China's Sloping Land Conversion Program: A village level analysis of land use, environmental, and economic changes

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ABSTRACT. China's Sloping Land Conversion Program seeks to improve both the environmental and economic conditions of rural farmers by paying them a cash and grain subsidy over a period of five to eight years. In exchange, farmers retire a portion of their agricultural land and plant a cover crop of trees or grasses to help prevent soil erosion. This paper evaluates the economic and environmental impact of the program four years after its first implementation. Results suggest the program was successfully targeted at poorer farmers on erosion-prone sloping farmland. There is also some evidence the program is improving farmer incomes and pushing more farmers into off-farm labor markets. However, the targeting of highly sloping farmland (greater than 25 degrees) could be improved.

I.   Introduction

Started in 1999, China's Sloping Land Conversion Program (SLCP) has gained increasing attention from researchers inside and outside of China because of its large scale and institutional innovation compared with previous national conservation efforts. The SLCP is the first large-scale effort in China to retire farmland in order to reduce soil erosion. Unlike previous campaign-style, short-term environmental engineering efforts, it is designed to take into account the microeconomic incentives of individual farmers and engage them over a period of years.[1]

Through targeting sloping farmland in western China, the SLCP is implicitly a poverty reduction program as well because of the high levels of poverty among the farmers who try to make a living farming the marginal lands in the arid northwest, north-central, and mountainous southwest.[2] An added hardship was the late 1990s saw drought conditions across much of northwest China.[3] Perhaps as a result of the obvious hardships in the western regions, poverty reduction was soon added as an explicit goal by the program's leadership in the national government's State Council.[4] Therefore the program should be of interest to the poverty reduction and the environmental protection research communities as well as the growing interdisciplinary research agenda of sustainable development studies that recognizes the

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[1] Xu and Cao (2002), p. 80, write "the SLCP is unprecedented in ambition and scope, and there is no successful land conversion program to follow."

[2] This concept of the western provinces refers mostly to the provinces in the western part of 'traditional' China which does not include the huge, mostly desert areas in Xinjiang, Tibet, and Qinghai. This is analogous to the continuing labeling of Michigan as part of the Midwest in a United States that continued to expand after this label had been fixed.

[3] Xu and Cao (2002).

[4] Ibid.

important connections between environmental and economic outcomes, especially in the context of rapidly developing countries such as China.

The basic mechanisms of the SLCP are straightforward. In exchange for a period of yearly payments, farmers remove ecologically fragile land from farm production and plant trees or grasses, thereby reducing soil erosion on these lands—erosion which has been connected to local problems such as reduced crop yields and to larger regional problems, particularly flooding and sandstorms in eastern China.[5] Payments to farmers consist of three parts: cash, grain, and, in the first year, tree seedlings.[6] For each mu (15 mu=1 hectare) of converted farmland a farm household is provided annually with 20 Yuan cash, and either 150 or 100 kilograms of grain, with the larger amount going to farmers in the higher yield Yangtze River basin.[7] Payments to participating farmers are scheduled to continue for eight years for ecological trees, five years for economic trees (mostly fruit or nut trees), and two years for grasses.[8]

This large financial commitment over a relatively long period separates the SLCP from previous environmental programs which mainly involved mobilizing large amounts of labor for specific short-term tasks.[9] Perhaps more important than the amount of money involved is most of it is supposed to go to farmers instead of to the local officials charged with implementing the program.[10] Through direct payments to farmers, program planners hope to improve on the performance of previous environmental programs such as the Three North Program and Planting Grass and Trees Program.[11] One reason previous tree-planting programs had poor results was there was little incentive to provide aftercare. Tree planting was a politically mandated work task. Once the task of planting was completed that was the end of any personal responsibility.[12] Furthermore, because there was no direct economic benefit—in fact through lost labor time and

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[5] Zhang and Liu (2005). Bennett (2005). Zuo (2002a).

[6] Grain and seedlings subsidies could be paid as a cash equivalent. Bennett (2005) writes grain subsidies were generally monetized in later years as grain stocks were depleted.

[7] Uchida et al. (2005) calculate the total value of these subsidies at 2400 Yuan and 3450 Yuan per hectare in the Yellow and Yangtze River basins respectively. In the first year the seedlings subsidy adds 750 Yuan per hectare.

[8] The actual longevity of grassland payments is unclear. In many cases grass plantings are combined with tree plantings. For the farmers this allows them to collect the full subsidy for a longer period, and for the government it better guarantees that farmers won't immediately reconvert lands back to farms at the end of the compensation period as it is much harder to plow up a field of trees than a field of grass.

[9] Smil (2000).

[10] Xu et al. (2004).

[11] Ge et al. (2004), p. 110. Smil (1993), p. 61-2.

[12] Smil (2000) notes success until the late 1970s was measured simply by survival of trees on the day they were planted. Ross (1988) p. 68 also discusses this problem.

loss of land use rights there could be a direct economic loss—motivation to make programs work at the local level could be very low.

By contrast, the SLCP perhaps represents the beginning of a payment for environmental services model in China.[13] Farmers are paid to protect the water and air resources used downstream by cities, factories, and farms by removing from production land vulnerable to erosion. Particular focus has been placed on land with more than 25 degrees of slope in the Yangtze River basin and 15 degrees of slope in the Yellow River basin.[14] Payments begin to bring economic incentives in line with the full-use values of these western land and water resources to users both locally and downstream.

Already the largest land conversion program in the developing world,[15] and almost certainly the largest land conversion program ever attempted in China, the SLCP through 2004 had converted nearly eight million hectares of farmland to forest or grassland, representing roughly 6% of China's total farmland area.[16] In addition 11.28 million hectares of barren land was also replanted as part of the program.[17] In total this cost China's central government more than 75 billion Yuan (more than 9 billion dollars).[18] Although concerns over domestic grain supply have slowed the pace of farmland conversion, plans call for an additional five million hectares of farmland to be retired by 2010.[19] This would make the SLCP very similar in scale to the U.S. Department of Agriculture's Conservation Reserve Program (CRP), which at the end of 2000 had 13.6 million hectares of farmland enrolled in a set aside program that has many features in common with the SLCP.[20]

Although the SLCP represents a large financial commitment by the national government, for individual farm households the payments themselves are not enough to radically transform their individual economic situations. The assumption of program planners is retiring farmland will create more surplus labor that can migrate to the cities or, in combination with the small cash subsidy, create new on-farm or off-farm income generating opportunities.[21] This hoped for

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[13] Uchida et al. (2004). Bennett (2005).
[14] Uchida et al. (2005).
[15] Uchida et al (2004).
[16] Ben (2005).
[17] Ibid. Waste or barren land in China is not an ecologically rigorous categorization, as Ross (1988), p. 34, explains, but instead is a very broad category that can include any agriculturally or economically unproductive land.
[18] Ben (2005).
[19] Xu et al. (2004).
[20] Uchida et al. (2005). Johnson and Maxwell (2001).
[21] Xu et al. (2004).

economic transition is a critical outcome for the program in at least two ways. As an economic support mechanism, the program can only be considered a long-term success if it contributes to the economic transition away from a subsistence farm economy towards a rural industrial economy or a market farm economy where high-value cash crops are grown in sustainable ways. Secondly, for the long-term success of the environmental components of the program, this economic transition is a necessary condition to sustain the environmental gains made during the payment phase. If farmers don't see their incomes improve, they will most likely reconvert their land back to agriculture when payments end.[22] On the other hand, if they are making more money by working in the city, running their own businesses, raising vegetables on their remaining more productive land, or collecting fruits and nuts from their orchards, the opportunity cost of reconverting back to farmland would be too high. That this economic transition will happen fast enough to protect the environmental gains of the SLCP is a critical assumption made by program planners.

Another assumption is the ecological interventions of retiring a portion of western farmland and planting a cover crop of trees or grasses will have both the direct environmental benefit of reduced soil erosion and the indirect benefits of reduced flooding and sandstorms in the eastern part of the country. Although the SLCP perhaps represents a policy breakthrough in recognizing the existence of indirect, "downstream" environmental effects and their potential negative economic consequences, understanding the exact nature of the cause-effect relationships is still very challenging. Planting trees and grasses may reduce soil erosion but measuring the direct erosion effects is difficult, let alone quantifying the indirect environmental and economic effects. There is evidence of the potential gains of land cover change from research done in other contexts. Studies of individual experimental plots have shown the soil erosion mitigation potential of various vegetation covers,[23] and large-scale studies of the environmental effects of the CRP program in the U.S. have shown the success of farmland retirement for both erosion and broader environmental indicators.[24]

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[22] Ibid. Uchida et al. (2005). Bennett (2005).
[23] Hamilton and Pearce (1986).
[24] Using a land use model calibrated with field studies, Johnson and Maxwell (2001) showed that CRP areas had improved overall environmental integrity scores. The CRP lowered urban sprawl by restricting the amount of land available for development. Using county-level cross-sectional data for 1982 and 1992, Goodwin and Smith (2003) calculated that for each percentage point increase in CRP acreage, erosion decreased by 0.28 tons per acre (note this is a county-wide average of erosion mitigation, erosion savings on actual CRP plots would be orders of magnitude

Several studies have begun to test the assumptions made by SLCP planners, including looking for evidence of economic changes among participating farm households.[25] However, because of data limitations it has been hard to definitively answer questions about economic effects. On the environmental side, most studies of the SLCP have not even attempted to measure environmental outcomes. Instead they have tried to measure the level and quality of implementation in the aggregate, including the amount of farmland and barren land replanted, the survival rates of tree and grass plantings, and the amount of retired farmland and replanted barren land that is sloped.[26] The assumption is if sloping land is well targeted, and tree and grass survival rates are high, reductions in soil erosion will follow.

This paper will contribute to the understanding of the SLCP in four specific areas and begin to answer questions relating to the central environmental and economic goals of the program. Using a village-level retrospective panel dataset (2,459 villages) drawn from six provinces, this paper analyzes participation and targeting factors, as well as economic, environmental, and land use changes between 1997 and 2002.[27] This is the largest randomly sampled dataset ever used in an econometric analysis of the SLCP. It will also be the first use of a village-level dataset to analyze economic impacts of program participation. Because of the wealth of land use variables included in the survey, this paper will include a more detailed analysis than previously possible of how the SLCP affected land allocation decisions at the village level. A measure of environmental effectiveness is included which is, I believe, a first for this type of analysis.

Results suggest that the SLCP was targeted successfully towards villages with lower incomes and more sloping farmland. Gains in forest or grassland were made and these gains were roughly equal to the amount of land enrolled in the program. On the other hand, reductions in farmland, especially farmland sloping 25 degrees or more, were significantly smaller than total program area. Soil erosion shows small improvements under some analytical assumptions, but not under others. There is some evidence the program led to greater per capita incomes, as

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greater). Nationwide this translated into approximately 470 million tons of erosion reduction per year [423 million acres * 0.28 tons/acre * 3.970 (the average county's participation percentage)].

[25] Uchida et al. (2005). Uchida et al. (2004). Xu and Cao (2002). Xu et al. (2004). Zhang and Liu (2005).
[26] Uchida et al. (2005). Xu and Cao (2002).
[27] See Zhang et al. (2004) for a full description of this dataset. I want to thank Scott Rozelle, Zhang Linxiu, and their colleagues at the Center for Chinese Agricultural Policy for access to this dataset.

well as growth in off-farm labor forces, migration out of the villages, and in the number of households that gave up farming altogether.

II.   Background

The problems of soil erosion and deforestation and their connections with economic outcomes were recognized by the Chinese government at least as far back as the 1950s.[28] Nevertheless during this period no mitigation programs got out of the demonstration project stage.[29] Instead, in the Mao era (1949-1976) China practiced a form of mass movement environmental engineering that relied on directing large amounts of human labor.[30] In this era of rapid population growth, opening up new areas to farming was the primary land conversion trend,[31] which along with the rural industrialization program of the Great Leap Forward campaign, increased the rates of deforestation, land erosion, and desertification across China.[32] Tree planting campaigns were part of Mao's environmental mass movement strategy, but the success rate of reforestation was low.[33]

After 1978, with increased farm productivity stemming from the household responsibility system and the beginning of market reforms, the pressure to open new land for farming was reduced.[34] The still ongoing Three North Program was started in 1978 with the goal of reversing the environmental damage caused by farming and overgrazing fragile lands in northwest, north-central, and northeast China.[35] One of the primary goals of the Three North Program was to stop the advancing desertification and soil erosion that was threatening the productivity of northern farmlands, increasing the silt loads in northern rivers, and increasing the severity of sandstorms in northern cities. The primary mechanism was planting trees and grasses in the transition areas between desert and farmland. The slogan was to build "a great green wall," a tree shelter zone much greater in width and similar in length to China's Great Wall. This time the desert sand of

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[28] Shao Limin (2003).

[29] Ibid.

[30] Smil (2000), p. 169. Shapiro (2001), p. 3.

[31] Ross (1988), p 66. Smil (1984), p. 16.

[32] Shapiro (2001), chapter 5. Smil (1984), p. 15, 59.

[33] Ross (1988), p 34, estimates a 25% success rate for reforested areas between 1949 and 1981. According to Smil (2000), in the northeast during 1949-1989 losses from fire were eight times larger than afforested areas.

[34] Williams (2002), p. 36, cautions against making too much of political breaks. New regimes, in this case Deng Xiaoping's after 1978, tend to blame all problems on the previous regime. As environmental problems came to light, their severity was blamed on the mistakes of the Mao Zedong-led leadership. Noting this, there does seem to have been a greater degree of scientific rationality in public policy after 1978.

[35] Smil (2000). Smil (1984) p. 61-2. Williams (2002), p. 36-7.

the Asian steppe, instead of the Mongol horsemen, was the enemy to be kept at bay. Trees were planted on abandoned farmland, but this program was not a land conversion program in the same fashion as the later SLCP. As a rule, existing farmland was not converted to forestland.

Other 1980s tree planting programs focused on coastal and river basin areas,[36] but like the Three North Program these were tree and grass planting programs not farmland conversion programs. An environmental program similar to the Three North Program was the Planting Grass and Trees Program; however this program also had ineffective results. Common problems included inadequate water supplies, temperature extremes in the northern and western regions, and poor aftercare of tree seedlings.[37]

Along with the continued lack of success of these reforestation programs, several other events occurred in the late 1990s that laid the groundwork for the SLCP. The 267 day dry-up of the Yellow River in its lower reaches in 1997 and severe flooding along the Yangtze in 1998 are considered by many observers to be the catalytic events that awakened the national government to the environmental threats to China's continued economic expansion.[38] Both disasters led directly to billions of dollars of economic losses and the Yangtze floods took more than 1,500 lives.[39]

Agricultural practices upstream were pointed to by some environmental experts in China as a contributing factor to these environmental disasters.[40] Increasing reliance on irrigation in the arid regions of the middle and upper Yellow River had created a situation where there was not enough water to go around in drought years, especially severe drought years like 1997.[41] Heavy silt loads caused by erosion runoff led to reduced flood control capacity along the Yangtze, as well as the Yellow and other rivers, as natural and manmade flood retention reservoirs became silted up.[42]

Erosion is an especially serious problem on sloping farmland and other deforested land.[43] Roughly 70% of China's more than 91 million mu (6 million hectares) of highly sloping

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[36] Smil (1993), p. 61.
[37] Ge et al. (2004). Xu and Cao (2002).
[38] Zuo (2002a). Bennett (2005). Xu et al. (2004). Uchida et al. (2005).
[39] Ma (2004), p. 46, puts the Yangtze flood damage at 134.5 billion Yuan, and 1,562 lives lost. Including floods in two other river basins, 3000-4000 lives were lost and five million hectares of crops were lost. Bennett (2005).
[40] Zuo (2002a). Uchida et al. (2005). Bennett (2005). Pimentel et al. (1995) cite similar opinions for the role of soil erosion in major floods along the Mississippi River in 1993.
[41] Zuo (2002a).
[42] Ma (2004), p. 87. Murphey (2000). Smil (1993), p. 51. Smil (1984), p. 57.
[43] Hamilton and Pearce (1986). Pimentel et al. (1995).

farmland (25 degrees or more) is in its western region, with a sizable portion of this total in the upper reaches of the Yellow and Yangtze Rivers.[44] An estimated two-thirds of the approximately two billion tons of silt released into these two rivers comes from sloping farmland and other deforested land.[45]

Overall, between one-third and one-half of China's land area may be affected by soil erosion or desertification,[46] although estimates of these large-scale environmental processes in China and elsewhere remain controversial.[47] A mid-1980s estimate of soil erosion in China put the total at more than five billion tons per year, with approximately 80% of this coming from the watersheds of the Yangtze and Yellow Rivers.[48] Worldwide about 80% of agricultural land suffers moderate to severe erosion according to some estimates.[49] Erosion rates in the developing world have been estimated to average between 30 and 40 tons per hectare per year, which is about twice the estimated erosion rates in Europe and North America.[50] Erosion rates on even moderately sloped land (greater than 10 degrees) can be in the 200 to 400 tons per hectare per year range.[51] By comparison undisturbed forest has an erosion rate of between 0.004 and 0.05 tons per hectare per year.[52]

The direct onsite costs of soil erosion on agricultural land are reduced soil fertility and crop productivity.[53] Crop productivity is maintained through the increased use of fertilizers, which are both a direct monetary cost to farmers and a potential health hazard via direct exposure or from water pollution due to fertilizer runoff. Eroded land also retains less water leading to greater runoff,[54] which, along with the increased silt loading, contributes to flooding downstream.

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[44] Xu et al. (2004). Xu and Cao (2002) note SLCP implementation has shown that the actual amount of sloping cultivated and reclaimed land is significantly greater than the official 91 million mu estimate.

[45] Xu et al. (2004). A slightly different angle is Pimentel et al. (1995) which estimates 60% of all soil erosion from U.S cropland ends up in streams or rivers.

[46] Xu et al. (2004) cites estimates of 38% of land area affected by soil erosion and 18% by desertification, but does state the amount of overlap between the two. Smil (1993), p. 57, a nationwide survey found excessive soil erosion on 31%, desertification on 5%, and salinization or alkalization on 6% of farmland.

[47] For one debate on this subject between Crosson and Pimentel et al. see the Letters section of Science, vol. 269, p. 461-465, 2005.

[48] Smil (1984), p. 54-57.

[49] Pimentel et al. (1995).

[50] Ibid.

[51] Ibid.

[52] Ibid. Hamilton and Pearce (1986) caution this soil erosion potential is only for undisturbed forest where the leaf litter is the primary soil protectant. Bare soil under trees can suffer from worse soil erosion than open field because of increased droplet size of rain falling from canopy leaves.

[53] Pimentel et al. (1995) cites several studies where severe soil erosion reduced corn yields by 12-80%.

[54] Ibid.

Total annual costs of soil erosion in the United States have been estimated to be $44 billion, or about $100 per hectare.[55]

While also mentioning the costs associated with the droughts and floods of the late 1990s as catalytic factors, some researchers also believe the large grain surpluses of China's State Grain Bureau helped determine both the timing and institutional features of the SLCP.[56] In attempting to recentralize the grain market, the State Grain Bureau ended up with a huge surplus of grain roughly equal to China's total annual grain production. The SLCP created a need for these aging grain stocks that were subsequently bought from the State Grain Bureau at above market prices.[57] This curious maneuver probably made the program more costly to the government than it would have been otherwise, but it served the political purpose of helping a powerful government actor extricate itself from a politically embarrassing and financially expensive situation.

Still, there was likely more going on than intra-governmental bailouts in the late 1990s as evidenced by the five other national forest-related environmental programs started or greatly expanded in the two years after the Yangtze River floods. The most extensive of these was the National Forest Protection Program (NFPP) which banned or greatly restricted logging in China's dwindling natural forest reserves.[58] In the western reaches of the Yangtze and Yellow Rivers, where the SLCP was being organized, logging was completely banned. This situation only heightened the pressure on the SLCP, as many western farmers lost access to jobs and resources connected with those forests. In the context of the NFPP, the SLCP had to fill two potentially contradictory needs: reforest the large gaps in the natural forests, which were already too patchy to adequately protect the watersheds from erosion; and provide an alternative source of forest products to local residents now banned from harvesting in those forests.

III.   Implementation of the SLCP

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[55] Ibid. This estimate includes direct and indirect costs.
[56] Xu et al. (2004).
[57] Ibid.
[58] See Zuo (2002b) and Katsigris (2002) for a full description and the early socioeconomic impacts of the NFPP.

The SLCP was officially started in the three western provinces of Sichuan, Shaanxi, and Gansu in 1999 as a pilot project.[59] The next year it expanded to 174 counties in 13 provinces, and in 2002 it spread to 1,897 counties in 25 provinces—many outside of the original target area of western China.[60] This quick expansion was evidence of the popularity of the program at the local level. Unlike many national programs there was not a requirement for local matching funds so local governments eagerly sought to be included in the program.[61]

Notwithstanding this popularity at the local level, the SLCP remained very top-down in both motivation and implementation. Former Chinese Premier Zhu Rongji is widely credited with rallying national support for the program after touring western provinces in 1999.[62] Several powerful government organizations were involved in the program: the State Development and Planning Commission and the State Council's Office of Western Development were responsible for overall planning, the State Forestry Administration oversaw implementation, the Ministry of Finance disbursed the cash subsidy to participating counties, and the State Grain Bureau supplied the grain subsidy. Parallel structures were set up at the provincial and county levels. County forestry bureaus actually implemented the program along with township and village officials.[63]

At least in the early phases of implementation (1999-2001) the differences between the SLCP and previous programs were not as great as planners might have hoped, according to case studies.[64] Tree survival rates were in many cases still quite low.[65] The reasons for this included lack of adequate tree nurseries, water supplies, pest control, and farmer education, as well as, perhaps most importantly, an insistence that trees be planted in areas better suited for grasses.[66]

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[59] The SLCP was also in Ningxia and some other provinces at this time, but these were not part of the official pilot program.

[60] Xu et al. (2004).

[61] Xu and Cao (2002).

[62] Zuo (2002a).

[63] Ibid.

[64] Katsigris et al. (editors) (2004).

[65] Zuo (2002a) reports survival rates in Northern provinces were quite low. Bennett (2005) reports a 16-township sample from 2003 showed 10 townships falling below government standards (70-85% survival depending on region) by the third inspection, although only three were below 60%. Ge et al. (2004) report Dingxi County, Gansu Province only had 24% of SLCP land up to standard (85% survival for trees, 35% ground coverage for grasses) after one year. Du and Guo (2004) report survival rates were generally higher in the warmer, wetter south, including Tianquan County, Sichuan Province with total survival rates above 90% in the first year after one round of replanting. Xu and Cao (2002) report survival rates across all six case study counties were only 20-50% after first plantings.

[66] Although not in the context of grasslands, Ross (1988), p. 68 discusses the single-minded mania with afforestation at the expense of the actual natural resource base. Zuo (2002a) does document examples where serious technical consideration did go into the decision of where and when to plant trees verses grasses.

In spite of the potential accountability of yearly subsidy payments, some farmers reportedly did not have the incentive to stay and provide the necessary aftercare for their seedlings.[67] Perhaps some farmers did not believe that the subsidy would be taken away in subsequent years even if their trees died,[68] or perhaps the opportunity cost of aftercare was still too high. This would be especially the case if off-farm work was available. This problem points to potential contradictions in the program's goals: on the environmental side, yearly payments provide incentives for farmers to stay and care for tree seedlings, but the economic goals of the program include providing farmers incentives to leave the farm and find work elsewhere.[69]

Another reason incentives might have been low is that the principle of volunteerism was not truly respected in many cases. Studies have shown most farmers were willing participants because of the relatively high value of subsidies.[70] But there is perhaps an important difference between "willingness" and "voluntary" that affects the long-term incentive structure of the program. An institutional innovation of the program was supposed to be that it embraced the principle of volunteerism with farmers enrolled through economic incentive, not government regulation. However researchers studying the institutional structure and implementation of the program have found the evidence supporting a truly voluntary implementation mixed at best.[71] If some farmers were told they were "volunteering" to have their farmland retired, their motivation might be lower than it would have been under a completely voluntary program, regardless of the economic incentives.

Along with a lack of respect for volunteerism, another aspect of the SLCP which bore similarity to previous environmental programs was the requirement to plant trees on a portion of barren wasteland, equal or greater in area to retired farmland.[72] Local governments vied for

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[67] Ge et al. (2004).

[68] Ibid.

[69] Ibid. The authors report 90% of young male farmers were gone in Dingxi County before implementation even started.

[70] Xu and Cao (2002) report more than 95% of participating farmers in five of seven case study counties were willing participants. The percentages in the other two counties were 88% and 63%. In their sample, Uchida et al. (2005) find a majority of farmers' plots were scheduled to receive subsidies that exceeded the previous year's net revenue.

[71] Bennett (2005). Xu et al. (2004) report only 21% of participating farmers in their sample were consulted before implementation began and only roughly one-third reported having autonomy to pick which plots to retire or which types of trees to plant. Only 28% of non-participants reported autonomy in their decision not to participate.

[72] Xu and Cao (2002). Because farmers were not compensated for this task, nor were funds set aside to implement it, this was an unpopular requirement which in later years, according to Bennett (2005), was relaxed from a requirement to a suggestion. However the ratio of barren land to farmland retirements went up in later years (see Shao, p. 44), implying local communities still had to reforest barren land in order to receive program funds.

program funds by pledging to plant on ever larger percentages of barren land. If participating farmers could not meet these pledges, work teams were set up and program funds were diverted to pay for them.[73] Under these circumstances, the SLCP was not very different from earlier tree planting programs in methods, incentives, or institutional structure.

The selecting, preparing, and inspection of plantings for individual plots was very time consuming. Case studies report every available township official worked fulltime on the SLCP for at least two months during initial implementation.[74] Because this level of effort was clearly not sustainable, farmers might reasonably expect follow-up inspections to be cursory by comparison. Furthermore, because the funds came from the national government there was incentive for local inspectors to ratify farmer's plots, otherwise those earmarked funds might leave the community. At the same time, they might have felt pressure to cover up any problems with implementation because they could potentially lose their jobs if this high profile and expensive program were not handled correctly.[75]

A structural problem with the SLCP was that plots most likely to fail inspection (70-85% minimum survival rate, depending on area)[76] and potentially fall out of the program were the most ecologically critical and therefore most important for program success both environmentally and— because these marginal plots were most likely farmed by the poorest farmers—economically as well. Without proper infrastructure (nurseries with hardy locally appropriate species, water supplies, farmer education) trees have a low probability of survival on arid, sloping, marginal land. Furthermore, there were few or no program funds earmarked to supply this infrastructure if it were lacking, as it was most likely to be in poor, ecologically marginal, western areas.[77] A partial solution to this problem, from the perspective of local inspectors, might be to pass these marginal plots anyway so that the funds would be delivered and then replant the plots. Case studies report that many plots required replanting to meet standards.[78] To pay for replanting money often had been taken from the farmer's subsidy because the 50 Yuan planting allowance was not renewable.

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[73] Zuo (2002a).
[74] Ibid.
[75] Ibid.
[76] Bennett (2005). Ge et al. (2004).
[77] According to Bennett (2005) starting in 2002 funds were allocated for administering the program but these funds remained insufficient to meet local costs and were often diverted before reaching the township level.
[78] Xu and Cao (2002).

At the local level, the SLCP was mostly regarded as an economic support program by farmers and a political task by local officials, according to case study reports.[79] Both of these viewpoints created pressure to expand the program beyond initially mandated levels. On the economic side, if more land was converted than was budgeted, there was the expectation more funds would be provided to make up the difference. On the political side, local officials felt they could score political points with their superiors if they expanded the program beyond initial targets, as this showed political commitment to a program that had strong backing at the national level. In practice, funds for land converted over planned amounts were usually not delivered or, at best, were not delivered until the following year when new targets and budgets were set. Budgets which might or might not incorporate the overages from the previous year.[80]

The result of a time consuming inspection process, low survival rates, the necessity of diverting funds for replanting expenses, and over zealous conversion of land beyond planned targets was less subsidy payments to farmers.[81] This in combination with the failure to respect the principle of volunteerism may result in a loss of faith in the program and less willingness to participate in the future. Most importantly, if economic benefits are not evident, farmers may have little incentive to keep farmland out of production once payments end. This especially would be the case if they felt payments and benefits were less than had been promised.

IV.   Previous Studies of the SLCP

Determining whether or not the program has brought economic benefits to farmers has been an important objective for researchers both for its own sake and because of the aforementioned connections with the environmental sustainability and local incentive structure of the program.

Using a county case study methodology with household level surveys, Xu and Cao (2002) find evidence of increasing non-agricultural incomes in participating counties.[82] Four case-study counties in Gansu, Yunnan, Guizhou, and Sichuan (one county per province) each saw rises in non-farm per capita income ranging from 17% in Guizhou to 40% in Gansu which the authors

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[79] Zuo (2002a).

[80] Ibid.

[81] Xu and Cao (2002). Zuo (2002a). Xu et al (2004). Bennett (2005).

[82] Xu and Cao (2002) review the case studies done by various teams in 2001 as part of the China Council for International Cooperation on Environment and Development (CCICED) Western China Forests and Grasslands Task Force's survey and analysis of the SLCP.

attribute to more members of farm households finding off-farm jobs. These increases in non-agricultural income translated into higher per-capita total incomes only in Sichuan and Yunnan, while Gansu and Guizhou saw drops in total income of 20% or more.

Uchida et al (2005) find substantial rises in per capita income in Ningxia and Guizhou between 1999 and 2000 as a result of program participation.[83] In Ningxia, participating households had an average increase in net income of 75%, while households in Guizhou had a more modest increase of 8%. Most of this increase the authors attribute to the program subsidy payments themselves. However, because the survey only included participating households, the authors are unable to compare the changes in income of participants and non-participants

Using a later survey that included non-participants and a uniform three years of program participation, Xu et al (2004) are better able to assess the economic impacts of the SLCP.[84] Their survey of 360 households in Gansu, Shaanxi, and Sichuan finds that SLCP participation, net program payments, significantly reduced both cropping and total per capita income compared to non-participating households. When program payments are added, the differences between the two groups are statistically insignificant for all income categories analyzed, including cropping income, livestock income, off-farm income, and total income. The authors question the sustainability of a program that makes farmers relatively worse off net subsidies, especially because the hoped for program-induced economic transition was not evident after three years of participation.

Using the same 360-household dataset, Uchida et al. (2004) find evidence that the SLCP increased livestock inventories and non-cropping agricultural income (i.e., income from livestock).[85] The value of houses and fixed productive assets (e.g., machinery) also increased after three years of program participation. The authors suggest participating households may be using subsidies to build up livestock inventories and other assets in anticipation of future earnings. Freed up labor may have been used in home renovation projects as homes in rural China are often the main wealth asset of families. The authors also find weakly significant evidence of increased off-farm labor, with participating households increasing the number of

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[83] Uchida et al. (2005) Survey included 144 SLCP households from 16 randomly selected villages in Ningxia and Guizhou Provinces.
[84] Xu et al (2004).
[85] Uchida et al (2004) use several different analytical methods. Results discussed here are from their preferred technique of difference-in-differences matching.

adults with off-farm work by 0.04 individuals. The analysis did not find evidence of increasing agricultural incomes or migration due to participation in the program.

Zhang and Liu (2005) perform an economic analysis of the Beijing and Tianjin Sandstorm Source Control Program, which in design and implementation is almost identical to the SLCP.[86] The authors use a household panel survey covering 1998 to 2003 in 17 counties in Hebei, Shanxi, and Inner Mongolia to estimate a 9% increase in household income with program participation, a result that is fairly consistent across several estimation strategies. They also find evidence of income diversification away from agriculture to more non-farm sources. Due to the small sample size of non-participating households (by the end of the panel 93% of households had joined the program), conclusions about income diversification were based on graphical analysis of trends and not statistical analysis.

Participation factors are analyzed by Uchida et al. (2004) using both their household data and a supplemental village-level survey.[87] Only distance to the nearest river and population density were significant predictors of village participation, with villages closer to rivers and less densely populated more likely to participate in the program.[88] Slope, forest cover, income, distance to township office, and the number of out-migrants were among the variables that did not statistically predict participation. On the other hand, some of these variables were significant predictors of the intensity of participation, measured either by the number of participating households in the village or the amount of village farmland enrolled. Villages with more out-migrants had greater intensity of participation, as did villages with less forest cover and higher slope. [89]

Focusing specifically on the original targeting goals of program planners, Uchida et al (2004) do not find evidence that the program was specifically targeted at the poor. However, on the environmental side, Uchida et al (2005) using a multivariate analysis do find plots with

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[86] Zhang and Liu (2005). The Sandstorm Source Control Program is one of the six environmental programs created or reorganized after the 1998 Yangtze flooding. This program's impetus is the yearly sandstorms in the Beijing and Tianjin area whose source is the desertification spreading out of the Gobi desert region of north China. In its redesigned form, the program includes a farmland retirement component that uses a design similar to the SLCP.
[87] Uchida et al. (2004). Their village level survey was done in the same villages as the household survey.
[88] Ibid. The authors use Logit regression. Distance to river was only weakly significant.
[89] Ibid. These variables are ranking variables that order villages from most to fewest migrants, highest to lowest forest cover, or highest to lowest slope.

higher slopes and lower crop yields were more likely to be included in the program.[90] Xu and Cao (2002) in their review of the six-county case study data also find more than 80% of included plots had slopes of 15 degrees or more.[91]

V. Data

This study uses village-level data collected by researchers at the Center for Chinese Agricultural Policy in 2003 from 2,459 villages, 216 townships, 36 counties, and six provinces across China.[92] Sample provinces were randomly selected from each of China's major agro-ecological zones. Six counties were randomly selected from each province, two from each tercile of counties arranged by gross value of industrial output. Within each selected county six townships were randomly selected, again two from each tercile of gross value of industrial output.
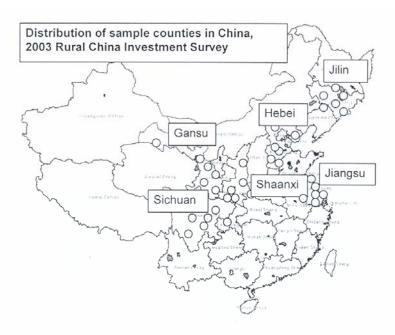

Figure 1. Geographical distribution of sample counties in China, Rural China Investment Survey, 2003

Adapted from Zhang et al. (2004)

Each village in the selected townships was asked to send two representatives (typically the village head and accountant) to a meeting with survey enumerators in the township offices. The average number of villages surveyed per township was 11. The average rate of village non-

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[90] Uchida et al. (2005).
[91] Xu and Cao (2002).
[92] See Zhang et al. (2004).

response was 6% and in no case did surveyors leave a township until at least 80% of villages were enumerated. Variables were collected on no-show villages to test for bias of non-response. No variables were found to be significant. If a township had more than 25 villages, a random selection of 25 villages was made. This procedure was necessary in only five townships.

Village-level socioeconomic, land use, and political participation data were collected for 2002 and 1997, along with a detailed enumeration of every public goods and economic development project implemented in the village between 1998 and 2003. These data neatly straddle the inception of the SLCP in 1999. Because the 1997 data points are based on the records and recollection of respondents in 2003 they are likely less accurate than the 2002 data, however, there is no reason to suspect these inaccuracies are systematic in a way that would bias the analysis, which concerns changes between 1997 and 2002, not the absolute values of the data at either time point.

This survey was designed to track investments at the village level between 1997 and 2003 and was not specifically designed to evaluate the SLCP, which was merely one of the investment categories, albeit one of the most common. The broader scope of the survey is both a strength and a weakness for the present purpose of evaluating this program. On the plus side, it has more variables than other surveys more directly focused on the SLCP, including a very detailed series of land use and physical infrastructure variables. Also, because the SLCP was merely one of many investment projects being surveyed, there was perhaps less political pressure to put the SLCP in an artificially positive light.

On the negative side, a few variables of specific interest to an SLCP analysis are not as well defined as they could have been under a different survey design. The income per capita variable is assumed to include the value of both the cash and grain subsidy, although this inclusion was not specifically directed in the questionnaire. The survey questionnaire did specify that SLCP area should be included in total forest land area, which creates the possibility growth in forest area is a mechanical result of question design. Because of the likelihood at least some SLCP plots with low survival rates have been included in total forest area, the forest area variable should be considered an upper bound on actual forest area. Of course this forest area variable also suffers from the fact that these newly planted plots bear little resemblance to mature natural forest, but this distinction is not made in the forest cover variable.

See Table I for a breakdown of SLCP villages by province. This table shows villages enrolled in the program by the end of 2002. An additional 235 sample villages enrolled in the program in 2003, nearly two-thirds of which (150 villages) were in Jilin province. These 2003 villages are only included in the probit participation analysis.

Table I: Sample villages enrolled in SLCP by province*

Province	SLCP village	Non-SLCP village	Percent SLCP enrollment (by province)
Jiangsu	33	424	7.2%
Gansu	168	160	51.2%
Sichuan	202	163	55.3%
Shaanxi	236	133	63.9%
Jilin	125	242	34.1%
Hebei	92	481	16.1%
Total	**856**	**1603**	**34.8%**

* Sample villages enrolled in program by the end of 2002.
Source: Center for Chinese Agricultural Policy 2003 Rural China Investment Survey.

VI.   Descriptive Statistics

Table II gives a breakdown of the SLCP in the 856 sample villages enrolled in the program by the end of 2002. The mean project area was 604.3 mu, and the mean investment was 99,259 Yuan. Median values were roughly half as large at 290.0 mu and 40,000 Yuan invested. At the end of 2002, the average village had been in the program for 2.0 years and had 57.7% of its households enrolled in the program, and the median values are almost identical to the means: 57.9% enrollment rate and 1.9 years in the program. The range of values in each variable of interest is large; however for 'percentage of village households enrolled' and 'time in the program' variables the range of values is within two standard deviations. Project area and investment do have some large outlier values; the largest project area was 11,715 mu, and the largest investment was more than 3.6 million Yuan.

Table II: Summary Statistics for the SLCP through 2002

	Mean	Standard Deviation	Median	Min	Max
Project Area (mu)	604	974	290	2	11,715
Percentage of Households enrolled (%)	57.7	36.7	57.9	0.2	100
Time in program (years)	2.0	1.3	1.9	0^	4
Total program investment (Yuan)	99,259	210,647	40,000	0	3,673,000
Investment per mu (Yuan)	233	342	150	0	4,000

^Villages that started the program in December 2002 are given a zero value for time in program.
N=715-855, differences due to missing data.
Source: Center for Chinese Agricultural Policy 2003 Rural China Investment Survey.

Most pre-program (1997) socioeconomic (Table III) and land use (Table IV) indicators show clear differences between SLCP and non-SLCP villages. For instance, non-SLCP villages

had on average 33% larger populations (1,567 vs. 1,174 people) and 66% higher per capita incomes (1,690 vs. 1,019 Yuan). In non-SLCP villages one percentage point more households owned businesses (4.33% vs. 3.32%). Roughly one-quarter of the non-SLCP village workforce worked off the farm (26.30%), compared to one-fifth of the average SLCP village (20.44%). Conversely, the percentage of households whose only income came from farming was 6.6 percentage points higher in SLCP villages (70.47% vs. 63.87%). Migration (villagers who live and work outside the village) was slightly higher in non-SLCP villages (12.33% of the workforce vs. 11.75%). Following from these, more of the average non-SLCP villager's income (32.42% vs. 27.30%) came from off-farm sources.

Education levels were also, on average, higher in non-SLCP villages. The labor force literacy rate was more than five percentage points higher (91.11% vs. 85.43%) and the post-secondary education rate was a point-and-a-half higher (8.61% vs. 7.04%).

Table III: Sample means for participating and non-participating villages in Sloping Land Conversion Program in 1997 and 2002: Socioeconomic indicators

	SLCP villages			Non-SLCP villages		
	1997	2002	**Percent change (of mean values) 1997-2002**	1997	2002	**Percent change (of mean values) 1997-2002**
Population	1,174	1,183	**0.77%**	1,567*	1,571	**0.25%**
Number of households	296	305	**3.04%**	429*	440	**2.56%**
Percent only farming households	70.47%	59.42%	**-15.68%**	63.87%*	55.78%	**-12.67%**
Percent exclusively non-farming households	4.81%	7.96%	**65.49%**	5.71%*	8.12%	**42.21%**
Percent business owning households	3.32%	4.84%	**45.78%**	4.33%*	6.08%	**40.41%**
Per capita income (Yuan)	1,020	1,324	**29.80%**	1,690*	2,132	**26.15%**
Percent non-farm income	27.30%	35.16%	**28.79%**	32.42%*	40.58%	**25.17%**
Total labor force	563	578	**2.66%**	770*	783	**1.69%**
Percent off-farm labor force	20.44%	30.00%	**46.77%**	26.30%*	35.77%	**36.01%**
Percent migration (percent of total labor force living outside the village)	11.75%	18.86%	**60.51%**	12.33%	18.51%	**50.12%**
Labor force literacy rate	85.43%	88.25%	**3.30%**	91.11%*	93.09%	**2.17%**
Percent of labor force with education beyond	7.04%	9.15%	**29.97%**	8.61%*	10.46%	**21.49%**

high school							

Land use and environment indicators also showed differences in 1997. At the village aggregate level, SLCP villages had slightly less total farmland (2,399 mu vs. 2,670 mu) but nearly five times the total forest area (2,933 mu vs. 614 mu). Mean grassland was much higher in non-SLCP villages (4,698 mu vs. 446 mu) but this was mainly due to a few extremely large outliers; the median level of grassland was zero for both groups of villages. Amounts of sloping farmland were double in SLCP villages (1,486 mu vs. 753 mu) and percentages of farmland sloped 25 degrees or more was more than twice as high in SLCP villages (38.94% vs. 16.96%). The state of soil erosion, as assessed by survey respondents on a 4-point scale, was more than half a point worse in SLCP villages (2.54 vs. 3.13).

On a per capita basis, SLCP villages had 20% more farmland (2.37 mu vs. 1.98 mu), nearly twice as much terraced farmland (0.39 mu vs. 0.21 mu), equal amounts of horticultural land, which includes vegetable plots and orchards (0.12 mu), but only one-third the irrigated farmland (0.29 mu vs. 0.85 mu). Per capita sloping farmland is double in SLCP villages (1.67 mu vs. 0.80 mu) and 25 degrees and above sloping farmland is more than double (1.01 mu vs. 0.42 mu). Total cropping area, which accounts for double-cropping on the same plot during the year, was nearly equal, with SLCP villagers having slightly more (2.82 mu vs. 2.73 mu).

Based on the pre-program economic and environmental differences, these statistics imply that the program was targeted according to planners explicit and implicit intentions: participating villages were on average poorer, more oriented towards agriculture, and had more sloping farmland.

Table IV: Sample means for participating and non-participating villages in the Sloping Land Conversion Program in 1997 and 2002: Land use indicators

	SLCP villages			Non-SLCP villages		
	1997	2002	Percent change	1997	2002	Percent change
Total farmland area (mu)	2,399	2,060	-14.13%	2,670*	2,598	-2.70%
Total sloping farmland (mu)	1,486	1,163	-21.74%	753*	728	-3.32%
Total farmland sloped 25 degrees or more	846	634	-25.06%	394*	369	-6.34%
Total forestland area (mu)	2,933	3,491	19.02%	614*	664	8.14%
Total grassland area (mu)	446	565	26.68%	4,698*	4,618	-1.70%
Percent farmland sloped 25 degrees or more	38.94%	36.76%	-5.60%	16.96%*	16.52%	-2.60%
Per capita farmland (mu)	2.37	1.93	-18.57%	1.98*	1.91	-3.53%
Per capita sloping farmland (mu)	1.67	1.24	-25.75%	0.80*	0.77	-3.75%

Per capita farmland sloped 25 degrees or more (mu)	1.01	0.71	-29.70%	0.42*	0.38	-9.52%
Per capita irrigated farmland (mu)	0.29	0.30	3.45%	0.85*	0.86	1.18%
Per capita terraced farmland (mu)	0.39	0.39	0%	0.21*	0.21	0%
Per capita horticultural land (mu) (includes orchard land)	0.12	0.18	50%	0.12	0.14	16.67%
Per capita crop planting area (counts area each time a crop is planted during the year) (mu)	2.82	2.39	-15.25%	2.73	2.66	-2.56%
Soil erosion (1=very serious, 4=none)	2.54	2.68	5.51%	3.13*	3.15	0.64%

Source: Center for Chinese Agricultural Policy 2003 Rural China Investment Survey. N=2,459.
* 1997 sample mean for non-SLCP villages statistically significantly different (at the 5% level) from 1997 value for SLCP villages. Using a two-sample t-test, unequal variances assumed.

Post-program implementation (2002) indicators showed similar trends for both program and non-program villages. Population growth was minimal in both categories; the average SLCP village grew by 0.77%, while non-SLCP villages grew by 0.25%. Per capita income grew by 29.80% in SLCP villages and by 26.15% in non-SLCP villages. Business owning households increased by 45.78% in SLCP villages and 40.41% in non-SLCP villages. The non-farm labor force increased 46.77% in SLCP villages and 36.01% in non-program villages. Exclusively farming households dropped by 15.68% in program villages and 12.67% in non-program villages. Migration increased by 60.51% in program villages and 50.12% in non-program villages. Non-farm income increased by 28.79% in program villages and 25.17% in non-program villages.

Education improvements were somewhat greater in SLCP villages. Labor force literacy grew in SLCP villages by 3.30% and by 2.17% in non-SLCP villages. The percentage of the labor force with at least some post-secondary education grew by 29.97% in program villages and 21.49% in non-program villages.

Differences in outcomes were somewhat more marked in the land use and environment categories. Total farmland shrank by 14.13% in SLCP villages but only by 2.70% in non-SLCP villages. Total forest area grew by 19.02% in program villages but only by 8.14% in non-program villages. Grassland grew by 26.68% in program villages while dropping by 1.70% in non-program ones. Sloping farmland dropped by 21.74% in program villages and only 3.32% in non-program villages. Highly sloping farmland (25 degrees or more) dropped by 25.06% in SLCP villages and 6.34% in non-SLCP villages. The severity of soil erosion lessened by 5.51% (on a four point scale) in program villages and by 0.64% in non-program villages.

Per capita differences were also marked in some cases. SLCP villagers had 18.57% less farmland on average in 2002 compared to 1997, while in non-SLCP villages farmers lost less

than 4% of their farmland. Sloping farmland amounts were down 25% in program villages while non-program villages lost less than 4%. Percentage wise, reductions in highly sloped farmland where slightly higher, 29.70% in SLCP villages and 9.52% in non-SLCP villages.

Total cropping area was down 15% for program villagers and less than 3% in non-program villages. Horticultural land increased in SLCP villages by 50% to 0.18 mu per villager, while in non-SLCP villages growth in per capita horticultural land was 16.67% to 0.14 mu. However, the amounts of terraced farmland did not change between 1997 and 2002 and the growth of irrigated farmland was minimal (0.01 mu) for both categories of villages.

These descriptive statistics show that the economic transition away from an exclusively farm economy was happening across these six provinces regardless of SLCP participation. A simple comparison of changes in mean values between 1997 and 2002 does not make an especially strong case for a program effect on economic transition indicators. They do show that the two categories of villages were not equal across most socioeconomic and land use variables before and after program implementation. In 1997, SLCP villages were poorer, had smaller populations, got more of their income from farming, and were less educated than non-SLCP villages. These differences remained within roughly the same range in 2002.

In terms of land use, SLCP villagers had more farmland per capita, more than twice as much sloped and highly sloped farmland, but only a third as much irrigated farmland in 1997. After program implementation, SLCP villages lost farmland and gained forest land. In the average village, 95% of lost farmland was sloping farmland, and 63% was sloping 25 degrees or more. Program villages did show a greater improvement in soil erosion according to the self-reported soil erosion index. All of these outcomes support the programmatic goals of the SLCP.

VII.   Analysis of SLCP participation

Descriptive statistics show that prior to SLCP implementation there were measurable differences of means between treatment and control villages across a series of land use, environment, and socioeconomic variables. This implies these variables may have influenced the decision to enroll, regardless of whether that decision was a participation decision made at the village level or was a targeting decision made at a higher level.

A more specific analysis of program participation/targeting can be done using a probit regression model, which will show which explanatory variables have a statistically significant

influence on the typical village's probability of participation. Table V shows the results of a probit regression that regresses a 0-1 dichotomous participation variable (1=SLCP participation, 0=otherwise) on 22 village-level socioeconomic, land use, and environmental variables. Coefficients in Table V are converted to show the change in probability of SLCP participation for each unit change in that explanatory variable, holding all other explanatory variables constant at their sample mean values.

For instance, a point change in the soil erosion index from 2=serious soil erosion to 1=very serious soil erosion increases the odds of program participation by 9.68%. Increasing by 10% the amount of farmland sloped 25 degrees or more increases odds of participation by 1.5%. While increasing by 10% the amount of flat land decreases participation odds by 0.2%. Adding one mu to per capita farmland increases participation odds by 3.32%, and an additional mu of irrigated farmland per capita decreases participation odds by 21.12%.

Table V: Probit regression estimating determinants of village participation in the SLCP (Dependent variable: 1=participation, 0=otherwise)^

	Change in probability of participation with each unit increase of predictor variable
Population	0.000000218
	(0.000013)
Average household size	-0.007763
	(0.009108)
Percent minority population	-0.000036
	(0.000458)
Per capita income	-0.0000972***
	(0.0000165)
percent non-farm income	-0.000320
	(0.000595)
Per capita enterprises	-5.28791
	(4.50553)
Percent labor force educated beyond high school.	-0.001892
	(0.001769)
Per household total cadres from village	-0.355242
	(0.377186)
percent exclusively farm households	0.000869*
	(0.000505)
Percent non-farm labor force	0.001265
	(0.000783)
percent Migration (village labor force working and living outside village)	-0.003203***
	(0.001131)
Per capita farmland	0.033179***
	(0.007529)
Per capita irrigated farmland	-0.211184***
	(0.021661)
percent households with electricity	0.000391
	(0.000523)
Cement/blacktop road passing through village (1=yes)	0.048487*
	(0.027387)
Distance to township center	-0.0000408
	(0.002319)
Per capita village debt	0.0000665**
	(0.0000338)

Total water area in village (mu)	-0.00000515
	(0.0000148)
Distance to main village water source	-0.021663*
	(0.012840)
Percent of total village land that is flat	-0.0001862***
	(0.000471)
percent of total village farmland sloped 25 percent or more	0.001471***
	(0.000470)
Soil erosion (1=very serious, 4=none)	-0.096795***
	(0.016541)

^This analysis also includes villages that enrolled in the program during 2003,
 bringing total village enrollment to 1,091. N=2,444.
*Significant at 10%, **significant at 5%, ***significant at 1%.
(Standard errors in parentheses)
Source: Center for Chinese Agricultural Policy 2003 Rural China Investment Survey.

Among the economic variables, as migration increases by 10% the odds of program participation drop by 3.2%. Each additional 100 Yuan of per capita income decreases participation by 0.97%. Per capita village debt increasing by 100 Yuan increases participation odds by 0.67%.

Several additional variables are weakly significant at the 10% level, including distance to main village water source, whether or not a cement/black top road passes through the village, and the percentage of households whose only source of income is agriculture.

Overall, the probit model results support the stated goals of program planners to target poor, environmentally threatened villages that had not transitioned to a post-agricultural economy. On the environmental side, as slope goes up and soil erosion worsens, the odds of program participation increase. On the poverty side, as income goes down and village debt goes up the likelihood of program participation increases. In terms of economic transition, villages with fewer out-migrants, more farmland, but less irrigated farmland are more likely to participate. However the coefficients are all quite small, especially for the critical predictors of per capita income and sloping farmland.

VIII.   Analysis of program effect

Both the descriptive statistics and probit model make evident there were pre-program differences between participating and non-participating villages and that sample villages were not equally likely to be selected for the program. This confirmed selection bias is good news for program planners who intended these economic and environmental factors to guide the selection process, but it makes evaluation of program effects more difficult.

The contours of how the SLCP was implemented also create problems for estimating program effects. The program started in the west in 1999 and then expanded eastward, mostly in

2001 and after. As it expanded eastward participation rates went down both within villages and across villages. The result is a correlation between being in the west, time in program, participation rate within villages, and program area (i.e., villages in the west are more likely to have been in the program longer and have higher participation rates and larger program areas). There are also marked geographic differences between the program treatment group and the non-program control group. Looking at Table I shows that 70.8% (606 of 856) of treatment villages are in the three western provinces of Sichuan, Gansu, and Shaanxi, while 71.5% (1,147 of 1,603) of the control group villages are in the three eastern provinces of Jilin, Hebei, and Jiangsu. Correlation between treatment variables and area argues against including area effects variables because this could result in underestimation of program effect. At the same time, marked geographic differences between treatment and control groups argue for the inclusion of area effects to control for unobserved differences between treatment and control groups that are predominately from different regions of the country.

This analysis regresses the simple difference (for land use and environmental variables) or the log difference (for economic variables) between 2002 and 1997 outcome variables on a program treatment variable and a series of socioeconomic, physical infrastructure, land use, and environmental control variables, which are all set at 1997 levels to avoid endogeneity with the right-side program treatment variable or the left-side differenced outcome variable. Then area fixed effects are added to the regressions to control for unobserved area effects. Results from both models are included in Tables VI-IX.

The program-induced effects are surprisingly strong given the relatively short time span between enrollment and the end of 2002 when these effects were measured. Of course these results are only as good as the data and the functional form assumptions made in estimating them. The strength of this dataset is the large number of socioeconomic and land use measurements which allow for the specification of a very detailed model. The risk is over-specification, leading to poor estimations of variable coefficients due to multicollinearity or incorrect functional form assumptions (the more variables added the greater the risk some will behave in non-linear ways).

In defense of this multivariate regression model, the size of the coefficients on the major variables of interest is fairly stable across different model specifications. As variables are added there are rarely wide swings in coefficient size, usually the program variable coefficients are stable or are reduced smoothly as the model is expanded.

VIIIa. Land use and environmental changes

Recalling that the SLCP is at its heart an environmental program that seeks to change land use decisions of farmers across rural China, the land use changes occurring between 1997 and 2002 as a result of program participation are central to any evaluation of program outcomes.[93] Because of the difficulty of measuring soil erosion changes, land use change is a possible proxy for environmental outcomes.[94] Uchida et al (2005) and Xu and Cao (2002) both use the slope of SLCP plots as the best available proxy for environmental success and both of these papers find farmland sloped 15 degrees or more is reasonably well targeted by the program. However, these studies don't give a detailed picture of program-induced land allocation in the village.

The central issue is the exchange of farmland for forest, orchard (included in horticultural land) or grassland and what percentage of this farmland is sloping land, especially land sloping 25 degrees or more. Sloping farmland is the key intermediate environmental outcome and is a proxy for soil erosion reductions. However, in addition to this proxy the analysis includes a soil erosion outcome variable based on a locally estimated four-point scale. Including this variable in the econometric analysis gives a first approximation of the early effects of the SLCP on this outcome critical to the environmental goals of the program.

It can be argued that using econometric analysis is the wrong strategy to use with SLCP-related land use changes. If the program is directed from above and for the most part implemented faithfully in the village, as case studies imply, the transaction between program size, farmland, forest, and grassland should be a straightforward and transparent one. But land use change, even under the strictures of a top-down, fairly uniformly regulated policy, is perhaps more complex than this. Certainly socioeconomic and environmental differences at the village level and unobserved differences at the county level affect the land use decisions of villagers and the success of those decisions. Regression analysis allows us to ask what effect the program had on forest cover changes, controlling for income level, electricity coverage, and availability of tap

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[93] Land use change is itself still an intermediate outcome that indicates but does not confirm the main environmental goal of reducing soil erosion—which is also an intermediate outcome in the overarching goals of reducing air and water pollution both locally and downstream and downwind. Soil erosion is perhaps best characterized as the primary onsite environmental goal of the SLCP.

[94] Experimental plots can be used to estimate the likely soil erosion gains from different land use categories. See Hamilton and Pearce (1986).

and surface water among other variables, all of which could conceivably affect forest cover. The question becomes what portion of changes in forest cover or the amount of sloping farmland are the result of the SLCP and what portion may be due to other factors.

To test for these program-induced land use and soil erosion changes, two program treatment variables are used: a dummy variable set at one if a village implemented the SLCP before 2003 and zero otherwise; and a total SLCP project area (measured in mu) variable.[95] The participation dummy estimates the effect of enrollment in the program on land use change over the 1997 through 2002 period, while the project area variable estimates the efficiency of the program, i.e., did each mu of program area lead to an additional mu of forest, grass, or orchard? Also this treatment variable indicates how much farmland, especially sloping farmland, was retired per mu of project area.

The simple change (2002 value minus 1997 value) in forest, horticultural and grassland area, farmland (including sloping and highly sloping farmland), and the erosion index are separately regressed on each of these two program variables as shown in equations 1 and 2. Each Ordinary Least Squares (OLS) regression includes as control variables the 1997 village-level values for population, average household size, per capita income (logged), percentage of income coming from non-agricultural sources, percentage of labor force with education above high school, literacy rate of labor force, per household number of township-level or higher cadres from the village, percentage of households only in engaged in farming, percentage of households not engaged in farming, percentage of households owning their own business, per capita number of business enterprises in the village, per capita village debt (logged), percentage of labor force working in non-agricultural industries, percentage of labor force working and living outside the village, distance from township, whether or not a cement road runs through the village, percentage of households with tap water, percentage of households with electricity, percentage of households with telephone service, per capita farmland, per capita irrigated farmland, per capita horticultural land, per capita surface water area, per capita forestland, percentage of farmland sloping 25 degrees or more, and the state of soil erosion (4-point scale). The variables B1-B3 are

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[95] The project area variable has two possible specifications which makes its interpretation somewhat problematic. It should refer specifically to the amount of farmland retired as part of the program for which the government paid a specific subsidy. However, it is possible that in their calculation of the total program area variable some respondents included the re-planted barren land, which was not subsidized by either cash or grain payments to farmers. Descriptive statistics below also imply respondents may have been using this looser definition of project area because, on average, farmland reductions are significantly smaller than project area. This disparity could also be explained by new farmlands brought into production to offset the program-induced reductions.

the estimated regression coefficients. Area dummy variables control for either county or province differences in village location, and C is the error term.

(Eq. 1) Y1-Y0 = B1*SLCP participation dummy(1=participation) + B2*Controls (+ B3*area dummy) + C

(Eq. 2) Y1-Y0 = B1*SLCP project area + B2*Controls (+ B3*area dummy) + C

       The descriptive statistics in Tables II-IV give a starting point for making comparisons with the regression results. Taking the difference of the averages[96], Table IV shows SLCP villages lost 339 mu of farmland between 1997 and 2002, of which 323 mu was sloping farmland, and 212 mu was farmland sloping 25 degrees or more. SLCP villages on average gained 558 mu of forest, 119 mu of grassland, and 61 mu of horticultural land (not shown in Table III). The average SLCP project size was 604 mu. SLCP project area should go into one of three areas, forestland, grassland, or horticultural land. Adding the three categories together gives 757 mu, or 125% of project area. Dividing farmland reductions by project area gives similar rough 'efficiency' scores of 56.18% for total farmland, 53.46% for sloping farmland, and 35.06% for farmland sloping 25 degrees or more. Clearly some of the land use changes occurring were outside of the scope of the SLCP. The regression analysis below attempts to isolate the land use effect of the program by controlling for as many pre-program village-level differences as the data will allow.

       The results of the regression analysis are displayed in Tables VI-VII. The treatment variables are significant in most cases. Adding area fixed effects reduces the size of the program effect in all cases, which, if this model is robust, are due to unobservable differences at the province or county level that affect these land use outcomes.

Table VI: Estimated effects of SLCP participation on land use and environmental changes, 1997 to 2002.^

Program treatment variable: participation in SLCP (1=participation, 0=otherwise)			
Model Dependent variable	OLS without area effects	OLS with province fixed effects	OLS with county Fixed effects
Change in forestland (mu)	471.35*** (49.52)	436.14*** (50.75)	291.83*** (54.53)
Change in grassland (mu)	334.71*** (132.69)	280.72** (137.06)	169.74 (154.23)
Change in horticultural land (mu)	34.92***	25.46**	23.32*

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[96] The average of the differences would probably be a more accurate way to describe the average effects on land use change of the program. This paragraph is meant only as a stylistic comparison with the regression analysis using the numbers available to the reader in Tables II-IV.

	(10.61)	(10.93)	(12.24)
Combined change in forest, grass, and horticultural land (mu)	840.98***	742.32***	484.89***
	(143.23)	(147.49)	(164.35)
Change in farmland (mu)	-220.61***	-189.66***	-151.04***
	(26.30)	(26.76)	(28.99)
Change in sloping farmland (mu)	-222.36***	-198.18***	-162.06***
	(19.38)	(19.70)	(21.08)
Change in farmland sloping 25 degrees or more (mu)	-117.55***	-104.23***	-60.19***
	(15.57)	(15.93)	(17.18)
Change in soil erosion index	0.091***	0.052***	0.022
(1=very serious soil erosion, 4=none)	(0.017)	(0.017)	(0.018)

(Standard errors in parentheses). N=2,452.
* Significant at 10%, ** significant at 5%, *** significant at 1%.
^Regresses the 1997-2002 simple difference of each land use or soil erosion variable on 0-1 program participation dummy variable and the 1997 village-level values for population, average household size, per capita income (logged), percentage of income coming from non-agricultural sources, percentage of labor force with education above high school, literacy rate of labor force, per household number of township-level or higher cadres from the village, percentage of households only in engaged in farming, percentage of households not engaged in farming, percentage of households owning their own business, per capita number of business enterprises in the village, per capita village debt (logged), percentage of labor force working in non-agricultural industries, percentage of labor force working and living outside the village, distance from township, whether or not a cement road runs through the village, percentage of households with tap water, percentage of households with electricity, percentage of households with telephone service, per capita farmland, per capita irrigated farmland, per capita horticultural land, per capita surface water area, per capita forestland, percentage of farmland sloping 25 degrees or more, and the state of soil erosion (4-point scale). Source: Center for Chinese Agricultural Policy 2003 Rural China Investment Survey.

Estimated participation effects (0-1 participation variable, Table VI) in the OLS without area effects regression are 471.35 additional mu of forestland (33% of 1997 mean village value, hereafter 97mvv)[97] , 334.71 mu of grassland (10% of 97mvv), and 34.92 mu of horticultural land (29% of 97mvv), adding up to a total addition of 840.98 mu (18% of 97mvv). Reduction in soil erosion was 0.091 points (on a four-point scale, which is 3% of 97mvv), which was statistically significant.

With province effects added the magnitudes of all the coefficients are reduced, but by relatively small amounts with little loss of statistical significance. Changes with province effects added are 436.14 additional mu of forestland (31% of 97mvv), 280.72 additional mu of grassland (9% of 97mvv), and 25.46 additional mu of horticultural land (21% of 97mvv), adding to a total of 742.32 mu (16% of 97mvv) of additional land due to program participation. Farmland is reduced by 189.66 mu (7% of 97mvv), sloping farmland by 198.18 mu (20% of 97mvv), and highly sloping farmland by 104.23 mu (19% of 97mvv) in the OLS regression with province effects added. The soil erosion index is improved by 0.052 points (2% of 97mvv). All these results remain statistically significant.

Adding county fixed effects reduces these numbers more dramatically to 291.83 mu of forest growth (20% of 97mvv), 169.74 mu of grassland (which was not statistically significant), and 23.32 mu of horticultural land (19% of 97mvv), adding up to a total addition of 484.89 mu (10% of 97mvv). Total farmland was reduced by 220.61 mu (9% of 97mvv), sloping farmland by

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[97] Note these mean village values do not correspond to the values in Table IV which are broken out by whether or not a village received the SLCP.

222.36 mu (22% of 97mvv), and farmland sloping 25 degrees or more by 117.55 mu (21% of 97mvv). Adding the county fixed effects reduces farmland loss to 151.04 mu (6% of 97mvv), sloping farmland to 162.06 mu (16% of 97mvv), and 25 degrees or more sloping farmland to 60.19 mu (11% of 97mvv). Reduction in soil erosion was 0.022 (0.75% of 97mvv), and this result was not statistically significant.

Table VII: Estimated program area effects of SLCP on land use and environmental changes, 1997 to 2002. (Participation dummy multiplied by area (mu) enrolled in SLCP program.)^

Program treatment variable: area enrolled in SLCP (mu)			
Model / Dependent Variable	OLS without area effects	OLS with province fixed effects	OLS with county fixed effects
Change in forestland (mu)	0.734*** (0.033)	0.723*** (0.034)	0.588*** (0.038)
Change in grassland (mu)	0.245*** (0.096)	0.204** (0.099)	0.116 (0.112)
Change in horticultural land (mu)	0.017** (0.008)	0.0081 (0.0079)	0.012 (0.009)
Combined change in forest, grass, and horticultural land (mu)	0.996*** (0.102)	0.935*** (0.106)	0.717*** (0.118)
Change in farmland (mu)	-0.321*** (0.018)	-0.294*** (0.019)	-0.243*** (0.020)
Change in sloped farmland (mu)	-0.311*** (0.013)	-0.295*** (0.013)	-0.243*** (0.015)
Change in steeply sloped farmland (25 degrees or more) (mu)	-0.215*** (0.010)	-0.205*** (0.011)	-0.166*** (0.012)
Change in soil erosion index (1-4)	0.000079*** (0.000013)	0.000044*** (0.000012)	0.0000036 (0.000014)

(Standard errors in parentheses). N=2,452.
* Significant at 10%, ** significant at 5%, *** significant at 1%.
Both participating and non-participating villages included in regressions.
^Regresses the 1997-2002 simple difference of each land use or soil erosion variable on enrolled area program treatment variable and the 1997 village-level control variables listed under Table VI.
Source: Center for Chinese Agricultural Policy 2003 Rural China Investment Survey.

The estimated effects of SLCP area are displayed in Table VII. The OLS without area effects regression estimates each additional mu of program area led to an additional 0.734 mu of forestland, 0.245 mu of grassland, and 0.017 mu of horticultural land, or a combined total of 0.996 mu.

Province fixed effects reduce the size of the coefficients very slightly and only eliminate statistical significance in the case of horticultural land. The greatest reduction in coefficient size is in the soil erosion index where adding province effects reduces the size of the improvement to 0.000044 points for each mu of project area, and this coefficient remains statistically significant. With province effects the changes in forestland are 0.723 mu of additional forest land, 0.204 mu of additional grassland, and a combined addition in forest, grass, and horticultural land of 0.935 mu for each mu of project area added. Farmland is reduced by 0.294 mu, sloping farmland by

almost the same amount, 0.295 mu, and highly sloping farmland by 0.205 mu for each mu of project area.

County fixed effects reduces this efficiency to 0.588 mu of farmland reduction, 0.116 mu of grassland, 0.012 mu of horticultural land (neither grass nor horticultural land were statistically significant), and a combined total of 0.717 mu for each mu of project area. In the OLS without area effects total farmland was reduced 0.321 mu for each mu of project area, sloping farmland was reduced 0.311 mu, and farmland sloped 25 degrees or more was reduced by 0.215 mu. Each additional mu of program area reduced soil erosion by 0.000079 points and this result was statistically significant. With county fixed effects added, the statistically insignificant soil erosion coefficient was reduced to 0.0000036 points.

Taken together the six regression models give results that are consistent with each other and with the rough patterns set out in the descriptive statistics. As more variables are added, the effect of the program variables are reduced but there are no wide swings in coefficients and their proportions in relation to each other remain similar across the two models. The two program treatment variables also tell stories that are consistent with each other. Additions of forestland are roughly twice as large as reductions in farmland regardless of whether the participation dummy or program area variable is used. Proportions of retired farmland that is sloping or highly sloping are also roughly consistent across both treatment variables. And both treatment variables show small but statistically significant coefficients for the soil erosion variable in the OLS without area effects and with province effects, however both of these coefficients drop by similar magnitudes and become statistically insignificant when county effects are added.

VIIIb. Economic changes

Along with land use and environmental changes, economic changes are important for eventual program success. Land use change analysis indicates SLCP farmers are indeed farming less land, particularly sloping land, and tending to more forest, grass, and horticultural land. Can the effects of these land use changes along with the effects of subsidy payments be seen in the economic situation of SLCP villages at the end of 2002?

Tables VIII-IX summarize the results of the OLS regressions of income and labor force changes on SLCP treatment and control variables. These help evaluate the early progress of the two main economic goals of the SLCP, which are raising farmer incomes and speeding up the

economic diversification of villages away from agriculture. It is theorized that two dimensions of program participation at the village level of particular importance for evaluating the progress of these economic goals are time in the program and the percentage of village households enrolled.

Retiring farmland can be done in one season but changing economic behavior often takes much longer. The primary SLCP-related economic catalyst is the surplus labor created by reducing the agricultural workload of participating farm households. Although creating this surplus labor can be done in perhaps as short a time as one growing season (during which time the preparing of land and the planting of trees is anything but labor saving), the rate at which this surplus is transitioned into new jobs or business opportunities depends on the flexibility of labor markets as well as other factors such as the investment climate, credit availability, and the skills and education of the job seekers. Time between the program-induced shock to the labor market and the end of 2002 when income and labor market conditions are measured is theorized to be an important program-related factor that may indeed influence these conditions. Overcoming fears, learning new skills and developing new markets are some of the processes that perhaps need to be supported over extended periods of time in order for an economic transition away from agriculture to occur. Therefore this paper theorizes that time in the program is a good way to specify the SLCP in an econometric analysis of program effect.

This analysis uses village-level economic variables and because even in program villages not all households participate in the program, the percentage of household participating should be an important specification of the SLCP. The income effect of the program may be large, but if only one percent of villagers are benefiting, the effects are unlikely to show up in village-level data.

Table II shows both of these program variables are reasonably well behaved. Time is censored at zero and four years and percent participating at zero and 100 percent. Medians and means are extremely close for both variables, separated by only one-tenth of a year for time in program (median 1.9 years, mean 2.0 years) and by 0.2% for percentage of households participating (median 57.9%, mean 57.7%).

Although these two variables on the face of it measure distinct dimensions of the program and perhaps could be put in the same regression, there is high correlation between them making

the simultaneous estimation of their separate coefficients very difficult.[98] Villages that got the program earlier had higher percentages of households participating. This may be explained by the fact that most of these villages were in western China (in the sample, 234 of the 236 villages that got the program in 1999 were in Gansu, Sichuan, or Shaanxi) where there is more sloping farmland than in the east, making more farmers eligible for the program. This also suggests the program initially was more focused on its primary targets of western farmers and sloping farmland while in later years this focus blurred.

(Eq 3) LogY1 – LogY0 = B1*%householdsSLCP + B2*Controls + B3*logchpop + B4*area dummy + C

(Eq 4) LogY1 – LogY0 = B1*timeSLCP + B2*Controls + B3*logchpop + B4*area dummy + C

Equations 3 and 4 characterize the regression models which separately regress the natural log difference of 2002 and 1997 village-level economic outcomes on a program treatment variable (either percentage of households participating or the length of time in the SLCP), the log of change in population between 1997 and 2002, and the same group of 1997 control variables listed above in the land use analysis section. B1-B4 are the estimated regression coefficients. Area dummies control for differences in village location, and C is the error term.

Table VIII summarizes the estimated results of the OLS regression model specified in Equation 3, which uses the percentage of households enrolled multiplied by the program participation dummy (1=participation, 0=otherwise) as the program treatment variable. In the version of this model without area effects several outcomes receive statistically significant effects from this program variable.

For each one percent increase in village household enrollment, per capita non-agricultural income increases by 0.29% [99] over the 1997 to 2002 time period. Following from that, each percent increase in household enrollment reduces the number of households whose sole source of income is farming by 0.14% and raises the number of households with no income coming from farming by 0.48%. The size of the labor force working off the farm is increased by 0.26% for

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[98] The correlation between these two variables is 0.71 in the full sample. Dropping the non-program villages (which are all zero values for both variables) reduces the correlation to 0.28. Regressions including both of these treatment variables together did not produce stable results.

[99] Income includes the value of annual SLCP cash and grain subsidies. Unfortunately it is not clear whether subsidy income is included in agricultural or non-agricultural income because respondents were not asked to specifically make this distinction regarding SLCP income.

each percent of SLCP enrollment, and out migration (living and working outside of the village) is increased by 0.28% (although this migration coefficient is only weakly significant). Growth in per capita total income and agricultural income and growth in the number of households owning their own businesses did not receive statistically significant effects from the percentage of households enrolled in the SLCP treatment variable.

VIII: Estimated participation rate effects of SLCP on changes in income, occupation, and migration, 1997 to 2002. (Participation dummy multiplied by percentage of village households enrolled.)^

Program treatment variable: percent of village households enrolled in SLCP			
Model ⟍ Dependent Variable	OLS without area effects	OLS with province fixed effects	OLS with county fixed effects
Growth in per capita total income (percent)	0.00021 (0.00018)	-0.00013 (0.00018)	0.000085 (0.00019)
Growth in per capita agricultural income (percent)	0.000044 (0.00038)	0.00023 (0.00039)	0.000058 (0.00044)
Growth in per capita non-agricultural income (percent)	0.0029*** (0.00084)	0.0011 (0.0009)	0.0016 (0.00098)
Growth in exclusively farming households (percent)	-0.0014** (0.00067)	-0.00081 (0.00070)	-0.0013 (0.00078)
Growth in exclusively non-farming households (percent)	0.0048*** (0.0018)	0.0040** (0.0019)	0.0033 (0.0021)
Growth in business owning households (percent)	0.0020 (0.0013)	0.00096 (0.00138)	0.00075 (0.0015)
Growth in off-farm labor force (percent)	0.0026** (0.0012)	0.00026 (0.00126)	0.00015 (0.0014)
Growth in migration (live and work outside of village) (percent)	0.0028* (0.0015)	-0.00041 (0.00162)	-0.0011 (0.0018)

(Standard errors in parentheses). N=2,452.
* Significant at 10%, ** significant at 5%, *** significant at 1%.
^Regresses the 1997-2002 log difference of each dependent variable on a program treatment variable defined by multiplying a participation dummy variable (1=participation in SLCP, 0=otherwise) by the percentage of village households enrolled, the log of the change in population between 1997 and 2002, and the 1997 village-level control variables listed under Table VI.
Source: Center for Chinese Agricultural Policy 2003 Rural China Investment Survey.

The province fixed effects model reduces the size of the coefficients compared to the OLS without area effects in all cases except growth in agricultural income and in that case the result is not statistically significant. However the size the coefficients are within an order of magnitude of the OLS without area effects in all cases and signs are in the expected direction in six of the eight outcome variables. The province effects model eliminates the statistical significance in all cases except growth in exclusively non-farm households where each percentage point increase in program participation leads to a 0.40% increase.

Adding county fixed effects reduces the magnitude of the program variable coefficient and eliminates the statistical significance in all cases. Still, except in the case of the migration variable, the signs are in the expected direction. The size of the reduction in program effect in the

fixed effects model is also fairly consistent, only in the case of the off-farm labor force variable is the reduction greater than two-thirds of the OLS without area effects estimation.

Table IX summarizes the estimated effects of time in the SLCP as characterized by Equation 4. Time since enrollment measured in years[100] is multiplied by the SLCP participation dummy (1=participation, 0=otherwise) to create the program treatment variable. With this 'time in program' treatment variable the size of estimated program effects is more consistent across both regression models than the 'percentage household enrollment' variable.

The OLS without area effects model estimates a growth in non-agricultural income of 6.6%, and growth in exclusively non-agricultural households of 17.4% for each additional year in the SLCP. The off-farm labor force increases by 11.2% and out migration increases by 16.8%. Growth in exclusively farming households, per capita total and agricultural income, and households owning businesses did not show statistically significant effects from the 'time in program' treatment variable.

Table IX: Estimated time effects of SLCP on changes in income, occupation, and migration, 1997 to 2002. (Participation dummy multiplied by years in program.)^

Program treatment variable: time in program (years)			
Model ⟍ Dependent variable	OLS without area effects	OLS with province fixed effects	OLS with county fixed effects
Growth in per capita total income (percent)	0.00804 (0.0051)	0.0030 (0.0053)	0.012** (0.0059)
Growth in per capita agricultural income (percent)	0.0045 (0.011)	0.018 (0.011)	0.013 (0.013)
Growth in per capita non-agricultural income (percent)	0.066*** (0.024)	0.024 (0.025)	0.046 (0.030)
Growth in exclusively farming households (percent)	-0.22 (0.019)	-0.0016 (0.0205)	-0.013 (0.024)
Growth in exclusively non-farming households (percent)	0.174*** (0.052)	0.183*** (0.055)	0.208*** (0.065)
Growth in business owning households (percent)	0.013 (0.037)	-0.0081 (0.0400)	0.00077 (0.047)
Growth in off-farm labor force (percent)	0.112*** (0.034)	0.067* (0.036)	0.081* (0.043)
Growth in migration (live and work outside of village) (percent)	0.168*** (0.044)	0.100** (0.047)	0.097* (0.055)

(Standard errors in parentheses). N=2,452.
* Significant at 10%, ** significant at 5%, *** significant at 1%.
^Regresses the 1997-2002 log difference of each dependent variable on program treatment variable defined by multiplying a participation dummy variable (1=participation in SLCP, 0=otherwise) by the number of years (or month fractions of years) since enrollment, the log of the change in population between 1997 and 2002, and the 1997 village-level control variables listed under Table VI.
Source: Center for Chinese Agricultural Policy 2003 Rural China Investment Survey.

Including province fixed effects in the regression model eliminates the statistical significance of growth in non-farm income; while the growth in off-farm labor is reduced to

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[100] This variable uses years as its unit but is actually measured in years and months, with months translated into year fractions.

6.7% growth per additional year of program participation and is only weakly significant. Growth in migration is 10.0% and growth in exclusively non-farming households is 18.3% per additional year of program participation.

Adding county fixed effects makes the growth in per capita total income statistically significant. For each additional year in the program the model estimates a 1.2% growth in total income. The effect of time in the program on the growth in exclusively non-farming households is also strengthened to 20.8% growth for each additional year of SLCP. Growth in the off-farm labor force and out migration are both weakly significant, with each year of program participation adding 8.1% and 9.7%, respectively. The model did not show statistically significant program effects for growth in per capita agricultural or non-agricultural income; nor did it show effects for growth in households owning their business, or for growth in exclusively farming households.

The two program treatment variables produce fairly consistent results in the OLS without area effects regressions. Growth in per capita non-agricultural income, exclusively non-farming households, off-farm labor force, and migration were all significant (or weakly significant) in both specifications. However adding area fixed effects makes the program effect insignificant in all but one case (growth in non-farm households with province effects) when using the percentage of households participating as the treatment variable; while time in the program remains statistically significant for a larger number of economic outcomes.

IX.   Discussion

Given the large amounts of time and money that have been put into the SLCP it would be disappointing to find no measurable changes at the village level in either land use or economic conditions. On the other hand, remembering that the average time of enrollment was less than two years it should not be surprising to find effects that are still small, especially for economic transition indicators.

Some aspects of land use changes should occur more quickly, and the regressions do show more consistent and statistically significant effects for these variables. Successful land use change, on the other hand, which turns eroding farmland into mature stands of forest that protect against soil erosion and provides other environmental services takes several decades. In that

context, this five-year snapshot of data is mostly unsuitable to evaluate the long-term land use changes that may or may not occur as a result of the program.

The soil erosion index provides a first attempt at measuring longer term environmental changes and, not surprisingly, the effects are small and inconsistent across the two regression models. Still, the presence of even small soil erosion improvements (0.091 points on a 4-point scale) after so short a time is exciting if the effects are real.

Underlying these soil erosion effects are the much more robust results evaluating land use change between sloping farmland, forest, grass, and horticultural (includes orchards) land at the village level.[101] Sloping land was added to the erosion controlling categories of forest, grass, and horticulture and removed from farming, but the efficiency of this exchange could have been greater. According to the county fixed effects OLS regression, each mu of program area led to 0.72 mu of new forest, grass, or horticultural land (most of this is in the forest category, see Table VII), but only reduced sloping farmland by 0.24 mu and highly sloping farmland (25 degrees or more) by 0.17 mu. Results for the OLS without area effects show proportionally larger coefficients but reach the same basic conclusion.

This discrepancy between program-induced additions and subtractions is perhaps partially explained by the program area variable including not only farmland but also barren land as well. Recall that replanting equal or greater amounts of barren land along with the subsidy supported reductions in farmland has been a program goal from the beginning. However, the county fixed effects analysis would then imply up to a three-to-one ratio between replanted barren land and retired farmland,[102] which reverses the reported national totals for the 1999-2002

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[101] Two related possible confounders should be considered. For one, there is probably some double counting going on based on survey design. Respondents were directed to include SLCP area in forest land totals and orchard area in horticultural land totals. However some SLCP area is in fact planted in orchard trees. How respondents handled this confusion is not recoverable from the data. Some respondents may have apportioned SLCP between the forest and horticultural categories, while others may have double counted the totals. Because horticultural totals are relatively small, the over counting should be small and it should be randomly distributed. A more serious issue is if the growth in outcome variables is a mechanical function of SLCP project size and not actual growth in these variables. Both survey design (where survey questions direct SLCP area to be included in forest area) and political pressure to make this program a success provide incentive to include SLCP land in forest or grassland area even if tree or grass survival rates were low.

[102] Each mu of program area led to a 0.24 mu reduction in farmland in the county fixed effects model. The difference (1.0-0.24=0.76) could be replanted barren land if the respondents included it in the program variable.

time period when each mu of retired farmland was only matched by 0.68 mu of replanted barren land.[103]

This discrepancy could also point to the large amount of farmland not on the official tax rolls, some of which might have been converted to trees or grassland without taking any farmland off the official rolls.[104] This explanation depends on whether survey respondents included total village farmland (something they might not know exactly) or just the official farmland that appears on the tax rolls in their responses. Another explanation is farmers may have used the labor saved from SLCP farmlands to bring new farmland into production.

In any case, the total retirement of farmland was less than expected based on the size of the project and the growth of forest, grass, and horticultural land. The good news is that nearly all of the farmland retired was sloping farmland, two-thirds of it sloping 25 degrees or more. This level of targeting efficiency is roughly in agreement with the analyses of Uchida et al. (2005) and Xu and Cao (2002), but the overall efficiency of the program—as characterized by program area—in retiring highly sloped farmland was only between 0.17 and 0.21 mu for each 1.0 mu of SLCP area. This remains a disturbing sign given that retiring highly sloping farmland was the prime environmental target of the program. The relatively small amounts of highly sloping farmland removed from production might also help explain why soil erosion reductions were small or statistically insignificant.

After an average of only two years in the program, the effect of the time in program treatment variable is fairly consistent across the three regression models and statistically significant for several outcomes, supporting the hypothesis that the SLCP is having economic effects and these effects are strengthened over time. The household participation rate treatment variable is mostly consistent with the time in program variable in the OLS regressions without area effects. However, only one outcome remains statistically significant in the province-fixed effects model (growth in non-farming households) and no outcomes remain significant in the county fixed effects model. It may be that the 'household participation rate' variable has smaller effects which are more easily masked by correlation with some of the area fixed effects variables. On the other hand it may be that the coefficient of the participation rate variable is in actuality an

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[103] Shao (2003). Totals for the 1999 through 2002 period were 47.7 million mu of retired farmland and 32.35 million mu of replanted barren land.
[104] Smil (2000).

unobserved effect of where the village is located, and that this area effect is corrected for in the fixed effects models.

On the whole, the regression results do support the contention that the SLCP is having an economic effect at the village level. One of the specific economic goals of the SLCP is to improve household incomes and, at least in the 'time in program' regressions, this appears to have happened. However these income effects are small—1.2% improvement in per capita income for each year in the program—and do, it is assumed, include the value of subsidies. (A rough estimate of the range of subsidy values is between 120 and 245 Yuan per mu per year depending on the grain price and whether a farmer received the 100 or 150 kilogram grain subsidy.) Without the subsidies, the income effect of the program would likely be negative. This is potentially disturbing given that subsidies are scheduled to stop after five or eight years**.**

The question becomes whether household income sources will be diversified away from agriculture quickly enough to keep incomes from falling and farmers from reconverting land back to agriculture once these subsidies stop. Unfortunately, decomposing the income effects of the SLCP is difficult because the data were not collected specifically to test for the effects of the SLCP but for a wider set of investment projects. The main problem this creates is separating the effects of the program on agricultural and non-agricultural income, as the subsidy income could have been reasonably included in either category by respondents.

The SLCP has no statistically significant effect on agricultural income, which could mean subsidy income was included in this category and offset the loses to income from retiring farmland. In the OLS without area effects model, growth in non-agricultural income is statistically significant while growth in total income is not. This could indicate subsidy income was included in non-agricultural income, which outstripped total income growth because the latter was slowed by the losses of farm income. Taken together, these two alternatives imply subsidy income was included in agricultural income where it offset the income losses from farmland retirement, while increases in non-agricultural income were due to changes in labor force structure.

Changes in labor force structure are generally supported by the regression results, especially growth in households that received all of their income from non-agricultural sources, growth in the off-farm labor force, and growth in out migration. Together these three indicators, along with growth in non-farm income, are the most compelling evidence to date the SLCP is

indeed a catalyst in rural economic diversification away from agriculture. However, under the more stringent set of assumptions of keeping p-values below 0.05 and including county fixed effects, only the growth in exclusively non-farming households is statistically significant.

Moreover, the permanence of these changes in income and labor force structure is still open to question. As discussed, the growth in non-agricultural income may be due to the temporary influx of SLCP subsidies. Changes in labor force structure should be less a function of subsidies than of the surplus labor brought about by the retirement of farmland, but to be lasting these former farmers must find work or business opportunities that at least offset the opportunity costs of not reconverting their SLCP plots back to farming.

Currently, farmers may be willing to accept a lower wage because it is supplemented by program payments, but when payments cease, their minimum asking price (i.e. the minimum wage or profit they will accept to keep from going back to farming) should go up. Whether labor-market earnings will be able to absorb the shock of the loss of subsidy money and make up the difference is still a question. The relatively small increases in total income attributable to the SLCP could indicate, through 2002 at least, these labor-market earnings had not made up the difference. Even with subsidies, SLCP farmers were only earning one percent more per year due to the program than non-participants (holding other variables constant). Without subsidies they most likely would have earned less than non-participants—although the analysis cannot confirm this. If this is indeed the case, the sustainability of the program remains in doubt, as farmers are unlikely to accept lower incomes to remain out of farming.

These misgivings aside, this analysis provides evidence that the SLCP may be meeting some of its environmental and economic goals in spite of the many shortcomings in design and implementation suggested by researchers.[105] Sloping land is being retired, although not as efficiently as might be hoped. Erosion may be lessening, but the data and analysis on this question is far from definitive. Incomes may be increasing due to program participation, however these gains are small at best and probably dependent on subsidy payments. Changes in the labor force seem to be occurring, although these effects don't all hold up under all assumptions.

Xa.   Robustness test : Program effect in Gansu and Shaanxi provinces

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[105] Bennett (2005) provides a very succinct critique of program design and implementation.

Running the analysis on a subset of the data serves both as a check on the results from the full sample and illuminates the possible effects of the program in the western parts of the country where the SLCP was initially targeted. The data from the two north-central provinces of Gansu and Shaanxi might be more relevant to SLCP evaluation because the program was applied more consistently here both in terms of timing and area of implementation. Table I shows that these two provinces had the higher and more similar rates of program participation than the three eastern provinces in the sample. The general economic conditions and physical environment are more consistent across these two provinces than across the full sample. Looking at Figure I shows 10 of the 12 sample counties from Gansu and Shaanxi grouped fairly close to each other, with nine of them in the Yellow River basin. In all, only two of the counties are in the Yangtze River basin where they should have received the higher grain compensation subsidy. The other 10 should have received the lower grain subsidy, making comparison more consistent in the sub-sample for this key program component.

Table X: Summary Statistics for the SLCP in Gansu and Shaanxi provinces

	Mean	Standard Deviation	Median	Min	Max
Project Area (mu)	882	1,282	420	8	11,715
Percentage of Households enrolled (%)	63.6	35.1	68.2	0.8	100
Time in program (years)	2.6	1.2	3.1	0^	4
Total program investment (Yuan)	144,726	275,397	63,000	0	3,673,000
Investment per mu (Yuan)	237	319	151	0	3,800

^Villages that started the program in December 2002 are given a zero value for time in program. Villages that first received the program in 2003 are not included.
^^N=328-404, differences due to missing data.
Source: Center for Chinese Agricultural Policy 2003 Rural China Investment Survey.

Table X shows the SLCP was more intensively applied in the Gansu/Shaanxi sub-sample as expected. Project area, percentage of households enrolled, time in program, and program investments are all noticeably larger in the sub-sample. Standard deviations and mean-median spread are roughly the same between the sub and full sample.

Table XI: Gansu and Shaanxi provinces sample means for participating and non-participating villages in Sloping Land Conversion Program in 1997 and 2002: Socioeconomic indicators

	SLCP villages			Non-SLCP villages		
	1997	2002	Percent change (of mean values) 1997-2002	1997	2002	Percent change (of mean values) 1997-2002
Population	974	1,001	2.77%	1,023	1,077	5.28%
Number of households	219	228	4.11%	215	227	5.58%
Percent only farming households	72.01%	60.05%	-16.61%	64.08%*	55.49%	-13.41%

Percent exclusively non-farming households	3.41%	5.73%	**68.03%**	3.37%	4.85%	**43.92%**
Percent business owning households	3.62%	5.04%	**39.23%**	4.42%	6.44%	**45.70%**
Per capita income (Yuan)	734	950	**29.43%**	1,069*	1,419	**32.74%**
Percent non-farm income	24.72%	33.39%	**35.07%**	28.62%*	38.27%	**33.72%**
Total labor force	466	485	**4.08%**	458	504	**10.04%**
Percent off-farm labor force	15.26%	23.29%	**52.62%**	23.93%*	30.68%	**28.21%**
Percent migration (percent of total labor force living outside the village)	8.98%	15.04%	**60.51%**	11.50%*	16.71%	**45.30%**
Labor force literacy rate	78.40%	82.57%	**5.32%**	81.06%	84.69%	**4.48%**
Percent of labor force with education beyond high school	7.13%	9.25%	**29.73%**	9.18%*	10.55%	**14.92%**

Source: Center for Chinese Agricultural Policy 2003 Rural China Investment Survey. N=697.
* 1997 sample mean for non-SLCP villages significantly different (at the 5% level) from 1997 value for SLCP villages. Using a two-sample t-test, unequal variances assumed.

Table XI shows pre-program 1997 mean values are closer in some cases between participating and non-participating villages in the Gansu/Shaanxi sub-sample including population, number of households, size of labor force, and percent non-farm households. Out migration of labor is the only variable where the difference of mean values is noticeably larger in the Gansu/Shaanxi sub-sample.

Table XII shows large differences remaining in 1997 pre-program land use indicators in the sub-sample. In fact compared to the full sample differences in total and per capita farmland are greater in the sub-sample. Participating villages in Gansu and Shaanxi provinces had 53% more farmland than non-participating villages compared to the full sample where they only had 11% more farmland. Total cropping area is also 53% greater in participating villages in the sub-sample compared to only 3% in the full sample. Other differences are roughly similar to the full sample.

Table XII: Gansu and Shaanxi provinces sample means for participating and non-participating villages in the Sloping Land Conversion Program in 1997 and 2002: Land use indicators

	SLCP villages			Non-SLCP villages		
	1997	2002	Percent Change	1997	2002	Percent change
Total farmland area (mu)	2,515	1,965	-21.87%	1,646*	1,558	-5.35%
Total sloping farmland (mu)	2,151	1,627	-24.36%	1,174*	1,128	-3.92%
Total farmland sloped 25	1,260	913	-27.54%	640*	576	-10.0%

degrees or more						
Total forestland area (mu)	1,575	2,399	52.32%	279*	242	13.26%
Total grassland area (mu)	302	496	64.24%	25,162*	24,739	-1.68%
Percent farmland sloped 25 degrees or more	47.61%	45.46%	-4.51%	30.79%*	29.24%	-5.03%
Per capita farmland (mu)	2.90	2.01	-30.69%	1.88*	1.65	-12.23%
Per capita sloping farmland (mu)	2.56	1.80	-29.69%	1.38*	1.24	-10.14%
Per capita farmland sloped 25 degrees or more (mu)	1.61	1.09	-32.30%	0.81*	0.69	-14.81%
Per capita irrigated farmland (mu)	0.09	0.09	0%	0.32*	0.29	-9.37%
Per capita terraced farmland (mu)	0.54	0.57	5.55%	0.33*	0.36	9.09%
Per capita horticultural land (mu) (includes orchard land)	0.17	0.26	52.94%	0.21	0.29	38.09%
Per capita crop planting area (counts area each time a crop is planted during the year) (mu)	3.30	2.47	-25.15%	2.16*	1.92	-11.11%
Soil erosion (1=very serious, 4=none)	2.31	2.50	8.23%	2.66*	2.70	1.50%

Source: Center for Chinese Agricultural Policy 2003 Rural China Investment Survey. N=697.
* 1997 sample mean for non-SLCP villages statistically significantly different (at the 5% level) from 1997 value for SLCP villages. Using a two-sample t-test, unequal variances assumed.

Overall descriptive statistics give some support to the contention that the Gansu/Shaanxi sub-sample provides a better comparison group mainly due to closer average populations. However farmland and total cropping area differences are quite a bit larger in the sub-sample. With mixed evidence from the descriptive statistics, the best case for the sub-sample remains the likelihood of greater similarity in unobserved natural environment, economic conditions, and program implementation factors in these two north-central provinces compared to the full sample.

Table XIII: Gansu and Shaanxi provinces probit regression estimating determinants of village participation in the SLCP (Dependent variable: 1=participation, 0=otherwise)^

	Change in probability of participation with each unit increase of predictor variable
Population	0.000019 (0.000035)
Average household size	-0.0039 (0.0106)
Percent minority population	-0.0011 (0.0007)
Per capita income	-0.000096** (0.000046)
Percent non-farm income	0.0010 (0.0011)
Per capita enterprises	-34.89* (20.21)
Percent labor force educated beyond high school.	-0.0026 (0.0031)
Per household total cadres from village	-0.533 (0.459)
Percent exclusively farm households	0.00088 (0.00093)
Percent non-farm labor force	-0.0011 (0.0015)
Percent migration (village labor force working and living outside village)	-0.0055** (0.0023)

Per capita farmland	0.048***
	(0.015)
Per capita irrigated farmland	-0.191***
	(0.058)
percent households with electricity	0.000078
	(0.00061)
Cement/blacktop road passing through village (1=yes)	0.049
	(0.052)
Distance to township center	-0.0033
	(0.0036
Per capita village debt	0.000037
	(0.000044)
Total water area in village (mu)	-0.0000032
	(0.0000345)
Distance to main village water source	-0.046**
	(0.018)
Percent of total village land that is flat	-0.0019**
	(0.00098)
Percent of total village farmland sloped 25 percent or more	-0.00016
	(0.00093)
Soil erosion (1=very serious, 4=none)	-0.094***
	(0.027)

(Standard errors in parentheses). N=697.
^This analysis also includes villages that enrolled in the program during 2003,
 bringing total village enrollment to 435.
*Significant at 10%, **significant at 5%, ***significant at 1%.
Source: Center for Chinese Agricultural Policy 2003 Rural China Investment Survey.

Generally results are similar to the full sample. Income, migration, per capita farmland and irrigated farmland, distance to main water source, percent of village land that is flat, and soil erosion are statistically significant factors for explaining village participation. Compared to the full sample, percentage of highly sloping farmland and per capita village debt are no longer significant and per capita village enterprises is newly significant, although only weakly so. In addition, the weakly significant percentage of exclusively farm households variable and whether an improved road passes through the village variable both become statistically insignificant in the north-central sub-sample. Coefficient sizes are also similar between the two samples. The insignificance of the highly sloping farmland variable in the north-central sub-sample seems to be partially explained by the larger coefficient on the amount of village land that is flat variable which is an order of magnitude larger in the sub-sample. Per capita village enterprises is another variable whose coefficient is much larger (six times larger) in the sub-sample. Normally with a smaller sample size one might expect less statistical significance, however in the case of distance to main water source the sub-sample has more statistically significance and twice as large a coefficient compared to the full sample.

Gansu and Shaanxi are in the heart of western China where the SLCP was initially implemented and targeting here is perhaps more relevant than in the full sample because environmental and economic hardship is greater than in some other areas of the county. Villages

in Gansu and Shaanxi were more likely to participate or be selected for the program if their average per capita incomes were lower, there were fewer enterprises and less irrigated farmland per capita, and lower percentages of residents migrated out of the village to live and work. All of these indicate the likelihood of greater economic hardship in participating villages. On the environmental side, participating villages had more per capita farmland but lower incomes, indicating farmland of poorer quality. These villages had less flat land, were farther away from water sources[106], and had greater levels of soil erosion. Taken together, these results imply as environmental hardship increased so did the likelihood of program participation. Therefore both from the economic and environmental perspective, in Gansu and Shaanxi the SLCP was targeted in accordance with the stated intentions of program policymakers.

Table XIV: Gansu and Shaanxi provinces estimated effects of SLCP participation on land use and environmental changes, 1997 to 2002. ^

Program treatment variable: participation in SLCP (1=participation, 0=otherwise)		
Model Dependent variable	OLS with province fixed effects	OLS with county fixed effects
Change in forestland (mu)	757.22*** (121.21)	517.78*** (54.53)
Change in grassland (mu)	766.57* (450.01)	439.21 (522.28)
Change in horticultural land (mu)	17.61 (28.25)	9.42 (32.75)
Combined change in forest, grass, and horticultural land (mu)	1,541.41*** (469.77)	966.41* (541.10)
Change in farmland (mu)	-336.96*** (57.29)	-342.94*** (64.55)
Change in sloping farmland (mu)	-346.32*** (57.03)	-321.91*** (63.92)
Change in farmland sloping 25 degrees or more (mu)	-142.19*** (42.76)	-110.33** (47.86)
Change in soil erosion index (1=very serious soil erosion, 4=none)	0.044 (0.039)	0.021 (0.043)

(Standard errors in parentheses). N=695.
* Significant at 10%, ** significant at 5%, *** significant at 1%.
Both participating and non-participating villages included in regressions.
^Regresses the 1997-2002 simple difference of each land use or soil erosion variable on 0-1 program participation dummy variable, and the 1997 village-level values listed under Table VI.
Source: Center for Chinese Agricultural Policy 2003 Rural China Investment Survey.

As might be expected from the greater intensity of program participation in the western provinces land changes were larger in the Gansu/Shaanxi sub-sample. Focusing on the county fixed effects model, the regressions show larger changes in forest and farmland, including

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[106] This result indicates another potential contradiction between the environmental and economic goals of the SLCP. Villages farther away from water sources may often be economically disadvantaged for that very reason and therefore be more likely to be targeted. But this contradicts the environmental targeting mechanism of protecting land near water sources to improve water quality. A further complexity is highly sloping land, the primary targeting factor, is also likely to be farther away from water than less sloping land.

sloping farmland, due to program participation compared to the full sample; however,

horticultural changes are smaller and insignificant.

Table XV: Gansu and Shaanxi provinces estimated program area effects of SLCP on land use and environmental changes, 1997 to 2002. (Participation dummy multiplied by area (mu) enrolled in SLCP program.)^

Program treatment variable: area enrolled in SLCP (mu)			
Model ⟍ Dependent Variable	OLS without area effects	OLS with province fixed effects	OLS with county fixed effects
Change in forestland (mu)		0.697*** (0.053)	0.595*** (0.053)
Change in grassland (mu)		0.240 (0.216)	0.133 (0.236)
Change in horticultural land (mu)		0.0026 (0.013)	0.0031 (0.0148)
Combined change in forest, grass, and horticultural land (mu)		0.939*** (0.224)	0.732*** (0.243)
Change in farmland (mu)		-0.292*** (0.026)	-0.257*** (0.028)
Change in sloped farmland (mu)		-0.294*** (0.026)	-0.253*** (0.028)
Change in steeply sloped farmland (25 degrees or more) (mu)		-0.204*** (0.019)	-0.174*** (0.021)
Change in soil erosion index (1-4)		0.000017 (0.000019)	0.000011 (0.000020)

(Standard errors in parentheses). N=695.
* Significant at 10%, ** significant at 5%, *** significant at 1%.
Both participating and non-participating villages included in regressions.
^Regresses the 1997-2002 simple difference of each land use or soil erosion variable on enrolled area
program treatment variable and the 1997 village-level control variables listed under Table VI.
Source: Center for Chinese Agricultural Policy 2003 Rural China Investment Survey.

Looking at the results in Table XV for the program area treatment variable both the

province and county fixed effects models for Gansu/Shaanxi sub-sample are very similar to the

full sample regression results both for significance levels and size of coefficients.

XVI: Gansu and Shaanxi provinces estimated participation rate effects of SLCP on changes in income, occupation, and migration, 1997 to 2002. (Participation dummy multiplied by percentage of village households enrolled.)^

Program treatment variable: percent of village households enrolled in SLCP		
Model ⟍ Dependent Variable	OLS with province fixed effects	OLS with county fixed effects
Growth in per capita total income (percent)	-0.00019 (0.00027)	-0.000051 (0.000278)
Growth in per capita agricultural income (percent)	0.00092 (0.00101)	0.00044 (0.00113)
Growth in per capita non-agricultural income (percent)	-0.0012 (0.0017)	-0.00016 (0.00193)
Growth in exclusively farming households (percent)	-0.00050 (0.00147)	-0.0021 (0.0016)
Growth in exclusively non-farming households (percent)	0.00080 (0.00333)	0.00092 (0.00369)
Growth in business owning households (percent)	-0.0017 (0.0025)	-0.0020 (0.0028)
Growth in off-farm labor force (percent)	-0.0022 (0.0028)	-0.00064 (0.00310)

Growth in migration (live and work outside of village) (percent)	-0.0045 (0.0033)	-0.0034 (0.0037)

In the Gansu/Shaanxi sub-sample there are no statistically significant income or labor force effects due to the village participation rate. These results are similar to the full sample where this treatment variable also did not register statistically significant program effects (except in the growth of non-farming households) when area effects were included in the regressions.

Table XVII: Gansu and Shaanxi provinces estimated time effects of SLCP on changes in income, occupation, and migration, 1997 to 2002. (Participation dummy multiplied by years in program.)^

Program treatment variable: time in program (years) Model Dependent variable	OLS with province fixed effects	OLS with county fixed effects
Growth in per capita total income (percent)	0.0017 (0.0067)	0.010 (0.0074)
Growth in per capita agricultural income (percent)	0.024 (0.025)	0.016 (0.030)
Growth in per capita non-farming income (percent)	-0.024 (0.043)	0.023 (0.052)
Growth in exclusively farming households (percent)	0.011 (0.036)	-0.017 (0.043)
Growth in exclusively non-farming households (percent)	0.188** (0.082)	0.265*** (0.098)
Growth in business owning households (percent)	-0.014 (0.062)	0.038 (0.075)
Growth in off-farm labor force (percent)	0.023 (0.069)	0.078 (0.083)
Growth in migration (live and work outside of village) (percent)	0.035 (0.083)	0.101 (0.099)

The effect of time in the program on the Shaanxi/Gansu sub-sample shows statistically insignificant results except for growth in exclusively non-farm households, which is the strongest result, not only here but in the full sample as well. For the other outcome variables of interest the size of coefficients in the sub-sample are consistent with the full sample (except for growth in business owning households where the small numbers create very inconsistent and statistically insignificant results in all cases). The loss of significance compared to the full sample may be mainly due to the smaller sample size (N=697 verses N=2,459).

Overall the sub-sample does not especially strengthen or weaken the contention that the SLCP is having an effect in rural China. Land use changes in Shaanxi and Gansu are greater than in the full six-province sample because the program was applied earlier and more extensively in the western provinces. Economic changes are mostly insignificant in the sub-sample. However, the sizes of coefficients are similar to those in the full sample, so it may be the smaller sample size is the main difference that explains the lack of significance. The alternative explanation is the program is not having the desired economic effects in the poorer western provinces and the effects seen in the full sample are due to changes in the richer eastern provinces only. If true, this would be a disturbing finding for a program whose original goal was to aid poorer western farmers.

Xb.   Robustness test: Changing the control group in Jiangsu, Hebei, and Jilin provinces

An additional robustness test limits the control group to villages first receiving the program in 2003 (instead of including these villages along with villages that never received the program[107] in the control group, as is done in the previous analyses).[108] Descriptive statistics for villages receiving the program by 2002 show a definite selection bias towards villages in poorer socioeconomic and environmental conditions, as intended by program planners. Assuming this selection bias continued in 2003 both for the observed variables and for a group of relevant unobserved variables, the 2003 start-date villages could provide a better control group to compare against the experimental group of villages that received the SLCP before 2003. Because most of the villages first receiving the program in 2003 are in the eastern provinces, the experimental comparison group should be limited to these provinces as well. This makes the program effect harder to measure because of the smaller sample size and, perhaps more importantly, the generally later start date for all the eastern villages—of the 248 eastern villages receiving the program before 2003, three-fourths (190) implemented in 2002. A further difficulty

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[107] "Never received the program" as of the time of the survey in 2003. Some of these villages may have indeed received the SLCP in later years.

[108] A similar method keeps the control group as before (all villages, including 2003 villages, not receiving the program by 2002) and program treatment variable, but adds a second dummy variable coded as 1=never got SLCP, 0=ever got SLCP (i.e., got SLCP in 2003 or before) to the model. This makes 2003 villages the comparison group because they are the only cases that are '0' in both dummy variables. The results (available from the author) for this 2-dummy variable method were roughly similar to the method reported here, which explicitly makes 2003 villages the control group.

is the over-representation of villages from Jilin in the 2003 control group (see Table XVIII), where they make up 81% of the total.

Table XVIII: Number of villages by SLCP implementation
year in the eastern provinces

Province	SLCP in 2002 Or before	SLCP in 2003
Jiangsu	33	3
Jilin	125	159
Hebei	90	35

Table XIX gives the results of the 'time in program' treatment variable for the eastern provinces sample. As in earlier tables here the comparison is between villages that implemented the SLCP before 2003 and all other villages. This provides a comparison for the results in Table XX, which are the results of the procedure described in the previous paragraph wherein the control group is limited to villages first receiving the program in 2003. Both tables only include results of the models with either province or county fixed effects.

Table XIX: Jilin, Hebei, and Jiangsu provinces estimated time effects of SLCP on changes in income, occupation, and migration, 1997 to 2002. (Participation dummy multiplied by years in program.)^

Program treatment variable: time in program (years) / Model / Dependent variable	OLS with province fixed effects	OLS with county fixed effects
Growth in per capita total income (Yuan)	0.0015 (0.0140)	0.0075 (0.0135)
Growth in per capita agricultural income (Yuan)	0.015 (0.017)	0.018 (0.017)
Growth in per capita non-agricultural income (Yuan)	0.121** (0.054)	0.109** (0.055)
Growth in exclusively farming households (households)	0.0075 (0.0435)	0.023 (0.044)
Growth in exclusively non-farming households (households)	0.020 (0.135)	0.0046 (0.1375)
Growth in business owning households (households)	-0.088 (0.090)	-0.071 (0.092)
Growth in off-farm labor force (persons)	0.0018 (0.077)	-0.032 (0.080)
Growth in migration (live and work outside of village) (persons)	0.023 (0.104)	-0.035 (0.107)

Standard errors in parentheses. N=1,393
* Significant at 10%, ** significant at 5%, *** significant at 1%.
^ Regresses the 1997-2002 log difference of each dependent variable on program treatment variable defined
by multiplying a participation dummy variable (1=participation in SLCP, 0=otherwise) by the number of
years (or month fractions of years) since enrollment, the log of the change in population between 1997 and 2002,
and the 1997 village-level control variables listed under Table VI.
Source: Center for Chinese Agricultural Policy 2003 Rural China Investment Survey.

Results in Table XIX show the effect of time in the program is mostly insignificant in the eastern provinces sample, as was the case for the western provinces. Again, smaller sample size, compared to the full sample, may be a reason for this lack of statistical significance. In spite of

this, the coefficients are roughly comparable both to the full sample and the western provinces sample which provides some support to the overall validity of the full sample results. Anomalies include the growth in non-agricultural income, which in the eastern sample are much larger than in either of the other two cases and actually show weakly significant results in the province fixed-effects model, and changes in farming households, which are not in the expected directions. Growth in non-farming households is the most consistently strong result across the full and western samples, but not in the eastern sample. Both of these anomalies may be due to a more diverse economic landscape already being in place in the eastern provinces. Eastern farmers may have already diversified away from farming before the SLCP, making the program less a subsistence than an economic subsidy, which could be quickly put into income generating non-farm activities.

Table XX: Jilin, Hebei, and Jiangsu provinces estimated time effects of SLCP on changes in income, occupation, and migration, 1997 to 2002. (Participation dummy multiplied by years in program.)^
Sample restricted to 2003 or before program villages.

Program treatment variable: time in program (years)		
Model Dependent variable	OLS with province fixed effects	OLS with county fixed effects
Growth in per capita total income (Yuan)	0.024 (0.016)	0.033** (0.016)
Growth in per capita agricultural income (Yuan)	0.031 (0.020)	0.040** (0.020)
Growth in per capita non-agricultural income (Yuan)	0.089 (0.086)	0.093 (0.091)
Growth in exclusively farming households (households)	0.0080 (0.0167)	0.0027 (0.0173)
Growth in exclusively non-farming households (households)	0.050 (0.168)	-0.026 (0.177)
Growth in business owning households (households)	-0.153 (0.129)	-0.117 (0.135)
Growth in off-farm labor force (persons)	0.058 (0.083)	0.060 (0.087)
Growth in migration (live and work outside of village) (persons)	0.129 (0.125)	0.129 (0.131)

Standard errors in parentheses. N=447
* Significant at 10%, ** significant at 5%, *** significant at 1%.
^ Regresses the 1997-2002 log difference of each dependent variable on program treatment variable defined by multiplying a participation dummy variable (1=participation in SLCP, 0=otherwise) by the number of years (or month fractions of years) since enrollment, the log of the change in population between 1997 and 2002, and the 1997 village-level control variables listed under Table VI.
Source: Center for Chinese Agricultural Policy 2003 Rural China Investment Survey.

Results for the 2003 villages control group (Table XX) again show mostly statistically insignificant results, as might be expected with the further reduction in sample size. Interestingly, when county fixed-effects are added, growth in total and agricultural income are larger and more statistically significant than in any other sample. The coefficients are in the expected directions, except for changes in business-owning households (which are insignificant and inconsistent

across all the models) and changes in the number of farming/non-farming households. Coefficients are also very comparable to the results from Table XIX and roughly comparable to the results from the full and western samples, which supports the contention that the observed program effect is not solely due to selection bias issues.

XI.   Conclusion

The pace of China's Sloping Land Conversion Program has slowed in recent years both because of the reported success of the program at achieving its goals of retiring the most ecologically fragile sloping land in the middle and upper reaches of the Yangtze and Yellow Rivers and because of a renewed fear over grain security. For reasons that may trump environmental or economic reasons, China's leaders want the country to remain self sufficient in grain production and the initial ambitious targets for the expansion of the SLCP through 2010 could conceivably contribute to domestic production shortfalls.[109] At the same time, for reasons that have nothing to do with domestic grain security, researchers have criticized the fast expansion of the program for diluting the original goals of helping poor western farmers and retiring arid, sloping farmland in watersheds specifically threatened by soil erosion.[110] The slowdown of the program may, therefore, be a case of the Chinese government doing the right thing for the wrong, or at least debatable, reasons.

This paper analyzed the effects of the SLCP while its fast expansion was in full swing. The analysis used a large village-level dataset that included large numbers of villages from the original three western provinces—Gansu, Sichuan, and Shaanxi—where the program was formally started in 1999. The land use, environmental and economic effects of the program are assessed as they stood at the end of 2002, as compared to the end of 1997 before the program was implemented. Villages from three eastern provinces—Jilin, Hebei, and Jiangsu—make up the rest of the dataset. Villages in these provinces received the SLCP mostly after 2000. In total the dataset included 856 treatment villages that implemented the program by the end of 2002 and 1,603 control villages without the program by that date.

Descriptive statistics showed marked differences between program and non-program villages in 1997 before the program was implemented. In 1997, the average program village had

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[109] Xu, Uchida, Xu, Deng, and Huang (2004) find the SLCP had little affect on grain production at least during the early phases of the program.
[110] Bennett (2005). Xu and Cao (2002). Zuo (2002a).

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lower per capita incomes than the average non-program village, lower percentages of non-farm income, smaller off-farm labor forces, lower levels of education, and more per capita farmland but less irrigated farmland, among other differences.

Participation analysis, using a probit regression model, told a similar story. Poorer villages with weaker environmental endowments were more likely to participate or, perhaps more accurately put, be selected for participation. Specifically villages with lower per capita incomes, more village debt, and less high-yield irrigated farmland were more likely to participate, as were villages with more sloping farmland and higher levels of soil erosion.

Analysis of land use change found evidence that the SLCP led to increases in forest, grass, and horticultural (orchard) land and decreases in sloping and highly sloping (25 degrees or more) farmland. However, the efficiency of the program could have been better. Each mu (15 mu=1 hectare) of program area caused a combined increase of forest, grass, and horticultural land of between 0.7 and 1.0 mu, but only a reduction in highly sloping farmland of between 0.17 and 0.21 mu.

Program participation led to estimated improvements in soil erosion of 0.09 points, or 0.00008 points for each additional mu of SLCP area, according to a four-point soil erosion index estimated by village respondents. However, the statistical significance of these estimates did not hold up when county fixed effects were added to the regression model.

Regression analysis found some evidence the SLCP was increasing incomes and helping villages diversify their economies. Each year of program participation improved per capita total income growth by roughly one percent, although this included the value of subsidies. The SLCP also led to 10-20% increases (per year in program) in the number of villagers migrating out the village, giving up farming completely, or joining the off-farm labor force.

Restricting the analysis to the western provinces of Gansu and Shaanxi reduces the statistical significance of the regression results in most cases which may be due to the reduced statistical power of the smaller sample size or may call into the question the validity of the results from the full sample. On the other hand, coefficient sizes are fairly consistent between the full and sub-samples which may indicate the lack of statistical significance in the sub-sample is due to a loss of statistical power and not a poorly specified model.

A similar loss of significance is found when the sample is restricted to the eastern provinces of Jiangsu, Hebei, and Jilin, although growth in non-agricultural income becomes

significant in this sample, perhaps indicating eastern farmers were already in a more economically diversified situation before the program and could therefore more readily apply program subsidies to off-farm income activities. The income situation of eastern farmers changes somewhat when the control group is limited to villages first receiving the program in 2003. Here the statistically significant gains in income are in total income and agricultural income, indicating perhaps eastern farmers retired farmland that was not a significant source of income before the program and therefore was not a significant loss to income afterwards. If true, the greater income effects for eastern farmers are somewhat disturbing for a program whose primary economic purpose was to help poorer western farmers improve and diversify their economic situations.

Taken together, the results imply even under the most relaxed assumptions the program-induced effects for most economic outcomes of interest are quite small. This makes it hard to definitively claim a role for the SLCP in the economic and labor force changes that are indeed happening across China. One strong result across two of the three samples is changes in the number of exclusively non-farming households which grew significantly as a result of time in program. Land use changes were also consistent across both the full and western samples, with the western sample having larger land use changes as might be expected in the area where the SLCP was applied earlier and more intensively.

On the whole, this analysis of China's Sloping Land Conversion Program paints a mixed picture. Income improvements and land use changes probably have occurred as a result of the program, but the sizes of these improvements are perhaps smaller than expected. On the other hand, economic transition effects, specifically changes in labor force composition, perhaps happened more quickly than expected, although these effects are only marked under certain assumptions. If these SLCP-related economic transition effects are real and continue, there is hope the environmental and economic goals of the program can be sustained even after program payments end.

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