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Different incentives, similar choices: Farmer autonomy and targeting in China's Sloping Land Conversion Program

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Abstract: This paper examines the determinants of enrollment at the parcel level in China's Sloping Land Conversion Program (SLCP). The SLCP, which bears similarities to the Conservation Reserve Program in the United States, pays farmers to plant trees on highly erodible cropland, and has effected major land use changes in western China over the past decade. With 15 million households, it represents by far the largest payments for environmental services program worldwide, and implementation varies considerably from one village to another. Although SLCP is important both environmentally and socio-economically, economists have an incomplete understanding of how land is chosen for enrollment, and even whether the program is *de facto* mandatory. This paper uses a household dataset collected by the author's collaborators in Shaanxi Province, which contains detailed parcel and household information on 3397 pieces of land from program inception in 1998 until 2006. On some parcels, farmers made the decision of whether to enroll, while on other parcels the local government decided for them. The paper finds no evidence that farmers place more weight on productivity relative to ecological factors. Instead, farmers place more weight on land characteristics relative to other land on the same farm, and also consider education and other household characteristics. Farmers and local governments differ at least as much in their frame of reference, the scale within the landscape to which land under consideration is compared, as in the weights that they place on different criteria of suitability for enrollment.

1. Introduction

Payments for environmental service schemes, such as the Conservation Reserve Program (CRP) in the United States, Sloping Land Conversion Program (SLCP) in China, and various policies in Latin America, aim to provide market incentives for land conservation. While such programs have the potential to both provide environmental amenities and support farm income, the extent to which they actually supply environmental amenities depends on the degree to which they are targeted towards cost-effective conservation measures in environmentally sensitive areas. An untargeted conservation program could become merely a supply management program, not a conservation program at all.

In principle, targeting could be based on either administratively selecting land, allowing farmers to select land, or a combination, which is the case for SLCP. This paper addresses the following related questions: What factors determine the decisions of local governments of whether to give farmers a choice about enrollment? What factors determine enrollment decisions by farmers when they do have a choice? And how do enrollment decisions made by farmers compare to those made by the local government?

Whether farmer, local government, or a combination of decision-makers is socially optimal in payments for environmental services is not self-evident from theory. Wu et al. (2001) find that a strategy that targets land with the highest benefit-cost ratio provides the largest environmental benefits for a fixed budget if output demand is perfectly elastic. If output demand is not perfectly elastic, output effects must be considered. However, SLCP probably has small output effects. Uchida and Rozelle (2006) and Feng et al. (2005), using different data sources and methodologies, both find that because of the low quality of land enrolled in SLCP both production and price impacts are small. Thus an optimally targeted SLCP program, with no administrative costs, would simply target the land with the highest benefit-cost ratio.

The CRP, which solicits competitive bids for points calculated according to an environmental benefits index, uses such benefit-cost targeting (Claassen et al. 2008). Both bidding and the use of an environmental benefits index can increase cost-effectiveness, but the administrative costs of both approaches would probably be prohibitive for a program such as SLCP, and the current program is far from using such a finely targeted enrollment procedure. There are only two subsidy payment levels for SLCP, one for the northern half of the country (and of the sample used in this paper), and another, 50% higher, for the southern half. In SLCP, steeper and less productive land is more likely to be enrolled, but exactly what criteria are most important, and even whether farmers or local government officials are making the decisions, can vary from one location to another and can be less transparent than the process used in the United States.

This paper derives criteria that farmers are expected to use in their decision-making, and criteria that local governments are expected to use. The resulting hypotheses are tested using a Heckman selection model, in which in the first stage the local government decides whether to make enrollment mandatory on a particular piece of land, and in the second stage the farmer decides whether to enroll where enrollment is voluntary.

Studies of enrollment decisions for payments-for-environmental-services

A number of studies of both the CRP and SLCP have attempted to quantify the factors that go into making enrollment decisions. Brimlow (2009) notes that in various studies land quality, land productivity, and landowner characteristics all affect the probability of enrollment in the CRP, but that the effects are not consistent across studies. In the United States, the effects of different factors can be difficult to identify because payment rates are highly correlated with, and determined by, land characteristics. Chang and Boisvert (2009) take a different approach, modeling whole-farm and partial-farm enrollment as separate binary decisions. This approach is probably not applicable to SLCP because few farmers enroll their entire farm in SLCP (in principle, none are supposed to), and because many decisions are made by local officials based on contiguous areas rather than the scattered parcels of individual households.

Uchida et al. (2005) provides the most detailed discussion of factors that go into making enrollment decisions in SLCP. They find that slope is the most statistically significant predictor of SLCP enrollment, significant at the 1% level, and that yields and distance from the farmer's house are also significant at the 5 or 10% level, depending on the specification. Proximity to a road may increase the likelihood of enrollment, because of the ease of monitoring, but the effect is not statistically significant. (This paper does not consider the distance to the nearest road because of the insignificant effects in other studies and difficulty in defining what constitutes the nearest dirt road.) They find that the quality of targeting varies by region, whether looking at slope or at yields, as measured by the proportions of less-suitable land enrolled and more-suitable land not enrolled[1].

Chen et al. (2009) and Cao et al. (2009) discuss factors that farmers consider in hypothetical decision about whether to convert land back to cropland after subsidies end. The State Forestry Administration (SFA) has extended subsidies beyond the original 5-8 year contracts, and given the political economy of farm subsidies, they may remain in place indefinitely. Hypothetically, subsidies are important to farmers in the program relative to environmental factors, and 23-37% would re-convert their land if they were to end. The probability of re-conversion declines with age and income, and increases with the number of farm laborers in the household and with household land holdings. Distance and slope are unrelated to hypothetical re-conversion decisions.

None of the studies discussed above distinguish decisions that were made by farmers from those that were made by local officials, who could have different objectives. To some extent, the objectives of local officials reflect those of farmers, especially with respect to agriculture. Rozelle and Boisvert (1994) find that village leaders in China are motivated by personal gain and a desire for independence to pursue industrial development, but also attempt to promote village welfare and maintain agricultural productivity. But local officials are also subject to top-down mandates and informational asymmetries. With 15 million households each enrolling an average of more than one tiny parcel, it is impossible for a local official to consider all of the land and household characteristics that might factor into a farmer's decision.

[1] Slope is the most important environmental factor in the region studied in this paper. Slope is less relevant in northern China where desertification is a more important issue than water erosion (Wang et al. 2007), but the study region has sufficient precipitation that water erosion is more relevant than desertification.

Institutional context

The SLCP is, in principle, a voluntary program similar to the CRP. However, in China there is no private ownership of farmland, and executive departments have substantial leeway in writing and implementing regulations, meaning that participation is in practice mandatory for many farmers. (For example, the National Forestry Law and SLCP Ordinance are only approximately 3500 words each, much shorter than the Farm Bill in the United States.) And courts rarely accept cases of farmers attempting to sue a local government. Although farmers have often limited autonomy in determining whether to participate in SLCP, most participants in the sample say that they are better off as a result of participating. Some farmers say they are worse off, but others say they would like to enroll even larger areas than they have.

During China's rural de-collectivization of the early 1980's, villages distributed usufructrory rights to farmland to households for terms of several decades, and have routinely extended these rights to 30-50 years. Most of these land rights were granted in exchange for fulfilling state grain procurement quotas, on so-called responsibility land. Now, grain procurement quotas have been phased out, and farmers are essentially renting land from the village under long-term contracts at a rental rate of zero. Smaller areas of land are rented from the village for cash (contract land), allocated to farmers in exchange for making it suitable for agriculture (cleared wasteland), or subleased among farmers (less than 1% of the land in this study). Farmers generally make agricultural production decisions as though they own the land (Jacoby et al. 2002), but do not have the authority to change the land use, and often receive only the agricultural value of land as compensation when their land is appropriated for public uses or urban development.

SLCP in many ways resembles a mandatory program controlled by forestry and township officials, and is in many respects unpredictable from the perspective of farmers or even lower-level officials. Farmers in China do not have land ownership rights, and until very recently, farming was taxed rather than subsidized. SLCP is arguably not only China's first ostensibly voluntary farm subsidy program, but also its first large-scale farm subsidy program of any kind. As in many other Chinese government programs, executive-branch implementation is crucial. The program is administered by many levels of bureaucracy down to the township government and village levels, and its authorizing regulations are written in general terms that afford minimal legislative or judicial authority.

Steps in program implementation

In consultation with village leaders, and sometimes with farmers, individual township officials write an annual reforestation plan, which they submit to the county office of the SFA. From there, the plan makes its way to the provincial forestry administration, to the national SFA, and finally to the State Council, China's cabinet, for final approval. Each level tends to approve only a portion of the land area proposed by the level below it, as in a typical budgeting process. After the plan receives final approval, enrollment quotas are allocated back down the administrative hierarchy. Administrative costs were very high; many townships spent a majority of their staff time administering the program in its early years. Each year, especially in the early years of the program, each level of government has had little or no idea of whether it will receive an enrollment quota. Because of rising grain prices and budgetary uncertainty, many local officials have complained that they could not predict even whether the program would continue on a large scale at a national level.

Farmers in villages eligible for the program attend required village meetings in which village officials explain the program and how it is implemented in their area. At the meetings, the farmers are told which pieces of land they must enroll, which they may not enroll, and which they can choose whether or not to enroll. The path of least resistance for the farmer is to follow the local government's plan to enroll certain areas and not others. Those farmers who enroll sign a contract with the SFA or another designated local government unit, and agree to plant trees on land that has been rented from or allocated by the village. Appendix 1 contains an English translation of one version of the contract, from northern China. In southern China, subsidy payment rates are exactly 50% higher per hectare, but there are no other substantive differences in the contract. The details of the implementation vary with the type of trees planted, and the program has gone from an in-kind grain subsidy to a cash subsidy[2]. The contract states that land is to remain enrolled indefinitely even though subsidies are for only 5-8 years (not including finite extensions)[3]. In the sampled villages at the time of the survey, there existed no procedure for un-enrolling a plot once enrolled. The program was designed with the hope that farmers would voluntarily substitute non-farm employment and/or high-value crops as income sources to replace their lost pre-enrollment grain production income.

Survey design

To better understand targeting and other aspects of the program, the author's collaborators from the Northwest Sci-Tech University of Agriculture and Forestry

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2 Upon enrollment, in the appropriate season, the SFA provides ecological-tree seedlings free of charge, or shares the cost of orchard seedlings with the farmer. In either case, the village trains farmers in planting the seedlings. In most villages, planting the trees is a required community undertaking, whereas taking care of the trees is the responsibility of the individual farmer. If the plots pass a series of inspections, the farmer receives an annual subsidy payment to compensate for the opportunity costs of retiring his grain-producing land. In the early years of the program, this payment was in kind in the form of grain; it later changed to a cash payment, but because grain markets are well developed farmers did not consider this a substantive change. Almost all plots enrolled eventually pass inspection; when tree survival rates are low, farmers are generally given new seedlings and their plots are declared passing as long as they make a good-faith effort to reforest the area by planting the new seedlings.

3 Payments last for 5-8 years, after which the farmer must either continue to keep the land enrolled for the remainder of his land-use contract (which is extended by the reforestation contract to 50 years), or pay an unspecified fine. (No farmer in the sample knew how much the fine would be for violating the land retirement contract, and only one had actually cut his trees and paid such a fine. The vast majority of farmers saw the contract as binding.) Although subsidies have been extended, both unofficially through local procedures to spread payments over time and now officially nationwide, they are still in principle for a finite period of time.

conducted a survey of 682 farmers in Shaanxi Province, representing 3397 parcels of land. Sampling was stratified according to the total land enrolled in SLCP for selecting villages, and random within villages. Most respondents had enrolled some but not all of their farms in SLCP. The questionnaire asked farmers about the alternatives they were offered, as well as the choices they made and the characteristics of their land and household. Farmers were asked to classify land into three main categories, based on the way in which local officials were actually implementing SLCP (not simply national regulations, under which all enrollment is voluntary): Land required to be enrolled in SLCP, land not allowed to be enrolled in SLCP, and land where the farmer had a choice of whether to enroll in SLCP. Most farmers reported that they farmed some plots where they could choose whether to enroll and others where they had no choice about whether to enroll[4].

2. Descriptive and reduced-form regression results

SLCP does not exactly target the steepest land for enrollment. As shown in Table 1, steep land is not necessarily enrolled in the program and flat land is sometimes enrolled. Among 3394 plots of land, 454 are flat or gently sloping but enrolled, while 431 are steep or very steep and not enrolled. Within particular villages, a substantial fraction of enrolled land is not as steep as some non-enrolled land, and a substantial fraction of non-enrolled land is steeper than other enrolled land in the village. (See Figure 1.) Within individual households, there is much less overlap than within villages, but some households did not enroll a piece of land steeper than one that they did enroll.

This section reports descriptive statistics and linear probability model regression results on all land in the sample, regardless of who was making decisions regarding its enrollment, and all households in the sample, regardless of whether they had any land enrolled in the program. (Because of the probability of selecting a village proportional to the amount of land enrolled, all sampled households were located in villages where substantial amounts of land were enrolled and virtually all households had land similar to enrolled land in the village.)

Land and crops

Tables 2 and 3 describe the land allocated to farmers in the dataset, whether or not the land is part of the program. Plots tend to be small (2/15 of a hectare) and are on average nearly 1 km from the farmer's house. Many plots are much steeper than would typically be cultivated in the United States, and most are on the side of a hill, with some in flat areas. (All else being equal, a plot near the bottom of a hill will have a higher erosion rate than one near the top of a hill.) Soil quality is relatively low, as reported by

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[4] Farmers said that they had a choice on about half of the total plots in the sample. On approximately ¼ of the plots, they reported that they were required to enroll, and the final ¼ were not eligible for enrollment. Farmers in the sample enrolled about 40% of their land, including 1/3 of the land on which they had a choice of whether to enroll. In most of the villages surveyed, farmers believed that they were required to participate, but that they could not enroll their entire farm.

the farmer, using an ordinal metric familiar to farmers in the sample. Although there are some paddies in the sampled region, most of the land in the sample, especially larger pieces of land and those that are enrolled, is not irrigated at all. Insolation is a function of the slope's exposure (with southern exposures having higher insolation than northern exposures) and steepness (see Appendix 2).

Before the program began, the most common cropping patterns for local farmland were maize in the summer with wheat in the winter and rice in the summer with rapeseed in the winter. Farmers had typically planted enrolled land to maize-wheat prior to enrollment[5]. Relative to current yields on plots that were not enrolled, yields of both maize and wheat prior to enrollment were substantially lower. For both winter and summer crops, yields were usually at least average in the year immediately prior to enrollment.

Villagers plant a wide variety of trees and shrubs on enrolled land as part of the program, more than one species in every sampled village and sometimes more than one species on the same plot of land. SFA regulations limit counties to planting economic (orchard) trees on no more than 30% of the enrolled area, with the remainder planted to ecological (forest) trees. In practice, however, most trees planted in the sample have potential economic value, but are suited to inferior land and might also be considered forest trees. For example, chestnut and walnut can be grown for either nuts or timber.

Land characteristics and enrollment

The factors that best predict whether land is enrolled in SLCP are slope and soil quality (see Table 4)[6]. Slope, soil quality, wheat yields (current for non-enrolled plots or prior to the program for enrolled plots), and distance from the farmer's house are all correlated with enrollment at the 1% level in unconditional linear probability regressions. The probability of plot enrollment rises from 15% for flat land to 88% for very steep land. Among plots with a history of growing wheat, an increase of one metric ton per hectare in wheat yields (compared to a mean of 3 tons per hectare) is associated with a 12 percentage point decrease in the probability of enrollment. An extra kilometer of distance from the farmer's house (about a doubling of the average distance) is associated with a 10 percentage point increase in the probability of enrollment. The probability of enrollment ranges from 15% on good soil to 58% on poor soil.

The effects of crop yields, distance, and soil quality are much less in a conditional than in an unconditional regression, but remain mostly statistically significant, even when accounting for clustering at the village or household levels. Higher insolation is associated with a lower probability of enrollment (i.e., for a given slope, a northern exposure is more likely enrolled than a southern exposure), but the effect is statistically significant at the 5% level in only one specification.

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5 The number of observations for crops is less than the total number of plots because plots that were in the fallow part of a rotation cycle as of the reporting time were coded as missing.

6 Table 5 does not include village dummy variables because the aim is to present a correlation between enrollment and the characteristics of land, not between enrollment and the characteristics of land relative to other land in the village, which is discussed further later in the paper.

Results in Table 4 remain significant when the standard errors are adjusted for household or village clustering. In fact, household clustering causes many standard errors to go down, which reflects the negative intra-cluster correlation. Under de-collectivization, each household was given a combination of higher and lower quality land.

Demographics

The demographics of the sample are roughly representative of rural China (see Table 5). The average household size in 1998 was approximately 4 individuals, often including older relatives. Anyone who lived in the household for at least 3 months during the year, or was an unmarried son or daughter of a household member whether or not the child lived in the village, was counted as part of the household. Land holdings were relatively small, averaging less than 1 hectare (15 *mu*) per household. However, only one household in the dataset had no land (all of its land was appropriated in 1999). On average, the head of the household had completed primary school, though 87 had no education and 4 had postsecondary education[7]. Among household members of all ages, 44% were identified as working on-farm in 1998, compared to 12% working off-farm. In many households, no one was identified as working on-farm because no one was doing farm work for more than a relatively small fraction of the year.

The average size of farmers' houses increased approximately 25% from 1998 to 2006, paralleling the growth of GDP in rural China[8]. Livestock holdings, in contrast, were little changed during the period at approximately one animal unit per household in both 1998 and 2006[9].

Household demographics and enrollment

Some household characteristics are correlated with whether land is enrolled in SLCP (see Tables 6-8). Because geography is the primary determinant of whether land is enrolled, all household specifications include village dummy variables[10].

In contrast to the findings of studies of the CRP (Sullivan et al. 2004), there is no evidence that the age of the household head predicts enrollment (see Table 6). Nor is there any evidence that household wealth (using the size of the house or the size adjusted for the number of household members before the program began as a proxy for wealth) is related to the probability of enrollment (Table 7). Household size and livestock holdings

[7] About 1% declined to state their education levels.

[8] In fewer than 1% of households was neither the household head nor the enumerator able to estimate the area of the house, largely for households that lived in caves.

[9] One animal unit is equivalent to one female beef cow, and animal unit coefficients range from 0.0025 for broilers to 1.9 for dairy bulls (Delaware Dept. of Agric. 2000). Households reported poultry only when the total number was at least 20. Most animal units in the dataset consist of swine, or of beef or work cattle. Because the survey asked about many different types of livestock and because the numbers of major livestock are usually zero or one, recall bias is likely to be small.

[10] Not including village dummy variables produces spurious correlations. For example, remote areas tend to have both more land suitable for enrollment and more traditional family structures.

(either of which could be related to household grain consumption) do not affect the probability of enrollment by a statistically significant margin. Because the sample size includes more than 3000 parcels, even a relatively small effect of one of these variables would be discernible, as can be seen from the statistical significance of the small effect of the number of household members working off-farm.

While more household members working off-farm and fewer working on-farm before the program began increase the probability of plot enrollment, the magnitudes are relatively small, only 1 or 2 percentage points per household member (Table 8). The size of the effect in part reflects the fact that local government officials, not farmers, make many enrollment decisions. More educated farmers are more likely to enroll a piece of land, but the coefficient is only significant at the 10% level in the pooled sample.

Larger land holdings at the household level are correlated with a higher probability of enrollment (Table 7), but this correlation likely does not represent a causal relationship. This correlation likely results from the way in which land was distributed during de-collectivization—to promote equity in distribution, households that received more land received lower-quality land. Controlling for land characteristics reduces the estimated coefficient on the size of household land holdings, and fully controlling for all unobserved measures of land quality would likely further reduce its magnitude. The coefficient on land area per household member, a variable that might be more likely to factor into household decision-making regarding continuing to produce grain than total land holdings, becomes insignificant when controlling for observed land quality

3. Decision-making and theory

The survey team asked both village leaders and farmers for perspectives on the factors by which enrollment decisions were made. Village leaders were asked to rank the importance of six factors in determining what land to enroll, with 1 being most important (see Table 9). The main factors they cited were slope and creating a contiguous parcel with other enrolled land. Low yields and distance were secondary factors. Among the minority of village leaders who cited allocating quotas to poor families in the village or allocating quotas to all families as factors, these factors were not considered as important as the land characteristics. Some village leaders said that the government used high erosion rates or a subjective assessment of the suitability for cultivation, but did not use any factors other than slope in predicting erosion and used slope and yields as proxies for the suitability for cultivation. Thus the table includes all underlying factors that the government considered, even for villages where the criteria were referred to in other ways.

This paper assumes that the local government represents a unified decision-maker because incentives do not differ in important respects between the different levels of local government involved. Although all levels of government are involved, from the village collective to the national level, most decisions about enrollment criteria are made at a local level. In the course of the survey, local officials were often surprised to learn that decisions were made in different ways in other nearby jurisdictions. Local governments did not merely implement central plans, but rather competed for enrollment quotas and developed their own specific enrollment criteria.

Enumerators asked farmers an open-ended question about why particular plots were selected for enrollment, and their responses are tabulated in Table 10. Among those who knew (at least 20% did not know because the program was often mandatory), the factors farmers most often cited as the most important were steep slopes, low yields, creating a contiguous area, and distance. Contiguous areas were created by local policy and by lack of tractor access to land surrounded by enrolled land. Some farmers gave vague answers, such as 'according to the policy', 'according to the example of others', or 'according to what land is not suited for growing grain'. Only 2 out of 499 respondents said that good land was selected for the program in order to plant orchards on it; the rest of the responses are all consistent with enrolling inferior land.

Both farmers and local officials play a role in determining which plots were enrolled. On 52% of the plots in the sample (1697 parcels), the farmer was either required to enroll or not allowed to enroll (see Table 11). On 45% of plots, the farmer reported having a choice regarding whether to enroll. The survey design accounted for the possibility that farmers might say that the program was voluntary when they meant that they were willing to participate, and included a response option to record this situation. On only 3% of plots did the respondent choose "don't know or agreed with government's plan and didn't ask [whether it was possible to deviate from the plan]". In most households, not all pieces of land had the same choice status—for example, one plot might be required to be enrolled, another optional, and another not allowed to be enrolled.

Where farmers had a choice about whether to enroll, the default option or path of least resistance was to enroll certain plots and not others. Most plots of land followed the default option set by the local government, which could reflect either the power of suggestion or farmers and local governments using similar criteria in their decision-making. Among plots where the farmer had a choice but the default was to enroll, 26% chose not to enroll. Among plots where the farmer had a choice but the default was to not enroll, only 8% enrolled. A total of 219 plots (6.8%) go against the default option provided by the government, including a handful of special situations[11].

A model of decision-making was developed from these qualitative responses to derive testable hypotheses. The two-stage analysis includes only land considered eligible for enrollment. Ineligible land includes paddies and certain other flat land, basic grain production land, areas already planted to tree cover, etc.

Derivation of hypotheses

Assume that farmers attempt to maximize profits subject to a concave production function, and that their objective function can be written as follows. For simplicity, land is divided in this model into equally sized parcels within which characteristics are uniform, and cultivating each parcel requires one unit of labor.

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[11] Seventy-four plots were required to be enrolled but not actually enrolled because the government made a plan but did not receive the budget necessary to implement the plan. On 8 pieces of land, a farmer planted orchard trees since the program began without enrolling in the program. All plots where a farmer continued to grow grain between the rows of trees while waiting for the trees to mature are counted as enrolled in the table.

$$\max E_i \; \forall_i \quad \pi = \Sigma(r_h - Y_i)E_i + w_h \Sigma E_i - (\Sigma E_i)^2 \qquad [1]$$

where E is the fraction of land of type i that is enrolled
r represents the subsidy rate
h represents a household
Y represents grain yield prior to retirement
w is the marginal wage rate for the household

The first term represents income associated with the land itself, the second term indicates time available for outside work associated with enrollment, and the third term represents the household's concave production function. Taking a derivative over the choice variable,

$$\delta\pi/\delta E_i = r_h - Y_i + w_h - 2\Sigma E_i \equiv 0 \qquad [2]$$

which implies that

$$E_i + \Sigma E_j = (r_h - Y_i + w_h)/2 \qquad [3]$$

where $j \neq i$.

Therefore,

$$E_i = (r_h - Y_i + w_h)/2 - \Sigma E_j \qquad [4]$$

At the optimum interior solution, the comparative statics are as follows:

$$\delta E_i/\delta Y_i = -0.5 < 0 \qquad [i]$$

$$\delta E_i / \delta Y_j = \delta E_i/\delta E_j * \delta E_j/\delta Y_j = (-1)(-0.5) = 0.5 > 0 \qquad [ii]$$

$$\delta E_i / \delta w_h = 0.5 > 0 \qquad [iii]$$

These comparative statics imply three hypotheses:

Hypothesis #1. Farmers are less likely to choose to enroll higher yielding plots relative to subsidy levels (i).

Hypothesis #2. Farmers are more likely to enroll a plot if other plots on the same farm are high yielding (ii).

Hypothesis #3. Farmers are more likely to enroll a plot if their outside wage is higher (iii).

The local government is assumed to maximize a utility function that includes protecting the environment while following program mandates not to enroll entire areas. Their objective function can be written as

$$\max_{E_i\ \forall_i}\ G = \Sigma C_i E_i \ \ (\Sigma E_i)^2$$

where C represents ecological benefits of enrollment.

Solving for the optimum and taking comparative statics as above shows that $\delta E_i/\delta C_i > 0$, which implies the final hypothesis.

Hypothesis #4. Local governments are more likely to make enrollment mandatory on plots where the ecological benefits of enrollment are larger.

Corollary to hypotheses 1-4: Farmers will put more weight on agronomic and demographic factors identified in hypotheses 1-3, and local governments will put more weight on ecological factors, in enrollment decisions.

4. Testing the hypotheses

The model is one of two-stage decision-making, the government's decision of whether to give the farmer a choice about enrollment and the farmer's decision of whether to enroll when a choice is available. With such two-stage decision-making, linear probability or other one-stage regression estimates of the second-stage farmer decision-making are likely subject to selection bias. For this reason, the hypotheses are tested using a Heckman probit 2-stage estimator, with controls for slope classifications, which explain many decisions by both farmers and government officials. (Linear probability model results without controls are also reported for ease of interpretation.)

In the Heckman probit model, the village mean of slope is used in the selection equation (village decision-making) but not in the farmer's decision-making equation in order to better identify the model. This exclusion is based in theory and supported by the linear probability model results. If a village leader enrolls the steepest land in the village subject to a quota on the amount of land that may be enrolled, less steep land in villages will be mandatory to enroll where the average slope is moderate than in villages where the average slope is steep. In contrast, there is no theoretical reason to expect village average slope to enter into farmer decision-making.

Heckman probit and linear probability results in Tables 12-15 have differing interpretations. Heckman probit results in Tables 12 and 15 represent elasticities, facilitating the comparison of the importance of different variables that may have different means or units. "Select" in Table 12 means that land is selected into the category in which farmers can choose whether to enroll, as opposed to mandatory to enroll. Therefore, a positive coefficient in a selection column means that land is *less* likely to be enrolled (because farmers will not necessarily decide to enroll it when given a choice). In contrast, a positive coefficient in the mandatory enrollment columns of the linear probability results in Tables 13 and 14 mean that a plot is *more* likely to be enrolled. The linear probability results also of course represent partial derivatives rather than elasticities.

Hypothesis #1

As shown in Table 12a and 13a column 6, higher wheat yields are significantly associated with a lower probability of enrollment among plots where farmers had a choice regarding whether to enroll, which is consistent with Hypothesis #1[12]. Similarly, farmers are more likely to choose to enroll land with lower soil quality (Tables 12b and 13b column 6). Soil quality appears to explain a greater proportion of the variance in enrollment, perhaps because it is a better measure of the long-term productivity of land than is the most recent wheat yield (which is missing for plots that did not grow wheat in the year before the survey or before enrollment). Farmers are also more likely to choose to enroll steep and distant plots (Tables 12c, 13c, 12d, and 13d column 6), which may reflect the higher costs of cultivating such land. Results are similar in a multivariate regression (see Appendix 3) suggesting that the costs of cultivation as well as yields, are important to farmers.

Hypothesis #2

As shown in Tables 12a and 13a column 5, the coefficient on the mean of household wheat yields is positive and highly significant. This is consistent with Hypothesis #2, as are the 5th columns of other sections of Tables 12 and 13. In Tables 12b and 13b, the higher the average soil quality for a household the more likely a plot is enrolled, and in Tables 13c and 13d, the higher the average slope and distance the less likely a plot is enrolled. In each of the four tables, the coefficient on the household mean is significant and of the opposite sign to the coefficient on the variable itself. The most likely plots to be enrolled are those that are suitable for enrollment and assigned to households whose other land is unsuitable. For example, controlling for the slope of the plot in question, the steeper the mean slope of the household’s land the less likely the plot is to be enrolled.

Hypothesis #3

Table 14 and 15 columns 7-12 are consistent with Hypothesis #3. Because wages prior to enrollment would be subject to significant recall bias, the analysis uses the proportion of family members working off-farm as a proxy for opportunity costs of time for household members. The more household members are working off-farm the more likely it is that a farmer will choose to enroll a plot. At the average household size of just over 4, an increase of one household member working off-farm increases the probability of enrollment by 3-4 percentage points. Similarly, the more educated the household head (another proxy for wages) the more likely the household is to choose enrollment on a particular plot. When farmers have a choice about whether to enroll, the probability of enrollment goes up by approximately one percentage point for every year of education of

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12 Running the analysis with the difference between wheat yields and subsidy rates gives very similar results (not shown). Because enrollment is limited by binding county quotas and subsidy rates do not vary within counties, subsidy rates do not determine how much land is enrolled. Thus they are not a major consideration for either farmers or government decision-makers regarding which parcels of land to enroll in the program.

the household head, compared to no effect of education when the decision is made for the farmer. In other words, farmers with more education are more likely to choose to shift away from growing grain. Although the coefficient on the proportion working on farm is not statistically significant, it is of the expected sign (those with more household members engaged in farming are less likely to enroll). The prevalence of multitasking on small farms introduces measurement error in the number of household members working on farm, likely reducing the significance of this coefficient.

Hypothesis #4

Tables 12c and 13c are consistent with Hypothesis #4. Local governments are more likely to require the enrollment of steep and very steep plots than flat or sloped plots.

5. Discussion of farmer versus local government decision-making

It is clear from Tables 12-15 that farmers and local governments differ in how they weight at least some factors in enrollment decisions. Although farmers usually follow the default plan, there are some significant differences between local government and farmer criteria. In Table 12c, terraces are more likely to be selected into farmer decision-making (less likely to be mandatory to enroll), but more likely to be chosen for enrollment by farmers. Similarly, in Table 13c, the coefficient on the dummy variable for terraces is significantly negative for government decisions but significantly positive for farmer decisions. Local governments generally do not require that terraces be enrolled, because terracing is already an erosion-control measure for steep slopes. But farmers often choose to enroll terraces because they are difficult to cultivate with modern machinery. In Table 14 and 15, the education of the household head and employment status of household members factor into farmer but not into government decisions.[13]

Because of multicollinearity and omitted variable bias, these correlations do not necessarily imply causation. To address this problem and gain additional insight into decision-making, a set of placebo tests were run on the data, comparing farmer to local government decision-making.

However, not all results are robust to placebo tests. Two types of placebo tests were run, running local government decision-making regressions on variables modeled as of importance to farmers (and vice versa), and including village mean variables for farmer decisions (and household mean variables for government decisions).

The coefficients on plot characteristics in general, and overall model fit, are higher for farmer-decision regressions than for government-decision regressions. Farmers appear to put more weight on all plot characteristics--not only those that might be expected to be of more relevance to farmers (e.g., wheat yields) but also slope, the primary ecological factor used in government decisions. This is perhaps because the farmer decisions are actually about enrollment whereas the government decisions are

[13] In Table 15 (though not in Table 14) the proportion of family members on the farm appears to increase the probability of a farmer being given a choice regarding enrollment but have no effect on the choices made by the farmer. This could reflect government officials making a greater effort to ask the opinions of those who are seen as dependent on, and engaged in, agricultural activities.

about who is going to decide, which could be related to unobserved social and institutional factors in addition to plot characteristics.

The results are mostly robust to placebo tests involving relative plot characteristics. Farmers put weight on the household mean slope but no significant weight on village mean slope, whereas government decision-makers put more weight on the village mean than on the household mean. For distance, farmers appear to consider only the household mean, while the government appears to consider neither the household nor the village means. Similarly for soil quality, farmers appear to consider the household mean (and put weight of the opposite sign on the village mean), while the government considers only the village mean. For wheat yields, farmers are more likely to enroll a plot if other land in the household is high yielding. In contrast, they are less likely to enroll a plot if other land in the village is high-yielding, which is perhaps a rational consideration of others' yields given the stochastic nature of yields on individual plots. Local governments appear to put less weight on relative yields both at the household and village levels.

6. Robustness and potential biases

Heterogeneity

The main results in this paper are pooled estimates of the average effects of land and household characteristics on enrollment. Effects might vary by location, given the mountainous nature of the study region and substantial heterogeneity in land characteristics, or by household demographics. The analysis was run separately for the northern and southern watersheds within the sample, and for richer and poorer farmers.[14]

Decision-making by region. When running the analysis separately for the northern and southern watersheds within the sample, lower sample sizes reduce the significance of the results, but the signs of coefficients are consistent between sub-samples. Results are somewhat more significant in the northern loess plateau than in the southern mountainous areas, where more heterogeneous geography may lead to larger measurement error.

Rich versus poor farmers. The sample was divided in half according to a proxy for farmer wealth, the size of the farmer's house in 1998 divided by the square root of the number of household members. All results were consistent between the two halves of the sample. The number of village cadres in the sample was too small to draw any conclusions about that subset of farmers.

Clustering. In addressing heterogeneity, an alternative method to subdividing the sample is to cluster the standard errors. Clustering the standard errors by village reduces the

[14] Subsample results for distinguishing north and south and rich from poor farmers were calculated using a linear probability model. Because farmer and government decision-making criteria are similar, a two-step selection model does not give useful results for subsamples. Running a Heckman probit on subsamples of the data results in a serious loss of efficiency, with few statistically significant coefficients and in some cases models that do not converge, especially in models with a larger number of variables.

significance of some results. Wheat yields and distance are no longer significant except relative to household and village means. In contrast, clustering by household increases the significance of the results because of negative within-cluster correlation in land characteristics.

Measurement error

Some of the variables used in the analysis are imprecise or even subjective, such as soil quality (good, medium, and poor). More precise measurements of such variables might help to measure the ecological benefits of the program, but would not likely be useful in modeling decision-making. For example, soil scientists model erosion as a function of rainfall, soil, slope position, cover, and practices as well as slope (Wischmeier and Smith 1960), but since both farmers and local governments used slope as the only predictor of erosion, incorporating such additional variables would not be useful in modeling their decision-making. In modeling local government decision-making, some variables may in fact be known to the econometrician with more precision than to the decision-maker.

The dependent variable of enrollment is measured essentially without error because no plots were un-enrolled. Therefore, a plot was enrolled if and only if it was enrolled as of the date of the survey. Thus while measurement error may increase standard errors, it will not lead to attenuation bias.

Recall bias

Because all data were collected in 2007 and some variables apply to time periods as early as 1999, there is a possibility of recall bias in some of the independent variables. Slopes, distances from the farmer's home, and soil quality do not change over time, and whether a family member was living outside of the village should be relatively easy to recall even for 8 years prior to the survey. Recall bias is probably most of concern for wheat yields prior to enrollment, which are also subject to stochastic risk. Although there is surely error in reported wheat yields, the results using other independent variables that do not change over time are similar to those for wheat yields.

Another method of addressing recall bias is to compare results from earlier periods, in which recall may be less accurate, to those from later periods, in which recall is likely to be more accurate. The analysis was run[15] as though plots enrolled after 2002 (the median in the sample) were not enrolled, measuring the factors that were used in earlier decisions. The effect of education is somewhat lower for earlier decisions, perhaps indicating that education has become more important for obtaining employment outside of agriculture, but no other major differences were noted. This suggests that decision-making processes did not change substantially over time, and that recall bias is not driving the results. (If the results were driven by recall bias one would expect a larger bias in earlier years.)

[15] Like the sub-sample analysis, the analysis of early enrollment decisions had to be run with the linear probability model because the Heckman probit model did not converge.

Endogeneity of choice status reporting

The way in which farmers reported choice statuses could be a function of the choices that were made by local governments. For example, if all decisions in a village were made by the government, a farmer might be more likely to inaccurately report that he had a choice on a particular piece of land if he agreed with the government's decision on that piece of land. Although relatively few farmers chose the survey option that they didn't bother to find out whether they had a choice, others may have misreported choice statuses based on whether they liked the government's decision.

The most obvious methods of addressing this problem have significant shortcomings. No instrumental variable that is correlated with choice status but not with bias in choice status reporting is available in the dataset. Asking local governments for administrative records of choice statuses cannot solve this problem because under national regulations and in written documents all enrollment is voluntary. Even if enumerators had made tape recordings of all discussions of enrollment procedures between farmers and the government, which was obviously impractical, there would still be an element of subjectivity in interpreting the tapes as to whether farmers had a choice on particular plots of land.

A comparison of earlier and later enrollment decisions, discussed under recall bias, partially addresses this potential problem. To the extent that bias in choice status reporting increases with the recall period, estimated coefficients would vary between earlier and later enrollments. They do not vary significantly, suggesting that any effect of endogenous choice status reporting is limited.

Aggregation of ordinal response choices

The variable soil quality takes the values of poor, medium, and good, which were assigned values of 1, 2, and 3. If the distance between poor soil and medium soil is not the same as the distance between medium soil and good soil, the average soil quality measure that was calculated at the household and village levels is invalid. To address this concern, regressions involving average soil quality were run separately with two methods of calculating average soil quality that assume upper and lower bounds on the relative distances between the ordinal categories. To form one bound, average soil quality is calculated as the percentage of good soil, which assumes that poor and medium soil are the same, while to calculate the other bound average soil quality is calculated as the percentage of poor soil, which assumes that medium and good soil are the same. The signs and significance of the results do not vary between the alternative specifications[16].

External validity

[16] The slope classifications reported in the survey may also appear ordinal, but actually correspond to equally spaced quantitative slope angles. Thus slope is an interval, not an ordinal, variable in the dataset, and averaging the slope classification codes yields valid variables.

The probability of selecting a village was proportional to the amount of land enrolled in that village, but the number of households interviewed in each village varied slightly due to scheduling, enumerator team experience, weather, and other factors. The arbitrary variation in sample size within villages could affect the external validity of the results. To address this problem, observations were weighted by the inverse of the number of households interviewed in each village. Weighted regressions produced almost identical results to unweighted regressions.

7. Discussion and conclusions

As a government intervention in land-use decisions on privately managed land, payments-for-environmental-services programs necessitate both government and farmer decisions. Large farms and thus moderate administrative costs form the basis for most payments-for-environmental-services programs to date. Under these conditions, offering variable subsidy rates based on environmental benefits and letting farmers choose whether to enroll, as with the environmental benefits index in the CRP, probably approaches an optimal solution. However, challenges arise when a country with small farms, such as China, introduces a payments-for-environmental-services program. Offering variable prices according to the environmental benefits of specific pieces of land becomes administratively impractical.

Without finely tuned price incentives, either the government, the farmer, or some combination of the two must decide exactly which pieces of land to enroll. While farmers possess more detailed information, they lack a price incentive to enroll land with the highest ecological benefits, leaving open the question of whether farmer or government decisions come closer to socially optimal. Previous studies have modeled predictors of enrollment in the CRP or farmer preferences under SLCP, or made black-box predictions of SLCP enrollment, but none have distinguished between the criteria used in farmer and government decisions.

This paper finds unexpected similarity between farmer and government criteria. Relative to the local government, farmers do not necessarily place more weight on agronomic criteria than ecological criteria in deciding which land to enroll. Enrolling steep plots promotes both the SFA's goal of controlling erosion and the farmer's goal of retiring land that is difficult to cultivate, especially with modern machinery. Enrolling low-yielding plots not only reduces opportunity costs for farmers but also helps local officials to meet grain production targets.

Empirically speaking, differences between farmer and government decisions in SLCP lie more in their frame of reference than in ecological versus economic criteria. Generally, villages with steep land on average will only consider the steepest land for enrollment. However, government decisions are not perfect--even where farmers perceive the program as mandatory, many villages have steep non-enrolled land and flat enrolled land, undermining the environmental benefits of the program. In contrast, farmers appear to consider land characteristics relative to other land in the same household, as opposed to other land in the same village. Farmers also consider non-farm income opportunities in calculating the opportunity cost of enrolling land in the program.

The results suggest that when administrative costs of price signals are prohibitive a synthesis of farmer and government input approaches an optimal solution. Government makes better decisions about which land to enroll within the landscape, whereas farmers make better decisions about which land to enroll within the farm.

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9. Tables

Table 1. Enrollment by slope

	No. Enrolled	No. Not enrolled	Pct. enrolled
Flat	163	964	14.46
Gentle slope	291	548	34.68
Steep slope	741	425	63.55
Very steep slope	39	6	86.67
Terraced	56	22	71.79
Total	1290	1965	39.63

Table 2. Categorical land characteristics

Variable	Obs	Proportion of plots	Proportion of area
Slope			
Flat	3342	0.36	0.22
Sloped	3342	0.25	0.24
Steep	3342	0.35	0.42
Very steep	3342	0.013	0.11
Terraced	3342	0.023	0.011
Hill position			
At or near top	3344	0.087	0.19
Side	3344	0.54	0.58
At or near bottom	3344	0.072	0.046
Flat area	3344	0.3	0.19
Soil quality			
Good	3394	0.17	0.12
Medium	3394	0.41	0.39
Poor	3394	0.42	0.49
Irrigation status			
Paddy	3397	0.039	0.015
Irrigated	3397	0.095	0.066
Non-irrigated	3397	0.87	0.92
Major trees planted on enrolled land			
Acacia	1264	0.17	0.28
Chestnut	1264	0.07	0.078
Prickly pear pepper	1264	0.17	0.069
Walnut	1264	0.13	0.086
Tea	1264	0.058	0.055
Major crops on non-enrolled land			
Wheat (winter)	1679	0.66	0.65
Rapeseed (winter)	1679	0.15	0.12
Maize (summer)	1427	0.73	0.72
Rice (summer)	1427	0.083	0.047
Major crops prior to enrollment			
Wheat (winter)	1057	0.74	0.77
Rapeseed (winter)	1057	0.067	0.06
Maize (summer)	857	0.79	0.79
Rice (summer)	857	0.0011	0.0014
Relative yields in year prior to enrollment			
Previous winter crop below average yield	1004	0.17	0.2
Previous winter crop average yield	1004	0.77	0.74
Previous winter crop above average yield	1004	0.058	0.052
Previous summer crop below average yield	880	0.15	0.15
Previous summer crop average yield	880	0.8	0.81
Previous summer crop above average yield	880	0.05	0.042
Land tenure arrangement			
Private vegetable plot	3391	0.013	0.0074
Responsibility land	3391	0.91	0.87
Contract land	3391	0.051	0.085
Cleared wasteland	3391	0.013	0.011

Table 3. Quantitative land characteristics

Table 3a. Quantitative land characteristics with plots equally weighted

Variable	Obs.	Mean	Std. Dev.	Min	Max
Area (ha)	3397	0.15	0.23	0.003	7.33
Distance from home (m)	3397	797.88	840.49	0	10000
Relative insolation	3332	1.01	0.16	0.55	1.4
Yields of major crops					
Current maize yield (MT/ha)	1063	3.4	1.66	0	7.5
Current wheat yield (MT/ha)	1109	3.36	1.19	0	8.25
Pre-enrollment maize yield (MT/ha)	720	3.06	1.37	0	7.5
Pre-enrollment wheat yield (MT/ha)	806	2.52	1.19	0.3	7.5

Table 3b. Quantitative land characteristics with plots weighted by size

Variable	Obs.	Mean	Std. Dev.	Min	Max
Area (ha)	3397	0.5	1	0.003	7.33
Distance from home (m)	3397	957.5	1156.1	0	10000
Relative insolation	3332	0.96	0.21	0.55	1.4
Yields of major crops					
Current maize yield (MT/ha)	1063	3.7	1.68	0	7.5
Current wheat yield (MT/ha)	1109	3.28	1.15	0	8.25
Pre-enrollment maize yield (MT/ha)	720	3.03	1.28	0	7.5
Pre-enrollment wheat yield (MT/ha)	806	2.29	1.18	0.3	7.5

Table 4. Effects of land characteristics on probability of enrollment [%]

	[1]	[2]	[3]	[4]	[5]	[6]	[7] village clusters	[8] household clusters
Sloped [0/1], Flat omitted	20.03					15.59	15.59	15.59
	[9.82]***					[6.12]***	[3.64]***	[3.94]***
Steep [0/1]	48.40					41.47	41.47	41.47
	[25.96]***					[15.12]***	[6.78]***	[10.16]***
Very steep [0/1]	73.48					51.87	51.87	51.87
	[10.85]***					[4.72]***	[4.54]***	[5.73]***
Terraced [0/1]	56.64					56.77	56.77	56.77
	[10.97]***					[9.12]***	[5.57]***	[5.51]***
Wheat yield in MT per ha		-12.4				-3.81	-3.81	-3.81
		[14.30]***				[4.37]***	[1.68]*	[2.41]**
Distance from home in km			10.68			3.43	3.43	3.43
			[10.70]***			[2.67]***	[1.15]	[2.17]**
Medium soil quality [0/1], Good soil omitted				13.05		2.96	2.96	2.96
				[5.49]***		[1.03]	[0.70]	[0.87]
Poor soil quality [0/1]				46.57		21.34	21.34	21.34
				[19.72]***		[6.68]***	[3.32]***	[4.33]***
Insolation ratio					-2.24	-13.66	-13.66	-13.66
					[0.42]	[2.06]**	[1.20]	[1.51]
Constant	15.15	79.37	32.15	15.34	42.68	35.37	35.37	35.37
	[11.25]***	[28.19]***	[27.50]***	[7.57]***	[7.79]***	[4.39]***	[2.42]**	[3.14]***
Observations	3184.00	1854.00	3236.00	3232.00	3177.00	1811.00	1811.00	1811.00
R-squared	0.20	0.10	0.03	0.15	0.00	0.31	0.31	0.31

** significant at 5%; *** significant at 1%

Robust t statistics in brackets
Absolute value of t statistics in brackets

Table 5. Household characteristics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Household size 1998	681	4.21	1.35	1	10
Land area (ha)	680	0.75	0.75	0	11.67
Land area per household member (ha)	680	0.19	0.22	0	3.89
House area 1998 (m2)	675	104.07	71.27	8	800
House area 2006 (m2)	675	130.47	95.94	8	800
Education of household head (years)	673	6.34	3.58	0	15
Age of household head (years)	678	49.78	11.06	28	81
Household members working on-farm (1998 proportion)	681	0.44	0.27	0	1
Household members working off-farm (1998 proportion)	681	0.12	0.18	0	1
Animal units 1998	680	1.11	1.58	0	13.75
Animal units 2006	680	1.14	1.43	0	9.25

Table 6. Effects of household demographics on probability of enrollment at the plot level (%)

	[1]	[2]	[3]	[4]	[5]	[6]
Number of household members	0.35			0.94		
	[0.56]			[1.74]*		
Education of household head [years]		0.34			0.35	
		[1.43]			[1.72]*	
Age of household head			-0.07			-0.11
			[0.93]			[1.51]
Sloped [0/1], Flat omitted				15.43	16.39	15.71
				[7.82]***	[8.28]***	[7.95]***
Steep [0/1]				43.6	44.4	43.57
				[20.92]***	[21.25]***	[20.85]***
Very steep [0/1]				57.21	59.22	58.92
				[9.15]***	[9.27]***	[9.20]***
Terraced [0/1]				39.77	39.81	39.72
				[8.48]***	[8.51]***	[8.47]***
Medium soil quality [0/1], Good soil omitted				9.36	8.77	9.16
				[4.38]***	[4.08]***	[4.27]***
Poor soil quality [0/1]				26.87	26.39	26.78
				[11.55]***	[11.28]***	[11.46]***
Constant	39.33	38.54	44.4	-0.74	0.76	8.48
	[14.08]***	[22.62]***	[10.95]***	[0.25]	[0.32]	[2.13]**
Observations	3240	3204	3222	3174	3138	3156
R-squared	0.19	0.19	0.19	0.4	0.41	0.4

Absolute value of t statistics in brackets ** significant at 5%; *** significant at 1%

All regressions in this table include a complete set of village dummy variables [coefficients not shown].

Except for the education of the household head, for which lagged values were not asked, all variables that change over time have been lagged to 1998 values

Table 7. Effects of household assets on probability of enrollment at the plot level (%)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Total household land holdings (ha)	4.95					3.45				
	[2.75]***					[2.20]**				
Land area/household member (ha)		13.5					6.15			
		[2.26]**					[1.18]			
House area in m2			0					0.02		
			[0.28]					[1.34]		
House area adjusted for household size				-0.01					0.01	
				[0.40]					[0.59]	
Animal units					0.67					0.48
					[1.25]					[1.03]
Sloped [0/1], Flat omitted						15.33	15.47	15.65	15.69	15.65
						[7.76]***	[7.84]***	[7.82]***	[7.84]***	[7.91]***
Steep [0/1]						43.33	43.43	43.88	43.82	43.65
						[20.77]***	[20.81]***	[20.67]***	[20.64]***	[20.87]***
Very steep [0/1]						55.2	55.73	57.05	57.08	56.76
						[8.77]***	[8.80]***	[9.08]***	[9.08]***	[9.07]***
Terraced [0/1]						39.75	39.66	39.59	39.7	39.42
						[8.48]***	[8.46]***	[8.41]***	[8.43]***	[8.39]***
Medium soil quality [0/1], Good soil omitted						9.49	9.55	9.51	9.48	9.55
						[4.44]***	[4.47]***	[4.39]***	[4.37]***	[4.45]***
Poor soil quality [0/1]						27.06	27	27.12	27.07	27
						[11.63]***	[11.59]***	[11.45]***	[11.43]***	[11.55]***
Constant	36.72	38.07	41.09	41.25	40.15	0.44	1.97	1.34	2.23	2.61
	[21.75]***	[26.21]***	[26.77]***	[27.06]***	[39.92]***	[0.19]	[0.89]	[0.58]	[0.98]	[1.30]
Observations	3240	3240	3160	3160	3225	3174	3174	3094	3094	3159
R-squared	0.19	0.19	0.18	0.18	0.19	0.4	0.4	0.4	0.4	0.4

Absolute value of t statistics in brackets ** significant at 5%; *** significant at 1%

All regressions in this table include a complete set of village dummy variables [coefficients not shown].

Except for the education of the household head, for which lagged values were not asked, all variables that change over time have been lagged to 1998 values

Table 8. Effects of household labor allocation on probability of enrollment at the plot level (%)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Number of household members working on-farm	-0.61				-0.82			
	[0.80]				[1.21]			
Number of household members working off-farm		4.26				2.08		
		[0.89]				[2.10]**		
Proportion of household members working on-farm			0.97				-5.58	
			[0.85]				[1.97]**	
Proportion of household members working off-farm				-1.75				9.42
				[0.54]				[2.27]**
Sloped [0/1], Flat omitted					15.52	15.5	15.51	15.46
					[7.87]***	[7.86]***	[7.87]***	[7.84]***
Steep [0/1]					43.57	43.66	43.69	43.58
					[20.91]***	[20.95]***	[20.96]***	[20.92]***
Very steep [0/1]					56.82	56.6	57.25	56.61
					[9.09]***	[9.06]***	[9.16]***	[9.06]***
Terraced [0/1]					40.04	38.76	40.54	38.42
					[8.50]***	[8.24]***	[8.60]***	[8.15]***
Medium soil quality [0/1], Good soil omitted					9.39	9.58	9.24	9.68
					[4.39]***	[4.48]***	[4.32]***	[4.53]***
Poor soil quality [0/1]					26.79	27.01	26.67	27.2
					[11.50]***	[11.61]***	[11.45]***	[11.67]***
Constant	41.97	40.35	40.37	41.61	4.83	2.16	5.85	2.01
	[25.82]***	[42.49]***	[42.32]***	[25.35]***	[2.08]**	[1.08]	[2.51]**	[1.01]
Observations	3240	3240	3240	3240	3174	3174	3174	3174
R-squared	0.19	0.19	0.19	0.19	0.4	0.4	0.4	0.4

Absolute value of t statistics in brackets ** significant at 5%; *** significant at 1%

All regressions in this table include a complete set of village dummy variables [coefficients not shown].

Except for the education of the household head, for which lagged values were not asked, all variables that change over time have been lagged to 1998 values

Table 9. Factors considered by village leaders in choosing land for enrollment n=44

Factor	Number cited	Average rank	Std Dev Rank	Min Rank	Max Rank
Slope	37	1.61	1.05	1	6
Contiguous area	36	2.32	1.24	1	6
Yield	27	2.59	0.89	1	4
Distance	23	3.26	1.13	1	5
Poverty	16	4.25	1.65	1	6
Some for all	14	4.64	1.74	1	6

Table 10. Responses to an open-ended question of farmers as to how land was chosen for enrollment

Steep slope, ecological factors, or landslides	152
Don't know	107
Yields or fertility	106
Contiguous area (policy or access)	42
Distance	39
Policy and others setting an example	28
All retired or all but basic grain production land retired	13
Trees planted along roads or rivers	4
Not suited to growing grain	3
Land suited for orchards retired	2
Drought-sensitive	2
Little sunlight	1

Table 11. Choice status and land enrollment

	Enrolled	Not Enrolled	Total
Must enroll	767	74	841
May not enroll	8	848	856
Choice	521	942	1463
******Designated	419	147	566
******Not designated	67	766	833
******No designations	13	13	26
Satisfied, unsure if have choice	7	76	83

Table 12. Weight placed on land characteristics in decision-making using Heckman probit estimator

Table 12a. Wheat yields

	Select			Chose to enroll		
	[1]	[2]	[3]	[4]	[5]	[6]
Wheat yield [MT/ha]	0.179	0.18	0.0217	-0.624	-0.657	-0.114
	[2.772]***	[2.788]***	[0.722]	[-4.798]***	[-4.473]***	[-2.594]***
Household mean	-0.224	-0.202		0.581	0.621	
	[-2.984]***	[-2.778]***		[4.580]***	[4.455]***	
Village mean	0.0881			0.0536		
	[1.173]			[0.607]		
Sloped	0.182	0.174	0.11	0.418	0.47	0.411
	[1.692]*	[1.625]	[1.060]	[2.236]**	[2.118]**	[2.015]**
Steep	-0.328	-0.325	-0.435	1.439	1.518	1.479
	[-2.375]**	[-2.350]**	[-3.332]***	[5.449]***	[4.935]***	[5.140]***
Very steep	-1.101	-1.101	-1.219	1.308	1.312	1.616
	[-2.702]***	[-2.708]***	[-3.033]***	[2.199]**	[2.034]**	[3.252]***
Terraced	1.39	1.379	1.296	5.978	37.65	8.413
	[2.782]***	[2.749]***	[2.587]***	[0.0208]	[.]	[6.01e-05]
Household mean slope	-0.0491		0.0529	-0.366	-0.397	-0.496
	[-0.507]	[-0.383]	[0.578]	[-2.916]***	[-2.954]***	[-3.826]***
Village mean slope	0.31	0.242	0.213			
	[2.743]***	[2.286]**	[2.192]**			
Constant	-0.46	-0.158	-0.345	0.411	0.505	1.101
	[-1.358]	[-0.652]	[-1.580]	[1.115]	[1.507]	[5.213]***
Observations	1,321	1,321	1,321	1,321	1,321	1,321

Table 12b. Soil quality

	Select			Chose to enroll		
	[1]	[2]	[3]	[4]	[5]	[6]
Medium soil	-0.392	-0.388	-0.347	0.393	0.422	0.0172
	[-3.846]***	[-3.807]***	[-3.874]***	[2.249]**	[2.465]**	[0.125]
Poor soil	-0.544	-0.542	-0.453	1.438	1.481	0.664
	[-3.899]***	[-3.889]***	[-4.896]***	[5.354]***	[5.921]***	[3.928]***
Household mean	0.0411	0.0738		-0.698	-0.639	
	[0.458]	[0.852]		[-5.180]***	[-4.966]***	
Village mean	0.198			0.354		
	[1.368]			[1.695]*		
Sloped	0.161	0.156	0.137	0.615	0.604	0.779
	[1.898]*	[1.837]*	[1.674]*	[4.857]***	[4.730]***	[6.420]***
Steep	-0.336	-0.338	-0.374	1.32	1.351	1.595
	[-3.059]***	[-3.083]***	[-3.703]***	[6.004]***	[6.682]***	[7.035]***
Very steep	-1.404	-1.4	-1.445	1.186	1.317	1.556
	[-5.309]***	[-5.300]***	[-5.582]***	[1.718]*	[1.955]*	[2.239]**
Terraced	1.047	1.044	1.01	2.107	2.07	2.359
	[3.248]***	[3.248]***	[3.166]***	[6.208]***	[5.930]***	[7.037]***
Household mean slope	0.0951	0.0887	0.113	-0.415	-0.407	-0.597
	[1.210]	[1.138]	[1.584]	[-3.196]***	[-3.205]***	[-4.410]***
Village mean slope	0.312	0.363	0.364			
	[3.328]***	[4.342]***	[4.367]***			
Constant	-0.728	-0.436	-0.357	-0.43	0.273	-0.472
	[-2.594]***	[-2.349]**	[-2.234]**	[-0.704]	[0.689]	[-1.381]
Observations	2,391	2,391	2,391	2,391	2,391	2,391

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 12c. Slope

	Select	Chose to enroll
	[1]	[2]
Sloped	0.0454	0.87
	[0.574]	[6.412]***
Steep	-0.518	1.814
	[-5.475]***	[4.998]***
Very steep	-1.601	1.699
	[-6.295]***	[1.965]**
Terraced	0.852	2.64
	[2.698]***	[8.082]***
Household mean slope	0.124	-0.626
	[1.743]*	[-3.563]***
Village mean slope	0.358	
	[4.363]***	
Constant	-0.631	-0.305
	[-4.298]***	[-0.680]
Observations	2,397	2,397

Table 12d. Distance

	Select			Chose to enroll		
	[1]	[2]	[3]	[4]	[5]	[6]
Distance from home [km]	-0.0739	-0.0739	-0.0833	0.308	0.308	0.11
	[-1.485]	[-1.484]	[-2.760]***	[3.403]***	[3.405]***	[1.818]*
Household mean	-0.0171	-0.0146		-0.331	-0.336	
	[-0.261]	[-0.234]		[-3.064]***	[-3.278]***	
Village mean	0.0116			-0.0196		
	[0.129]			[-0.146]		
Sloped	0.0544	0.0542	0.0569	0.819	0.819	0.86
	[0.679]	[0.676]	[0.716]	[6.431]***	[6.422]***	[6.573]***
Steep	-0.487	-0.488	-0.483	1.773	1.771	1.837
	[-5.024]***	[-5.027]***	[-5.069]***	[5.321]***	[5.319]***	[5.024]***
Very steep	-1.532	-1.53	-1.523	1.596	1.591	1.687
	[-5.936]***	[-5.935]***	[-5.944]***	[1.875]*	[1.877]*	[1.860]*
Terraced	0.842	0.84	0.844	2.578	2.578	2.674
	[2.657]***	[2.654]***	[2.669]***	[7.950]***	[7.951]***	[8.205]***
Household mean slope	0.143	0.142	0.139	-0.602	-0.6	-0.653
	[1.951]*	[1.946]*	[1.947]*	[-3.498]***	[-3.503]***	[-3.504]***
Village mean slope	0.327	0.328	0.329			
	[3.899]***	[3.922]***	[3.953]***			
Constant	-0.551	-0.543	-0.545	-0.233	-0.25	-0.293
	[-3.383]***	[-3.599]***	[-3.621]***	[-0.474]	[-0.530]	[-0.579]
Observations	2,393	2,393	2,393	2,393	2,393	2,393

Table 13. Weight placed on land characteristics in decision-making

Table 13a. Wheat yields

	Required to enroll			Chose to enroll		
	[1]	[2]	[3]	[4]	[5]	[6]
Wheat yield [MT/ha]	-9.812	-9.812	-3.12	-31.72	-31.92	-10.28
	[4.31]***	[4.31]***	[2.92]***	[10.65]***	[10.68]***	[7.10]***
Household mean	8.476	8.568		30.28	27.52	
	[3.13]***	[3.32]***		[8.68]***	[8.18]***	
Village mean	0.288			-9.92		
	[0.11]			[2.83]***		
Constant	48.287	48.838	54.159	74.88	54.25	70.77
	[7.85]***	[13.29]***	[16.32]***	[8.56]***	[11.21]***	[15.43]***
Observations	1373	1373	1373	743	743	743
R-squared	0.01	0.01	0.01	0.15	0.14	0.06

Table 13b. Soil quality

	Required to enroll			Chose to enroll		
	[1]	[2]	[3]	[4]	[5]	[6]
Medium soil	12.703	12.252	8.676	23.07	23.56	7.08
	[3.60]***	[3.47]***	[2.73]***	[5.98]***	[6.08]***	[1.98]**
Poor soil	26.107	25.921	18.403	72.53	72.71	39.77
	[5.83]***	[5.78]***	[5.93]***	[14.95]***	[14.92]***	[11.24]***
Household mean	-3.517	-6.631		-35.14	-30.7	
	[1.17]	[2.32]**		[10.18]***	[9.52]***	
Village mean	-15.786			19.33		
	[3.36]***			[3.51]***		
Constant	70.041	40.441	29.841	32.45	66.55	16.74
	[6.81]***	[7.57]***	[10.81]***	[2.84]***	[11.09]***	[5.52]***
Observations	2469	2469	2469	1406	1406	1406
R-squared	0.02	0.02	0.02	0.19	0.18	0.13

Absolute value of t statistics in brackets
** significant at 5%; *** significant at 1%

Table 13c. Slope

	Required to enroll			Chose to enroll		
	[1]	[2]	[3]	[4]	[5]	[6]
Sloped	-1.618	-1.947	-8.095	26.22	26.52	14.5
	[0.55]	[0.66]	[2.98]***	[7.91]***	[8.01]***	[4.62]***
Steep	19.573	19.369	6.382	66.46	66.56	40.69
	[5.58]***	[5.50]***	[2.61]***	[16.49]***	[16.51]***	[13.61]***
Very steep	58.96	60.443	42.991	75.81	75.46	42.71
	[7.03]***	[7.18]***	[5.54]***	[4.49]***	[4.47]***	[2.51]**
Terraced	-23.232	-21.351	12.782	82.82	82.32	65.56
	[2.54]**	[2.33]**	[2.00]**	[9.77]***	[9.71]***	[7.75]***
Household mean	-5.221	-11.627		-28.62	-25.62	
	[1.97]**	[5.08]***		[8.30]***	[9.23]***	
Village mean	-14.593			5.75		
	[4.71]***			[1.46]		
Constant	76.156	58.275	40.343	50.08	55.74	14.44
	[13.83]***	[14.53]***	[20.99]***	[7.93]***	[11.16]***	[6.31]***
Observations	2397	2397	2431	1386	1386	1387
R-squared	0.05	0.04	0.03	0.19	0.19	0.14

Table 13d. Distance

	Required to enroll			Chose to enroll		
	[1]	[2]	[3]	[4]	[5]	[6]
Distance from home [km]	5.922	5.922	5.21	19.46	19.41	8.19
	[3.28]***	[3.28]***	[4.76]***	[8.40]***	[8.39]***	[5.46]***
Household mean	-1.687	-1.127		-20.94	-20.37	
	[0.71]	[0.50]		[6.01]***	[6.31]***	
Village mean	2.681			2.34		
	[0.79]			[0.43]		
Constant	36.139	37.931	37.58	36.59	38.01	30.62
	[13.23]***	[24.84]***	[27.76]***	[9.49]***	[18.42]***	[17.78]***
Observations	2470	2470	2470	1410	1410	1410
R-squared	0.01	0.01	0.01	0.05	0.05	0.02

Table 14. Effects of household characteristics on enrollment [%]

	Required to enroll						Chose to enroll					
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Proportion on farm	-2.737	-4.732					-0.68	-5.06				
	[0.76]	[1.32]					[0.14]	[1.15]				
Proportion off farm			-12.208	-9.519					15.8	12.26		
			[2.34]**	[1.83]*					[2.18]**	[1.90]*		
Education of household head [years]					-0.36	-0.356					1	0.88
					[1.34]	[1.34]					[2.70]***	[2.68]***
Sloped		-0.077		-0.042		0.21		10.99		11.16		11.03
		[0.03]		[0.02]		[0.08]		[3.55]***		[3.61]***		[3.54]***
Steep		13.32		13.125		13.832		35.94		35.82		36.12
		[4.88]***		[4.81]***		[5.02]***		[10.62]***		[10.60]***		[10.68]***
Very steep		24.115		23.98		24.794		36.82		35.88		36.73
		[3.28]***		[3.27]***		[3.29]***		[2.38]**		[2.33]**		[2.39]**
Terraced		2.835		3.249		2.478		49.68		47.5		47.83
		[0.47]		[0.54]		[0.42]		[6.37]***		[6.06]***		[6.15]***
Medium soil quality		8.948		8.692		8.253		4.62		4.71		3.64
		[3.01]***		[2.92]***		[2.73]***		[1.35]		[1.38]		[1.06]
Poor soil quality		16.331		16.047		16.183		29.9		30		29.39
		[5.20]***		[5.10]***		[5.09]***		[8.18]***		[8.21]***		[7.99]***
Constant	44.561	26.581	44.772	25.885	45.286	26.413	37.26	5.05	35.17	1.36	30.8	-2.06
	[24.45]***	[8.36]***	[41.73]***	[9.02]***	[23.60]***	[8.01]***	[14.80]***	[1.38]	[24.37]***	[0.42]	[11.67]***	[0.56]
Observations	2531	2424	2531	2424	2493	2388	1410	1383	1410	1383	1397	1370
R-squared	0.21	0.25	0.21	0.25	0.21	0.25	0.17	0.36	0.17	0.37	0.18	0.37

Absolute value of t statistics in brackets
** significant at 5%; *** significant at 1%
All regressions in Table 8 include village dummy variables [not shown].

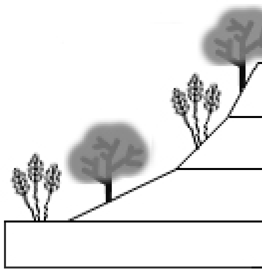
Table 15. Effects of household characteristics on enrollment using Heckman probit estimator

	Select						Chose to enroll					
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Proportion on farm	0.176	0.196					-0.125	-0.182				
	[1.785]*	[1.975]**					[-0.870]	[-1.231]				
Proportion off farm			-0.161	-0.242					0.568	0.753		
			[-1.095]	[-1.626]					[2.605]***	[3.366]***		
Education of household head [years]					0.000416	-0.00125					0.0446	0.0512
					[0.0554]	[-0.165]					[4.022]***	[4.578]***
Medium soil		-0.348		-0.355		-0.343		0.027		0.0409		0.0423
		[-3.890]***		[-3.955]***		[-3.775]***		[0.196]		[0.294]		[0.286]
Poor soil		-0.46		-0.468		-0.46		0.668		0.693		0.738
		[-4.968]***		[-5.035]***		[-4.911]***		[3.900]***		[3.856]***		[4.389]***
Sloped	0.0502	0.145	0.0437	0.138	0.0322	0.12	0.854	0.768	0.862	0.776	0.903	0.773
	[0.633]	[1.769]*	[0.552]	[1.687]*	[0.401]	[1.454]	[6.199]***	[6.317]***	[6.150]***	[6.318]***	[7.466]***	[6.061]***
Steep	-0.516	-0.368	-0.518	-0.369	-0.541	-0.399	1.764	1.576	1.766	1.55	2.032	1.714
	[-5.455]***	[-3.642]***	[-5.479]***	[-3.643]***	[-5.632]***	[-3.900]***	[4.775]***	[6.841]***	[4.764]***	[6.361]***	[6.831]***	[8.737]***
Very steep	-1.621	-1.462	-1.602	-1.438	-1.573	-1.42	1.624	1.556	1.626	1.496	2.203	1.888
	[-6.354]***	[-5.633]***	[-6.290]***	[-5.544]***	[-6.075]***	[-5.390]***	[1.904]*	[2.242]**	[1.912]*	[2.105]**	[2.514]**	[2.667]***
Terraced	0.845	1.008	0.873	1.059	0.837	0.998	2.64	2.376	2.559	2.289	2.622	2.28
	[2.669]***	[3.148]***	[2.746]***	[3.288]***	[2.641]***	[3.116]***	[7.903]***	[7.135]***	[7.690]***	[6.749]***	[7.742]***	[6.122]***
Household mean slope	0.118	0.106	0.119	0.107	0.129	0.121	-0.606	-0.591	-0.59	-0.559	-0.718	-0.65
	[1.658]*	[1.483]	[1.685]*	[1.487]	[1.797]*	[1.675]*	[-3.446]***	[-4.348]***	[-3.370]***	[-3.956]***	[-4.499]***	[-5.112]***
Village mean slope	0.365	0.372	0.365	0.372	0.351	0.354						
	[4.448]***	[4.449]***	[4.455]***	[4.459]***	[4.168]***	[4.170]***						
Constant	-0.711	-0.443	-0.616	-0.321	-0.607	-0.317	-0.303	-0.415	-0.466	-0.69	-0.317	-0.635
	[-4.660]***	[-2.691]***	[-4.170]***	[-1.986]**	[-3.730]***	[-1.807]*	[-0.681]	[-1.175]	[-1.150]	[-2.115]**	[-0.576]	[-1.599]
Observations	2,396	2,390	2,396	2,390	2,360	2,354	2,396	2,390	2,396	2,390	2,360	2,354

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

10. Figures

Figure 1. Overlap in slope between enrolled and non-enrolled plots



	By household	By village
Enrolled land -- not flatter than steepest non-enrolled land	1182	845
Non-enrolled land -- steeper than flattest enrolled land	61	718
Enrolled land -- flatter than steepest non-enrolled land	52	389
Non-enrolled land -- not steeper than flattest enrolled land	1941	1284

11. Appendices

Appendix 1. Sample enrollment contract

Related policy and explanation

1. For each mu retired, the central government will deliver 200 jin of grain per year, and 20 yuan in cash, for a period of 5 years.
2. For land enrolled in retire land return forest (grassland) including cropland and wasteland, tree seedlings or grass seeds will be provided free of charge by the county forestry or livestock department. Costs of economic tree seedlings above 50 yuan per mu are the farmer's responsibility.
3. According to the principle of "Who plants trees (grass) manages them and gets the benefits", usufructory rights to land under the program are extended to 50 years; during the term of the contract, the farmer is allowed to bequeath, transfer, rent, mortgage, or sell land rights according to relevant laws; if the farmer is unable to contract, rights may be transferred in an open auction or to a tenant, but the land use may not be changed, the land may not be returned to cultivation, otherwise the land will be confiscated and other penalties may be imposed according to applicable laws and regulations.
4. According to the "Retire 1 return 2" policy, for every mu of cropland retired, in addition to planting trees or grass on that one mu, should plant trees or grass on one nearby mu of wasteland; where the area of wasteland is large, they should practice "retire 1 return 3" or even more.
5. The content of this card is standardized by the county (municipality, district) people's government forestry administration, and is assigned a serial number. Each plot (place) of land has one card, and shall be stamped by the county (municipality, district) forestry administration, livestock bureau, land bureau, grain bureau, township people's government, village committee, and signed by the participating household, at which time it shall constitute a contractual relationship.
6. This card and other related documents should be presented to the local designated location to receive grain and cash and the legal forest (grassland) ownership certificate; upon loss, immediately apply for a replacement.
7. Seven copies of this card will be produced, and distributed to and retained by the participating household, local village committee, township people's government, and county forestry, livestock, grain, and land departments.

County (municipality, district) Forestry Bureau: Inspection notes __________ Stamp________ Date_________
County (municipality, district) Livestock Bureau: Inspection notes __________ Stamp________ Date_________
County (municipality, district) Grain Bureau: Inspection notes __________ Stamp________ Date_________
County (municipality, district) Land Bureau: Inspection notes __________ Stamp________ Date_________
People's Township Government: Inspection notes __________ Stamp________ Date_________
Villager's Committee: Inspection notes __________ Stamp________ Date_________
Participating household signature or stamp ___________ Date ____________

Appendix 2. Calculation of insolation

Relative insolation refers to the intensity of sunlight striking the plot relative to that striking a flat surface at the same latitude, which is normalized to 1. Because of the importance of morning sunshine to crops, hill exposure angles are calculated relative to a south-southeast exposure, not to a due south exposure. Relative insolation is lower when weighting by plot size because land with southern exposures is likely to be divided into smaller pieces than land with northern exposures in the study area.

The following assumptions were used to calculate relative insolation on each plot of land. The simplifying assumptions have little effect on the estimated relative levels of insolation between one plot and another.

--Flat, sloped, steep, and very steep correspond to 0, 15, 25, and 35 degree slopes respectively.

--All land in the sample is located at 34 degrees north latitude. In fact, latitudes vary between 33 and 35 degrees, with exposure slightly more important at higher latitude.

--Land is not located in the shadow of adjacent land with an extremely steep slope.

Appendix 3. Multivariate regression results

The following results are presented using a linear probability model because the Heckman probit model does not converge with a larger number of variables and smaller number of observations. The number of observations is smaller because not all variables are available for all observations. In particular, wheat yields are not available on plots that have not grown wheat.

Appendix 3 Table 1. Multivariate regressions separating farmer from government decision-making

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
	Required to enroll				Chose to enroll			
	Standard	Village dummies	Village dummies, hh clusters	Village clusters	Standard	Village dummies	Village dummies, hh clusters	Village clusters
Sloped [0/1], Flat omitted	4.029	9.816	9.816	4.029	10.560	9.083	9.083	10.560
	[1.19]	[2.95]***	[2.09]**	[0.77]	[2.62]***	[2.39]**	[1.72]*	[1.87]*
Steep [0/1]	19.937	27.095	27.095	19.937	37.298	36.387	36.387	37.298
	[5.64]***	[7.26]***	[4.95]***	[2.83]***	[8.32]***	[8.00]***	[5.65]***	[4.09]***
Very steep [0/1]	52.304	51.616	51.616	52.304	17.185	19.792	19.792	17.185
	[4.10]***	[4.30]***	[4.68]***	[4.54]***	[0.56]	[0.73]	[1.16]	[0.49]
Terraced [0/1]	32.588	3.861	3.861	32.588	65.545	45.888	45.888	65.545
	[4.24]***	[0.51]	[0.34]	[1.75]*	[5.83]***	[4.58]***	[3.96]***	[7.57]***
Wheat yield in MT per ha	-1.746	-1.094	-1.094	-1.746	-2.613	-4.755	-4.755	-2.613
	[1.55]	[0.94]	[0.62]	[0.72]	[1.72]*	[3.14]***	[2.08]**	[1.18]
Distance from home in km	4.013	5.809	5.809	4.013	5.038	5.662	5.662	5.038
	[2.53]**	[3.60]***	[2.48]**	[1.29]	[2.32]**	[2.70]***	[2.02]**	[1.10]
Medium soil quality [0/1], Good soil omitted	6.092	9.782	9.782	6.092	0.335	2.577	2.577	0.335
	[1.51]	[2.58]***	[2.23]**	[1.08]	[0.07]	[0.60]	[0.48]	[0.05]
Poor soil quality [0/1]	13.126	16.544	16.544	13.126	20.000	20.608	20.608	20.000
	[3.07]***	[4.06]***	[3.07]***	[1.81]*	[3.88]***	[4.39]***	[3.13]***	[2.82]***
Insolation ratio	-10.650	-4.977	-4.977	-10.650	-24.433	-12.289	-12.289	-24.433
	[1.33]	[0.65]	[0.45]	[1.14]	[2.13]**	[1.18]	[0.86]	[1.29]
Constant	29.915	14.347	14.347	29.915	42.744	36.144	36.144	42.744
	[3.01]***	[1.49]	[1.11]	[2.01]*	[3.10]***	[2.83]***	[2.16]**	[1.76]*
Observations	1336	1336	1336	1336	726	726	726	726
R-squared	0.10	0.28	0.28	0.10	0.26	0.49	0.49	0.26

** significant at 5%; *** significant at 1%

t statistics in brackets