maintaining a large public extension system are not without cost.

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Table 1. Distribution of extension agents in China, 1996-2006

Year	Total	By administrative level			By specialization				
		Above county[a]	County level	Township level	Crops	Livestock	Agricultural machinery	Aquatic products	Agricultural economics
Number of extension agents (1000 persons)									
1996	1025	69	375	581	421	332	139	24	109
1997	1013	66	378	570	417	312	161	30	94
1998	1058	60	358	640	407	338	183	34	95
1999	1035	65	356	614	411	329	168	33	94
2000	1013	71	353	589	415	320	153	32	92
2001	981	72	350	560	412	316	134	32	88
2002	934	68	343	523	401	299	119	30	84
2003	881	68	330	482	362	301	111	29	78
2004	832	66	320	446	345	292	95	29	72
2005	843	74	332	437	333	294	106	32	78
2006	788	73	318	397	326	266	97	28	70

[a] Above county level refers to prefectural, provincial, or national level agricultural extension units and agents.

Source: Ministry of Agriculture.

Source: Hu et al., 2009

Table 2. Per-capita budget for agricultural extension units, 2002

	Yuan/agent/year			%		
	Mean	Township	County	Mean	Township	County
Budget item						
Total	14,304	9,416	16,496	100	100	100
Government funds	11,197	6,136	13,467	78	65	82
Operating budget	8,990	4,871	10,837	63	52	66
Project grants	2,031	1,111	2,443	14	12	15
Other	176	154	186	1	2	1
Commercial	3,107	3,280	3,029	22	35	18

Source: Hu et al. 2009

Table 3. Time allocation of agricultural extension agents by personal characteristics, 2002

	Obs.	By working days per year					By percentage (%)				
		Office	AES delivery	Comm. work	Other	Total	Office	AES delivery	Comm. work	Other	Total
Overall	1245	135	81	56	92	365	37	22	15	25	100
Employment status											
Senior staff	84	138	107	29	90	365	38	29	8	25	100
Mid-level staff	424	129	94	50	92	365	35	26	14	25	100
Junior and other	737	139	71	63	93	365	38	19	17	25	100
Academic credentials											
BS and above	192	138	95	34	97	365	38	26	9	27	100
2 or 3 years Technical College	464	143	86	41	95	365	39	24	11	26	100
Secondary Specialized School and below	589	128	73	75	88	365	35	20	21	24	100
Position											
ESC leader	86	168	88	18	91	365	46	24	5	25	100
Station leader	488	130	95	57	82	365	36	26	16	22	100
Other	671	135	70	60	100	365	37	19	16	27	100

n=1245; random sampling standard error=1.4 percentage points or 5 days, larger for sub-groups. Percentages may not add to 100 due to rounding.
Source: Hu et al. 2009

Table 4. Time allocation for agricultural agents by institution and public investment, 2002 [a]

	Obs.	By actual working days					By percentage (%)				
		Office	AES delivery	Comm. work	Other	Total	Office	AES delivery	Comm. work	Other	Total
Overall	1245	135	81	56	92	365	37	22	15	25	100
Administrative level											
County	770	136	86	39	103	365	37	24	11	28	100
Township	475	134	73	83	75	365	37	20	23	21	100
Government funding											
Fully funded	823	160	85	25	96	365	44	23	7	26	100
Partially funded	244	116	87	64	97	365	32	24	18	27	100
Self funded	178	48	58	190	70	365	13	16	52	19	100
"Three rights" managed by											
County government	33	133	96	77	59	365	36	26	21	16	100
Township government	442	134	71	83	76	365	37	19	23	21	100
Government investment for operational budget (per capita OB: 1000 Yuan / year) [b]											
per capita OB<=5	369	95	74	115	80	365	26	20	32	22	100
5<per capita OB<=9	278	146	83	36	99	365	40	23	10	27	100
9<per capita OB<=22	543	154	84	31	96	365	42	23	9	26	100
per capita OB>22	55	166	98	2	100	365	45	27	0	27	100
Government investment for extension projects (per capita PG: 1000 Yuan / year) [c]											
per capita PG=0	953	137	77	60	91	365	38	21	16	25	100
0<per capita PG<=1.4	97	125	92	60	87	365	34	25	17	24	100
1.4<per capita PG<=5.0	98	126	91	43	105	365	35	25	12	29	100
per capita PG>5.0	97	142	100	22	101	365	39	27	6	28	100

a. Government investment includes the OB (core funding), PG, and capital construction funds (including buildings, instruments, and other). The OB is used for staff salaries, office expenses, extension activities, etc. Any capital construction or cash-basis retirement-related expenses are excluded from this paper.

b. The average per capita OB for the 1245 extension staff sampled was 9313 *Yuan* in 2002.

c. The average per capita PG for the 1245 extension staff sampled was 2040 *Yuan* in 2002.n=1245; random sampling standard error=1.4 percentage points or 5 days, larger for sub-groups. Percentages may not add to 100 due to rounding.

Source: Hu et al. 2009

Table 5. Tobit estimation of the agent time allocation model

Dependent variable: % of days spent providing AES	Model I		Model II	
	Coefficient	t value	Coefficient	t value
Government investment				
per capita OB 1996 (1000 RMB / person)			0.04	0.41
per capita PG 1996 (1000 RMB / person)			0.01	0.16
per capita OB 2002 (1000 RMB / person)	0.19**	2.39	0.18**	2.03
per capita PG 2002 (1000 RMB / person)	0.08	1.27	0.07	1.00
Institutional structure and reform				
Administrative level (county-level = 0):				
Township-level	-1.04	-0.23	-0.94	-0.21
"Three rights reform" (no reform = 0)	-0.33	-0.07	-0.46	-0.10
Nature of government funding (fully funded = 0)				
Partially funded	-7.06***	-3.39	-7.00***	-3.36
Self funded	-12.61***	-4.83	-12.43***	-4.73
Agent personal characteristics				
Position (no managerial position = 0)				
ESC leader	1.67	0.58	1.65	0.57
Station leader	3.04*	1.92	3.04*	1.92
Employment status (Junior and other = 0)				
Senior staff	4.68	1.49	4.65	1.48
Mid-level staff	2.39	1.40	2.37	1.39
Education (secondary specialized school and below = 0)				
BS and above	4.12*	1.79	4.18*	1.81
2 or 3 years technical college	4.36***	2.60	4.41***	2.63
Working specialization (crop management=0)				
Plant protection	0.72	0.25	0.73	0.26
Horticulture	8.79***	2.61	8.81***	2.63
Soil fertility	-5.51	-1.45	-5.52	-1.46
Agricultural machinery	-14.61***	-6.23	-14.71***	-6.26
Animal husbandry	-7.19***	-3.38	-7.24***	-3.41
Agricultural economics	-11.80***	-4.07	-11.89***	-4.10
Other	-10.57***	-3.85	-10.64***	-3.86
Work specialization matches training (yes = 0)				
No	-3.73**	-2.23	-3.79**	-2.26
Years of employment	0.24*	1.91	0.24**	1.95
Female (male = 0)	-6.78***	-3.87	-6.72***	-3.82
Age	-0.05	-0.38	0.05	-0.38
Constant	28.60***	6.16	28.20***	6.01
Pseudo-R^2	0.486		0.497	
Number of observations	1245		1245	

Notes: The symbols, ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively. The model includes 7 provincial dummy variables to control for regional fixed effects; their estimated coefficients are omitted for brevity.

Table 6. Characteristics of the sample villages by reform initiative in 2007.

Type of reform initiative	Number of sample villages	Population per village	Average number of households per village	Arable land per village (hectares)	Average arable land per household (hectares)
INC reform initiative and control, non-reform comparison villages					
Wuchuan, IMAR					
INC initiative (reform villages)	15	1,722	431	1,119	2.54
Non-reform (control villages)	15	1,597	435	1,075	2.46
Pengzhou, Sichuan					
INC initiative (reform villages)	15	1,978	653	110	0.17
Non-reform (control villages)	15	2,637	830	132	0.16
Pengzhou government initiative, MOA reform, and control, non-reform comparison villages					
Pengzhou, Sichuan: *Pengzhou initiative*	15	2,077	654	117	0.17
MOA reform initiative					
Reform county: Kalaqin, IMAR	15	2,289	584	237	0.38
Control, non-reform county: Songshan, IMAR	15	3,350	861	789	1.19
Reform county: Pixian, Sichuan	15	2,419	765	170	0.22
Control, non-reform county: Doujiangyan, Sichuan	15	2,136	654	200	0.41

Source: Authors' survey.

Table 7. Extension agents' income and their responsible land and households in 2007.

Type of reform initiative	Agent's annual income (CNY)	Responsible arable land per agent (thousand hectares)	Responsible sown area per agent (thousand hectares)	Responsible number of farmer households per agent (thousands)
INC reform initiative and control, non-reform comparison villages				
Wuchuan, IMAR				
INC initiative (reform villages)	21,550	3.07	2.87	1.53
Non-reform (control villages)	16,280	0.56	0.54	0.33
Pengzhou, Sichuan				
INC initiative (reform villages)	26,420	0.31	0.72	1.42
Non-reform (control villages)	21,660	0.39	1.25	3.52
Pengzhou government initiative, MOA reform, and control, non-reform comparison villages				
Pengzhou, Sichuan: *Pengzhou initiative*	21,970	0.29	0.73	1.56
MOA reform initiative				
Reform county: Kalaqin, IMAR	20,120	0.41	0.37	0.84
Control, non-reform county: Songshan, IMAR	21,030	1.62	1.55	1.60
Reform county: Pixian, Sichuan	24,680	0.37	0.62	1.52
Control, non-reform county: Doujiangyan, Sichuan	24,600	0.08	0.21	0.62

Source: Authors' survey.
Note: The data for the INC and Pengzhou initiatives are based on the pilot villages; for MOA they are the countywide averages.

Table 8. Services received and number of techniques adopted by farmers per year 2005–2007.

Type of reform initiative	Availability: Saw the agents (%)	Acceptance: Services received		Adoption: Techniques adopted	
		Percent (%)	Number	Percent (%)	Number
INC reform initiative and control, non-reform comparison villages					
Wuchuan, IMAR					
INC initiative (reform villages)	91.0	84.2	1.82	80.1	1.66
Non-reform (control villages)	19.5	18.8	0.22	17.9	0.22
Pengzhou, Sichuan					
INC initiative (reform villages)	84.0	79.0	2.30	74.3	1.93
Non-reform (control villages)	36.6	34.6	0.76	35.6	0.73
Pengzhou government initiative, MOA reform, and control, non-reform comparison villages					
Pengzhou, Sichuan: *Pengzhou initiative*	68.3	57.2	1.28	56.8	1.23
MOA reform initiative					
Reform county: Kalaqin, IMAR	89.7	84.5	2.57	83.2	2.25
Control, non-reform county: Songshan, IMAR	67.9	64.2	1.56	63.0	1.50
Reform county: Pixian, Sichuan	43.4	36.1	0.60	35.1	0.46
Control, non-reform county: Doujiangyan, Sichuan	27.0	25.0	0.39	22.7	0.33

Source: Authors' survey.

Table 9. Estimates of probit model on farmers' access, acceptance, and adoption of services per year, 2005-2007.

Type of reform initiative	Original model			Marginal effects		
	Availability: Saw agents	Acceptance: Accepted agents' services	Adoption: Adopted agents' services	Availability: Saw agents	Acceptance: Accepted agents' services	Adoption: Adopted agents' services
INC reform initiative						
Reform villages -Wuchuan, IMAR	2.28	1.94	1.81	0.54	0.56	0.56
	(18.48)**	(17.47)**	(16.82)**			
Control, non-reform villages- Pengzhou, Sichuan	0.49	0.50	0.52	0.19	0.19	0.20
	(4.11)**	(4.16)**	(4.33)**			
Reform villages - Pengzhou, Sichuan	1.89	1.74	1.62	0.50	0.53	0.52
	(13.79)**	(13.13)**	(12.50)**			
Pengzhou local government reform initiative						
Pengzhou local reform initiative - Pengzhou, Sichuan	1.32	1.05	1.09	0.41	0.37	0.39
	(9.54)**	(7.75)**	(8.04)**			
MOA reform initiative						
Control, non-reform county - Songshan (comp. to Kalaqin), IMAR	1.15	1.09	1.09	0.37	0.38	0.39
	(8.08)**	(7.75)**	(7.83)**			
Reform county - Kalaqin, IMAR	2.03	1.80	1.79	0.48	0.51	0.53
	(11.52)**	(11.04)**	(11.16)**			
Control, non-reform county - Doujiangyan (comp. to Pixian), Sichuan	0.13	0.12	0.08	0.05	0.05	0.03
	(0.96)	(0.89)	(0.58)			
Reform county - Pixian, Sichuan	0.60	0.45	0.48	0.22	0.18	0.19
	(4.58)**	(3.45)**	(3.67)**			
Farmer characteristics variables						
AGE (years)	0.00	0.00	0.00	0.00	0.00	0.00
	(0.66)	(0.43)	(0.32)			
EDU (years)	0.07	0.06	0.06	0.03	0.03	0.03
	(7.01)**	(6.24)**	(6.20)**			
OFFFARM (100 days)	-0.09	-0.07	-0.07	-0.04	-0.03	-0.03
	(2.90)**	(2.26)*	(2.20)*			
CADRE (Yes = 1， No = 0)	0.67	0.69	0.61	0.25	0.26	0.24
	(6.63)**	(7.16)**	(6.55)**			
HSIZE (persons)	0.03	0.02	0.02	0.01	0.01	0.01
	(1.24)	(0.67)	(0.65)			
LABOR (%)	0.00	0.00	0.00	0.00	0.00	0.00
	(0.47)	(0.59)	(1.00)			
HRSIZE (100 square meters)	0.12	0.10	0.10	0.05	0.04	0.04
	(2.81)**	(2.39)*	(2.51)*			
LAND (hectares)	-0.03	-0.02	-0.01	-0.01	-0.01	-0.00
	(1.41)	(0.84)	(0.39)			
Year dummies (2005 = 0):						
2007	0.21	0.25	0.25	0.08	0.10	0.10
	(2.35)*	(2.82)**	(2.83)**			
2006	0.05	0.07	0.06	0.02	0.03	0.02
	(0.59)	(0.78)	(0.62)			
Constants	-1.81	-1.71	-1.75			
Wald test (χ^2) between the parameters						
INC reform Pengzhou vs CK	229**	206**	184**	227**	206**	184**
Pengzhou local reform vs CK	98**	61**	66**	98**	61**	66**
MOA reform Kalaqin vs CK (Songshan)	147**	133**	135**	147**	133**	135**
MOA reform Pixian vs CK (Doujiangyan)	27**	15**	18**	27**	15**	18**

Source: Authors' calculations.

Notes: 1) Values in parentheses are z-ratios; 2) * and ** represent levels of significance at 5% and 1% respectively; 3) CK stands for control group (non-reform); 4) Total observations are 2,730.

Table 10. Estimates of ZIP model on farmer's acceptance and adoption of the agents' agricultural technology services per year, 2005–2007.

	Number–acceptance: Times farmers accepted the services	Number–adoption: Number of services adopted per farmer
INC reform initiative		
Reform villages - Wuchuan, IMAR	1.59	1.37
	(8.94)**	(7.03)**
Control, non-reform villages -Pengzhou, Sichuan	1.47	1.30
	(7.43)**	(6.24)**
Reform villages - Pengzhou, Sichuan	1.93	1.64
	(10.05)**	(8.01)**
Pengzhou local government reform initiative		
Pengzhou local reform initiative -at Pengzhou, Sichuan	1.58	1.37
	(7.89)**	(6.43)**
MOA reform initiative		
Control, non-reform county -at Songshan (comp. to Kalaqin), IMAR	1.66	1.48
	(8.43)**	(7.07)**
Reform county - Kalaqin, IMAR	1.95	1.66
	(10.06)**	(8.03)**
Control, non-reform county - Doujiangyan (comp. to Pixian), Sichuan	0.87	0.54
	(3.65)**	(2.08)*
Reform county - Pixian, Sichuan	0.99	0.18
	(4.59)**	(0.76)
Farmer characteristics variables		
AGE (years)	-0.01	-0.01
	(2.85)**	(2.77)**
EDU (years)	-0.00	0.01
	(0.27)	(0.68)
OFFFARM (100 days)	-0.05	-0.03
	(2.14)*	(1.23)
CADRE (Yes = 1， No = 0)	0.16	0.18
	(2.76)**	(2.94)**
HSIZE (persons)	0.01	-0.01
	(0.45)	(0.40)
LABOR (%)	0.00	0.00
	(0.97)	(2.65)**
HRSIZE (100 square meters)	0.06	0.06
	(2.07)*	(1.71)
LAND (hectares)	-0.02	-0.01
	(0.82)	(0.35)
Year dummies (2005 = 0):		
2007	0.04	0.09
	(0.48)	(1.05)
2006	0.01	0.04
	(0.08)	(0.43)
Constants	-0.68	-0.60
Wald test (χ^2) between the parameters		
INC reform Pengzhou vs CK	323**	226**
Pengzhou local reform vs CK	132**	101**
MOA reform Kalaqin vs CK (Songshan)	235**	167**
MOA reform Pixian vs CK (Doujiangyan)	44**	16*

Source: Authors' calculations.

Note: 1) Values in parentheses are z-ratios; 2) * and ** represent levels of significance at 5 percent and 1 percent respectively; 3) CK stands for control group (non-reform); 4) Total observations are 2,730.

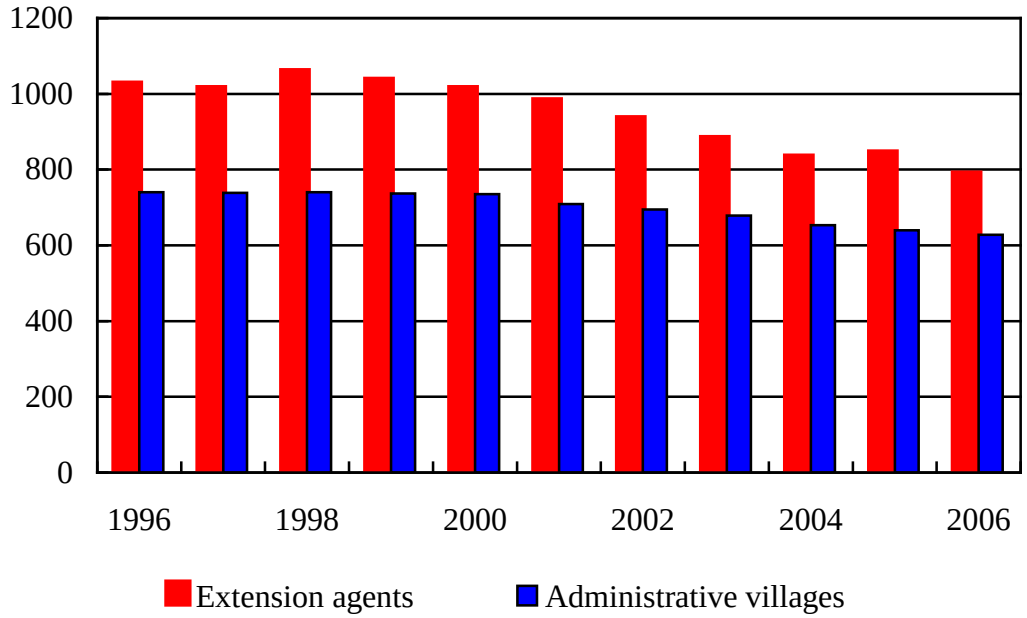

Figure 1. The number of public agricultural extension agents (1,000 persons) and administrative villages (1,000 villages) in China, 1996-2006

Source: Minstry of Agriculture, China