

Farmland Preservation in China: Status and Issues for Further Research

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Abstract

China has been gravely concerned about its ability to meet its food security goals in coming years, triggered by an apparent rapid decline in cultivated land and exacerbated by declines in the production of the principal food grain crops. The central government has responded by adopting measures aimed at stabilizing major crop production and maintaining China's agricultural land base. Careful examination of the evidence suggests that concerns about farmland preservation have been misplaced. There is little evidence of a growing threat to China's ability to meet its food security goals. Food security needs have been changing due to income growth and urbanization; corresponding shifts in cropping patterns account for much of China's loss of land planted to major crops. Most observers believe that water and R&D rather than land are the limiting factors in China's ability to meet food security goals. Maintaining strong agricultural research, development, and extension programs is of paramount importance if China is to keep crop production growth on a par with population growth. Institutions for irrigation and drainage management have fallen into decay and irrigation and drainage infrastructure has fallen into widespread disrepair as a result. Reforming these institutions so that irrigation and drainage become self-sustaining economically is of critical importance. Lack of transportation and storage infrastructure, especially cold storage, reduces productivity by keeping post-harvest losses high and by creating disincentives for farmers to expand production. Finally, inconsistent government policies have reduced productivity by hampering farmers' ability to plan and by creating conflicting incentives.

While the loss of cultivated land does not appear to be the critical nexus of China's food security problems, there do appear to be substantial inefficiencies in land allocation generally and farmland conversion in particular that have significant social costs, including—but not limited to—adverse effects on the maintenance of China's food production capacity. The root cause of these inefficiencies is the lack of institutions that force agents making land use decisions to take the opportunity costs of land into full account in those decisions. Farmland tenure is one such area. Insecure tenure reduces incentives to invest in maintaining and enhancing land productivity. It also limits exploitation of economies of scale by preventing the use of land rentals to consolidate small plots into sufficiently large operating units. Consolidation is likely to be increasingly important for retaining farmland in areas experiencing rapid economic growth where urban employment prospects are rapidly shrinking the farm labor force. An equally important set of issues pertains to the demand for farmland conversion on the part of local governments. The system of local government finance and policies governing residential construction actively encourage farmland conversion even as explicit land use policies attempt to discourage it.

Research conducted jointly by the Lincoln Institute and China's Ministry of Land and Resources can help identify promising avenues for policy innovation, develop longer run collaborative relationships, and build policy analytic capability in China. Several potential research projects seem especially well-suited for such purposes. Three possible projects are discussed in detail.

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Table of Contents

I. Introduction	1
II. Land Use Trends in China.....	2
III. Food Security in China	5
IV. The Role of Farmland Preservation in Food Security	7
V. Institutional Impediments to Maintaining Food Production Capacity.....	8
A. Institutions Governing Land Utilization	8
B. Irrigation Management Institutions.....	13
C. Crop Marketing Arrangements.....	14
VI. Conclusions and Directions for Future Research	15
A. Impacts of Residential Construction, Industrial Development, and Infrastructure Policies on Farmland Conversion	16
B. Land-use Effects of Local Government Competition for Industrial Development..	17
C. Incentive Systems for Farmland Preservation.....	19
VII. References	21

I. Introduction

The government of China has had pronounced concerns about its ability to continue feeding a growing population since the mid-1990s, when Lester Brown (1995) predicted that China would soon need to resort to grain imports on a scale massive enough to cause severe disruptions in world markets. Like Lester Brown, the government of China targeted conversion of farmland to industrial and residential uses, especially in the most productive agricultural regions, as the central threat to the nation's continued capacity to produce adequate levels of staple cereals. According to official government statistics, China lost over 14.5 million hectares of arable land between 1979 and 1995. Those losses were partially counterbalanced by the addition of 10.1 million hectares of arable land from reclamation activity, leaving a net loss of only 4.4 million hectares. But this additional arable land was lower in quality and located in areas with less favorable climatic conditions, suggesting that the loss of agricultural production capacity exceeded the net loss of arable land (Ash and Edmonds 1998).

In response to these food security concerns, the government of China introduced several measures aimed at protecting farmland, especially farmland with the greatest production potential. Regulations promulgated in 1994 forbade the removal of land designated as primary farmland from cultivation. This policy was revised in 1996 to require a "dynamic balance of cultivated land" or, in US parlance, "no net loss of farmland." Under this policy, conversion of any land previously planted to major crops (cultivate land in Chinese terminology) must be balanced by reclamation of land equal in area, although the State Council has the authority to arrange for compensating reclamation in other provinces if reclamation is infeasible. In 1995, the state introduced the Governors Grain Bag Policy, requiring each province to take measures to ensure that it remain self-sufficient in grain production. The Land Management Law of 1998 specified further that each province designate 80% of its cultivated land (that is, land planted to major crops) as primary farmland, reaffirmed the dynamic balance policy for primary farmland and tightened rules governing conversion of agricultural land for construction (Yang and Li 2000, Ho and Lin 2003). In addition, regulations in effect since 1994 require each province to draw up farmland protection plans to be implemented by designation of farmland protection districts at the county and township levels (Deng 2003).

These measures appear to have been insufficient to ensure maintenance of high levels of staple crop production. Output of both wheat and rice, the principal staple food grains, peaked in 1997 and has fallen steadily since. Both yields and sown area have fallen steadily. Wheat yields peaked in 1997, rice yields in 1998; the area planted to both peaked in 1997. China's total grain production was 7.5% lower in 2002 than in 1991. Decreases in wheat and rice production were even greater; in 2002, China's wheat and rice output were 20.6% and 13.5% lower than their respective levels in 1991 (Economic Research Service).

These trends have given China's Ministry of Land and Resources an interest in methods for improving the nation's farmland protection policies. This report considers the need for such improvements, with a goal of identifying key areas where changes are most

needed and/or promise to be the most productive. We begin with a review of recent trends in land use (Section II). We then consider those changes in land use in light of trends in food production and thus China's likely food security needs (Section III). Section IV considers the role of farmland preservation relative to other means of meeting food security goals. Section V considers farmland preservation in the context of land use policies more generally. Section IV offers some conclusions and directions for further research.

II. Land Use Trends in China

A lack of consistent, reliable data makes it difficult to identify trends in farmland. Official figures published by the State Statistical Bureau are known to have underreported farmland by a substantial margin, at least up until the mid-1990s. The State Statistical Bureau reported 96.8 million hectares of cropland in 1985 and 94.9 million hectares in 1995. Cropland estimates derived from remote sensing and detailed surveys exceed the figures reported by the Bureau during this period by more than 40%. Reconstructed estimates of total cropland vary substantially, raising problems of comparability. Estimates of total cropland in China for the early to mid-1990s range from 125 to 145 million hectares (US Embassy 1997, Heilig 1997, Ash and Edmonds 1998, Smil 1999).

Figures from the State Statistical Bureau indicate a net loss of cropland of 4.7 million hectares between 1978 and 1996, with the bulk of those losses (4.3 million hectares) occurring between 1978 and 1987 (Yang and Li 2000). Several attempts have been made to estimate changes in cropland—and their causes—using figures incorporating correction factors derived from remote sensing and detailed survey data. Heilig (1997) estimates that cultivated area fell from 139.6 million hectares in 1985 to 137.1 million hectares in 1995, a net loss of 2.6 million hectares. Using census data, Ash and Edmonds (1998) report total arable area of 139.7 million hectares in 1985 and gross losses of 8.4 million hectares through 1995; they do not report corrected figures for additions to cropland through reclamation and cropping of previously unused land. Smil (1999) reports gross losses of farmland of 5.7 million hectares between 1987 and 1995. Heilig (1999) estimates that cultivated land fell from 132.8 million hectares in 1988 to 131.1 million hectares in 1995, a net loss of 1.7 million hectares.

Losses of cultivated area were concentrated in the most productive farming areas of the country. The coastal and central provinces have more fertile soils than the remainder of the country as well as climates that allow multiple cropping. Farmland in the coastal provinces can be cropped 2-3 times a year, while land in the central areas can be cropped 1-2 times per year. By contrast, land in the western and border provinces can be cropped at most once annually (Ash and Edmonds 1998). According to State Statistical Bureau figures, provinces in coastal and central China lost 5.1 million hectares of cultivated land between 1978 and 1996. In these provinces, the rate of loss during the period 1987-1996 was only slightly lower than during 1978-1987, 2.1 million hectares during the former compared to 2.8 million hectares during the latter. In contrast, the western and border provinces gained 0.3 million hectares between 1978 and 1996, with losses of 1.4 million

hectares during 1978-1987 more than compensated for by increases of 1.7 million hectares during 1987-1996 (Yang and Li 2000). Heilig (1997) estimates an even greater loss of cultivated area in the coastal and central provinces, 3.9 million hectares between 1985 and 1995. Heilig (1999) estimates a loss of 1.3 million hectares of cultivated area in these provinces between 1988 and 1995. Ash and Edmonds (1998) report a net change in arable (as opposed to cultivated) land in the coastal and central provinces between 1985 and 1995, 2.1 million hectares.

It is important to note that not all of the farmland losses reported above represent land removed from food production. Contrary to standard practice in the US and elsewhere, the reporting category “cultivated land” includes areas used for major food grains, feed grains, soybeans, and tubers. It does not include horticultural crops, nor does it include aquaculture. A significant share of the farmland reported loss was, in fact, converted to horticulture or aquaculture use. For example, Smil (1999) estimates that between 1987 and 1995 1.2 million hectares of land were converted to orchards while 0.3 million hectares were converted to fish ponds, accounting for 21.8% and 4.4%, respectively, of the gross loss of farmland during this period. State Statistical Bureau data indicate that horticulture and fish ponds accounted for 40.2% and 8.1% of the decrease in cultivated land reported in 1994 (Lin and Ho 2003).

It is also important to note that other cropland losses represent only minor, if any, reductions in agricultural production capacity. A substantial share of newly cultivated land prior to 1987 was marginal in terms of agricultural productivity but highly vulnerable to erosion, desertification, and other forms of land degradation. After 1987, much of this land was allowed to revert to more sustainable agricultural uses like pasture and grassland, and to non-agricultural uses like forest (Ash and Edmonds 1998, Smil 1999, Yang and Li 2000, Lin and Ho 2003). Smil (1999) estimates that 1.9 million hectares of farmland were converted to forest and pastures between 1987 and 1995, accounting for a third of the gross farmland loss during this period. Ash and Edmonds (1998) estimate that afforestation accounted for 23.8% of arable land loss occurring between 1988 and 1992, while pasture and grassland accounted for an additional 14.1%. State Statistical Bureau data indicate that forest and pasture accounted for over a third of the loss in cultivated land reported in 1994 (Lin and Ho 2003).

Rapid urbanization was a special source of concern, since conversion of farmland to urban uses is largely irreversible. Remote sensing data indicated that between 1986 and 1995, the largest cities in China expanded in area at a rate of 7.5% a year (Ding 2003). Nevertheless, permanent losses of farmland to urbanization, industrial uses, infrastructure, and other irreversible uses do not appear to account for a large proportion of farmland losses nationwide. Smil (1999) estimates that 945,000 hectares of farmland were lost to urbanization, industrialization, and rural construction, accounting for about one-sixth of the total loss of farmland between 1987 and 1995. State Statistical Bureau data paint a similar picture: According to this source, state construction, collective construction, and rural housing combined accounted for 21% of the decrease in cropland reported during the period 1986-1995 (Lin and Ho 2003). Ash and Edmonds (1998) estimate that construction by the state, by collectives, and for individual peasant housing

accounted for a larger share of arable land loss, 27% of the arable land loss in China as a whole between 1985 and 1995 as well as roughly half of the arable land loss in the Center-East and North regions. Their estimates indicate that the share of arable loss attributable to construction and infrastructure had increased from the later 1980s to the mid-1990s; construction and infrastructure accounted for 33.2% of arable land loss during 1991-1995 compared to 25.2% during 1986-1990.

Urbanization, industrialization, infrastructure, and other non-agricultural uses appear to have been an especially large source of farmland loss in the rapidly industrializing coastal provinces. In 1995, over two-thirds of the cultivated land loss in Beijing, Tianjin, Shanghai, Hebei, Shandong, Jiangsu, Zhejiang, and Fujian provinces were due to conversion to non-agricultural uses (Ho and Lin 2004).

Natural disasters (presumably primarily flooding) were the other major source of farmland loss. Smil (1999) estimates that natural disasters were responsible for the loss of 965,000 hectares of farmland during 1987-1995, about one-sixth of the total loss of farmland during that period. State Statistical Bureau data yield a similar estimated share of cropland loss for the 1986-1995 period (Lin and Ho 2003). Ash and Edmonds (1998) estimate that natural disasters accounted for 14-25% of arable land losses during the years from 1987 through 1991.

China continues to experience similar kinds of land use changes, albeit not in the same proportions as in the past. In 2002, the Ministry of Land and Resources (2003) reported a total of 125.9 million hectares of cultivated land, 10.8 million hectares in horticulture, and 25.7 million hectares in other agricultural uses (notably livestock breeding and production facilities), a total of 162.4 million hectares in agriculture. Over 2 million hectares of cultivated land were converted to other uses between 2001 and 2002, while 0.26 million hectares were added through land consolidation (20.1%), reclamation (13.5%), and development of unused land (66.4%), for a net decrease of 1.68 million hectares. Reforestation accounted for almost two-thirds of total cultivated land conversion; construction accounted for 9.1% and natural disasters for 2.6%; horticulture, livestock production, and aquaculture accounted for the remainder.

Conversion of land to urban uses has continued to be significant in the coastal areas subject to the most rapid growth. An example is Pinghu City, located halfway between Hangzhou and Shanghai in Zhejiang Province. Most of the land in Pinghu is prime agricultural land that can be cropped two or three times a year. There is little waste land. Cultivated land and orchards account for 63.8% and 2.3% of the total land area; forests and unused land make up less than 2% of total area; and almost 15% is under water. Land taken for construction increased eightfold between 1998 and 2001, from 33.3 hectares in 1998 to 263.4 hectares in 2001. Cultivated land losses have heretofore been counterbalanced by area gained from land consolidation but the potential for preventing a net loss of cultivated land in this way is obviously limited (Wu, Ye, and Fang 2004). Even so, recorded conversion of farmland to urban uses during this period of rapid growth amounted to less than 1.9% of Pinghu City's 1998 farmland.

Conversion to urban uses is even more limited elsewhere in the country, including important inland agricultural areas. An example is Jingzhou City, located in the Yangtze River basin west of Wuhan in Hubei Province. Jingzhou has a total area of about 1.4 million hectares, of which 0.46 million are under water. Cultivated land and orchards together account for about 48% of the total area. Between 1997 and 2003, cultivated land in Jingzhou decreased by a little over 11,200 hectares, or 1.7%. Over 450 hectares were converted to orchards. Land used for transportation infrastructure increased by 672 hectares while land for other urban uses increased by 572 hectares; together, these uses accounted for about 11% of the decrease in cultivated land during the period and less than 0.1% of total cropland at the beginning of the period. As in China as a whole, the bulk of farmland loss during this period seems to have been due to abandonment of marginal land brought under cultivation prior to 1978: Reversion to forest accounted for almost one-fifth of the loss of cultivated land while increases in unused land accounted for an additional tenth. Over half of the decrease in cultivated land was due to an increase in water area, some of which represents aquaculture facilities (Shi 2004).

III. Food Security in China

Few Western observers place any credence in Brown's dire predictions of a China heavily dependent on imports of staple cereals; most believe that the methodology used to derive these predictions was extremely shoddy (see Alexandratos 1995 for a detailed critique). The consensus among Western experts, in fact, is that China will continue to meet most of its food consumption needs from domestic production, albeit with some imports of both food and feed grains. A study conducted under the auspices of the International Food Policy Research Institute, for example, estimated that by 2010 China would import less than 1% of its rice consumption needs, about 7.5% of its wheat consumption needs, and about 7.0% of its feed grain consumption needs; by 2020, the study estimated that China would be a net exporter of rice and self-sufficient in wheat, while net imports of feed grains, principally maize, would rise to 12.1% of consumption (Huang, Rozelle, and Rosegrant 1999). The most recent US Department of Agriculture baseline projections similarly estimate that by 2013/14, China would be a (small) net exporter of rice, a small net importer of wheat, a small net importer of corn, and a significant net importer of soybeans (Interagency Agricultural Projections Committee 2004). Studies by researchers affiliated with the Food and Agricultural Organization of the UN (Alexandratos 1995), the International Institute for the Application of Systems Analysis (Heilig 1999), and other experts (Smil 1999) arrive at largely the same conclusions.

These projections are consistent with current observed declines in the sown area and production of staple cereals such as wheat, rice, and millet. The principal reason: changes in diet due to income growth and urbanization that feature reduced consumption of staple cereals and increased consumption of vegetables, fruits, fish, poultry, and meat (Alexandratos 1995, Heilig 1999, Smil 1999). In 2002, for example, average grain consumption by urban Chinese households was only one-third that of rural households. Vegetable and oil consumption was roughly equal for urban and rural households, but urban households consumed 2-3 times as much red meat, poultry, eggs, and aquatic products as rural households (Economic Research Service). High income urban residents

consumed less rice and wheat but substantially more vegetables, red meat, poultry, eggs, milk, and aquatic products as low income urban residents (Hsu, Chern, and Gale 2002). Chern (2000) estimates that demands for fish, poultry, and red meat have extremely high income elasticities (3.41, 3.12, and 1.68, respectively) while grain demand is highly income-inelastic (0.11). Overall, this evidence suggests that urbanization and income growth will shift diets substantially, resulting in increased consumption of fish, poultry, and red meat and reduced consumption of cereals. These dietary shifts have been occurring since the early 1980s (Smil 1999) and have continued into the present. As an indication, consumption of grains in China fell by 1.8% between 1995 and 2002; even though total population increased by 12.3% during that period, rural-to-urban migration changed diets sufficiently to effect a net reduction in grain consumption (Economic Research Service).

From this perspective, the changes in cropland allocation observed in recent years are more appropriately viewed as accommodations to changing consumer demand than as signs of an inability to maintain staple food production. As noted above, conversion of “cultivated land” to orchards and aquaculture accounted for a large share of perceived farmland “losses” (especially once the reversion of marginally productive, environmentally fragile land to forest and grassland is netted out). A more accurate characterization would be to view these changes as increases in fruit, vegetable, and aquaculture production in response to heightened consumer demand. In fact, total sown crop area increased by over 5 million hectares (3.3%) between 1995 and 2002 (this figure includes multiple cropping). Area planted to food grains declined by 7.8%, but area planted to vegetables, fruits, soybeans, and feed grains increased by 82.4%, 24.5%, 7.3%, and 6.2%, respectively. As a result, between 1995 and 2001, production of vegetables increased by 88.2% while production of fruits (other than melons) increased by 58.0% (Economic Research Service).

Other economic factors, including agricultural price policies, have also played a significant role in recent cereal production trends (Deininger and Jin 2003). Falling wheat production levels since 1997 are largely due to reductions in sown area; yields have fallen as well, but only slightly. Low returns to wheat relative to other crops have induced farmers to shift land out of wheat into alternative crops. Horticultural crops are clearly more profitable than wheat as a consequence of high demand. The introduction of Bt cotton varieties in areas subject to high bollworm pressure during the 1990s raised returns to cotton relative to wheat, inducing farmers to shift land from wheat to cotton production. According to farmers in Jingzhou, for instance, cotton productivity there has doubled in recent years, and cotton production has rebounded strongly. Wheat is currently the least profitable major crop grown in China (Lohmar 2004).

Farmers in China clearly respond to economic incentives in making planting decisions, a fact that suggests that economic instruments can be used to reverse declines in grain production. If low returns relative to competing crops are the reason for the recent decrease in wheat production, for instance, measures like area payments (payments per unit area planted to a desired crop like wheat) or price supplements (like US countercyclical payments) can increase wheat plantings by making wheat economically

competitive with other crops. Area payments for rice and wheat are already in use as part of farmland preservation programs in Pinghu and Jingzhou, respectively. More widespread use could be an effective part of a strategy for maintaining overall grain production capacity in China.

IV. The Role of Farmland Preservation in Food Security

The projections of China's future import needs made by the aforementioned studies are not driven by dietary shifts alone. Maintenance and expansion of farm production capacity—including, but not limited to cereal production capacity—are clearly essential. All of these studies assume that losses of farmland will continue. All of them assume increases in productivity, specifically, increases in crop yields per unit of land area, will be sufficient to compensate in large measure for cropland losses that do occur. Yields can, of course, be increased by greater use of more intensive production methods such as increased use of fertilizer and multiple cropping. Even more important, though, are crop breeding and other forms of agricultural research and improved water management. Agricultural price policies and marketing infrastructure also play critical roles.

Many observers believe that water, rather than land availability, is the principal obstacle to increasing farm productivity in China (Heilig 1999, Lohmar et al. 2003). China's agriculture depends critically on irrigation. Rice, of course, is grown in paddies that require irrigation. Winter wheat also requires irrigation in northern China due to lack of rainfall during the winter months. Vegetables are increasingly grown in greenhouses or under plasticulture, both of which require irrigation (Lohmar et al. 2003). Many farming regions face shortages of water for irrigation. Farmers in many regions that rely on groundwater have pumping at unsustainably high rates; water tables are falling rapidly as a consequence. Water shortages are affecting even regions with abundant water resources because poor maintenance and operation of irrigation systems results in substantial losses of surface water diverted for irrigation. Improved flood control is also sorely needed; as noted above, natural disasters—largely floods—have been one of the largest sources of crop and cropland losses.

Agricultural research, in particular, crop breeding, has been the chief engine of yield (and total factor productivity) growth in China over the past few decades. Between 1980 and 1995, for example, varieties developed by China's crop breeding infrastructure increased potential rice yields at an average annual rate of 2.3%, potential wheat yields at an average annual rate of 1.3%, and potential maize yields at an average annual rate of 2.5%. Outreach efforts by China's extension system during this period resulted in dissemination of varieties and cultivation methods sufficient to cut the gap between potential and actual yields in half. The historical record also shows that agricultural productivity has stagnated whenever investment in agricultural R&D has been neglected (Jin et al. 2002).

An indication of the importance of crop breeding and investment in irrigation infrastructure can be seen in the results of a sensitivity analysis conducted by Huang, Rozelle, and Rosegrant (1999). When investment in agricultural research and irrigation are low, total food imports amount to 9.7% of demand by 2010 and 13.9% of demand by

2020, compared to about 5% of demand with agricultural research and irrigation investment at current levels. High levels of investment in agricultural research and irrigation result in food imports of only 0.5% of demand in 2010 and a substantial level of aggregate net exports by 2020.

Maintenance of land productivity can also be important in maintaining food production levels. A significant share of China's cropland is subject to erosion, salinization, and other forms of land degradation (Ash and Edmonds 1988). However, agricultural productivity on much of this land is low; for example, Huang, Rozelle, and Rosegrant (1999) estimate that food imports with low or high growth of erosion problems would have only minor effects on food prices, production, and import demand. Even so, investment in soil conservation could be important in maintaining crop production capacity in some regions.

Expansion of multiple cropping can, and has been, an important means of maintaining crop output in the face of farmland losses (Ash and Edmonds 1998). Losses of farmland in the rapidly urbanizing coastal areas where the climate and soils are most conducive to multiple cropping has therefore been a source of special concern. As noted above, conversion of farmland to urban uses in these areas to date has claimed only a small share of existing farmland. The results of the studies cited above suggest that increased investment in agricultural research and irrigation infrastructure, coupled with appropriate farm price policies, have the potential to compensate adequately for losses in production capacity due to farmland conversion in these areas.

V. Institutional Impediments to Maintaining Food Production Capacity

Arguably the greatest impediments to China's ability to maintain adequate levels of food production are not physical but institutional. Distortions and/or inefficient uses of existing farmland arise from institutional problems in three distinct areas. The first set of problems, and perhaps most obvious, lies in current arrangements governing utilization of both rural and urban land. The second major problem lies in current arrangements for irrigation management. The third set of problems arises from current arrangements governing crop marketing. This section discusses difficulties created by institutional design in each of these three areas.

A. Institutions Governing Land Utilization

All land in China is publicly owned. Private individuals or entities cannot own land outright (although they can acquire rights to use land for specific purposes). While the principle of public ownership is clearly established, the application of the principle is complex and often ambiguous. Formally, rural and suburban land belongs to village collectives while urban land, rivers, wasteland, forests, and grassland belong to the state. The precise delineation of ownership of rural land such as reclaimed wasteland or forests and grassland near villages can be the subject of dispute. More generally, conditions of ownership appear to be undergoing a process of evolution as China modernizes (Ho 2001, Ho and Lin 2003).

Land use is administered by governmental entities. Land belonging to village collectives is administered by the village committee or economic organization, subject to oversight by township, provincial, and, in some cases, state organs. Urban land is managed by municipal governments, again subject to oversight by higher level government bodies. The land remaining is managed by provincial governments or state agencies (Ho 2001, Ho and Lin 2003).

Rural collectives have the authority to allocate land to alternative uses such as farming, construction, housing, public works, and village enterprises. These land allocation decisions are subject to approval by township authorities and county land bureaus, however, and must conform with the township's land utilization plan as well as with regulations such as those governing local housing standards limits on the number of residential plots allowed per household (Ho and Lin 2003).

Farmland is leased to households under contractual arrangements in which the household pays a fee (typically including a grain quota) to the collective in return for a residual claim on the products of the land. The contract may contain other stipulations as well (for example, requirements that the land be farmed and maintained in good condition) that are enforced by various sanctions. The size of each household's allocation is based on the size and composition of the household and may be altered as the size and composition of the household change. Land allocations may also be altered by exchanges or subcontracting. Exchanges among village households in order to consolidate holdings have been in evidence since the introduction of the Household Responsibility System in the early 1980s, as has been subcontracting of land to non-members, especially by village members migrating in search of work. Exchanges of land among villagers were declared legal in 1986. Subcontracting of land to outsiders, subject to approval of two-thirds of the village membership, was declared legal in 1998 (Liu, Carter, and Yao 1998, Ho and Lin 2003).

The farmland allocation process has been the subject of some debate. Economists have argued on general principles that secure tenure is essential for efficient land use, including appropriate levels of investment in maintaining and enhancing land productivity as well as allocating land to the most efficient uses and/or users. Evidence from developing countries tends to confirm this general principle, although security at levels less than full outright ownership (e.g., long-term use rights coupled with transferability) often seems sufficient to induce adequate investment and efficient reallocation (see for example Otsuka and Place 2001). In countries where capital markets are not well developed and investment in land requires significant purchases of machinery, equipment, or other inputs, the principal contribution of tenure security is to allow land to serve as collateral for loans, thereby easing credit constraints that limit farmers' ability to invest in land productivity enhancements (Heltberg 2002).

Even though enhanced tenure security and transferability promise to enhance productivity by stimulating investment in land and by permitting reallocations to the most productive farmers, they run contrary to longstanding practices and principles of administration in China. For one thing, they force the state to rely more on market mechanisms to ensure

adequate grain supplies. For another, they limit the power of the collective—and, in particular, the village leadership. Enhanced tenure security may also result in less equitable land allocations, since periodic reallocations of land to accommodate changes in household size and composition or compensate for unanticipated adverse events ensure greater equity in access to food (Liu, Carter, and Liao 1998).

Concerns over adverse effects on long term investment in maintaining and improving land productivity due to insecure tenure have led the Chinese government to experiment with lengthening the duration of farmland contracts. In 1984, collectives were urged by the state to contract with member households for a period of 15 years. In 1993, the state urged an extension of standard contract length to 30 years. In 1998, revisions to the Land Management Law explicitly required that all farmland contracts be (a) written and (b) effective for a term of 30 years with few or no adjustments allowed; it will take some time before these revisions are implemented fully, however. Experiments with contract durations of 50 and 60 years have also been conducted in recent years (Deininger and Jin 2003, Ho and Lin 2003).

The degree to which tenure insecurity has had adverse effects on efficiency in farming in China is difficult to determine. Formal legal guarantees of tenure security were enacted only recently and have yet to be fully implemented; a survey conducted in Shaanxi Province in 2001, for instance, found that over half of the villagers interviewed had experienced land reallocation between 1998 and 2001 (Kennedy, Rozelle, and Shi 2004). *De facto* tenure security has depended on village administrative practices, which vary widely and may not conform exactly to legal strictures. The threat of reallocation may also be used by cadre to extract rent from villagers (Huang 1999). Land abundance and access to off-farm employment, especially urban employment, have been found to exert a great deal of influence on the degree to which village members are subject to land reallocation (Liu, Carter, and Yao 1998, Rozelle and Li 1998).

Empirical studies using differences in village administrative practices as indicators of differential tenure security have found some evidence that tenure security affects investment in land productivity. An econometric study using data from villages in Hebei and Liaoning Provinces in 1995, did find that farmers facing a greater risk (frequency) of land reallocation invested less in organic fertilizer (which improves soil structure and hence long term productivity), although the magnitude of these productivity losses was small (less than 1%) and the risk of reallocation had no statistically discernible effect on other forms of land management in this region (Jacoby, Li, and Rozelle 2002). Similarly, an econometric study using more recent (2001) data from villages in Guizhou, Hunan, and Yunnan Provinces found that farmers in villages with a policy of no land readjustments for population changes were more likely to invest, and invested more, in agricultural improvements. Farmers with land-transfer rights were similarly more likely to invest in agricultural improvements (Deininger and Jin 2003).

Tenure security and transferability are likely to become more important for maintaining agricultural productivity in the future, especially in areas experiencing rapid urban growth. Urban employment opportunities are widely available in fast-growing coastal

areas. A large and growing proportion of the men of prime working age in these areas are employed in the urban sector, leaving a farm labor force composed primarily of women and the elderly. Farmers interviewed stated that as much as 80% of the young men in the environs in Pinghu City worked in industry in nearby cities; in Jiangzhou, which has a lower level of industrial development, the comparable figure was 20%. Lack of urban residency rights keeps these families tied to the land but since their main source of income is non-agricultural, they have little incentive to invest in maintaining and enhancing land productivity. Moreover, limitations on labor time and capacity may induce them to leave some land uncultivated. Administrative sanctions have been somewhat effective in preventing widespread abandonment of farmland in such areas but cannot provide adequate incentives for investment in land. Lack of secure, transferable use rights prevents these families from subcontracting land to farmers under long term arrangements that would give lessees sufficient incentives for investing in land productivity and for consolidating plots into operational units of sufficient size for exploiting economies of scale through expanded use of machinery and other means.

Economies of scale could also be important for spurring investment in land productivity. In areas like Pinghu, for example, wages in urban employment are so much higher than returns to farming that farmers have little incentive to invest in the maintenance and enhancement of land productivity by applying organic fertilizer or keeping irrigation and drainage systems in good repair. Consolidation of small plots into sufficiently large operating units could both lower land productivity investment costs and increase returns to farming sufficiently to make increased investment in land worthwhile for farm operators (Wu 2004).

Lack of secure tenure rights has facilitated the conversion of farmland to non-farm uses via requisitions of land for use by rural enterprises and via sales of land to local governments for subsequent industrial development. Secure tenure rights act as a check on the arbitrary exercise of authority by village leaders who have been known to expropriate land from farmers to lease to rural enterprises or to sell to local governments, often without paying compensation and in many cases pocketing the returns themselves (Cai 2003, Ho and Lin 2003). Illegal land development of this kind has become a national scandal. Millions of farmers are known to have lost land due to illegal land development. According to the Ministry of Land and Resources, farmers were owed at least \$1.2 billion in compensation and relocation fees (Xinhua News Agency 2004).

The system of land allocation in urban areas encourages excessive conversion of farmland as well as inefficient use of land more generally. Urban land is allocated by a combination of administrative, quasi-market, and market mechanisms. State and non-profit entities receive a land allocation valid without specific time limits. Municipal governments may also lease land to private enterprises for terms that vary according enterprise type. The standard term is 40 years for commercial enterprises, 50 years for industrial enterprises, and 70 years for residential uses. The lessee pays a conveyance fee for the right to use the land for that term plus land use taxes at rates set by the state according to city size. The conveyance fee is fixed administratively (rather than determined by market conditions). Lessees are allowed to sublease land and can

therefore profit from arbitrage opportunities created by any divergence between the value of land as determined by market conditions and conveyance fees set administratively by the state (Ho and Lin 2004, Ding 2003).

The secondary market creates incentives for more efficient use of existing urban land. At the same time, this system creates incentives for excessive conversion of rural land to urban uses. Rural land can be expropriated by the state for infrastructure or purchased by local governments, either for re-conveyance to private interests or for municipal housing construction. In return, the collective whose land is converted receives compensation for the land and for unharvested crops and a resettlement allowance for those displaced by the transfer. The size of the compensation package is set administratively and is typically considerably less than the value of the land in private uses. The conveyance fee is divided between various levels of government, with local government receiving the majority (60%). Revenue from land transactions is a major source of funding for local governments as well, accounting for anywhere between a quarter and half of all municipal revenue. As a result, local governments have strong incentives to expand into rural areas in order to finance their ongoing obligations in the areas of infrastructure and housing (Ho and Lin 2004, Ding 2003).

Current regulations also make it more attractive for local governments to provide housing for growing populations by expanding into rural areas rather than increasing density within existing urban boundaries. Redevelopment of existing municipal land requires governments to pay compensation to current tenants and to cover resettlement expenses. Compensation paid to current residents is much higher than that paid to rural inhabitants. In Beijing, for example, land costs (primarily compensation) makes up as much as 60% of the cost redevelopment of existing urban areas compared to 30-40% of the cost of developing converted rural land. Tenants may also resist displacement tenaciously, which at the very least creates significant delays. In addition, it is more expensive to provide infrastructure to denser residential development. These factors combine to make it cheaper and easier to meet housing needs by converting rural land rather than increasing density within the existing municipal boundaries (Ding 2003).

Industrial development is widely seen as the key to economic growth and a rising standard of living for municipalities. Low land costs have encouraged local governments to acquire and set aside land for industrial development speculatively, that is, in the hope of attracting industrial investment. Much of that land has remained idled as hoped-for investment failed to materialize. By 1996, there were roughly 116,000 hectares of idle undeveloped land in economic development zones, over half of which was converted farmland that could no longer be converted back (Cai 2003, Ho and Lin 2004). In sum, limitations on land markets—which could, in the case of China, involve transactions for use-rights with a delimited term rather than permanent, complete property rights—are the source of numerous inefficiencies in land use. These inefficiencies are especially apparent with respect to farmland protection. Administratively set compensation levels create artificially low opportunity costs of converting farmland to alternative uses. They create incentives for illegal land transactions that allow rural collectives, rather than urban governments, to profit from

conversion, thereby undermining the state's control over land use (Ho and Lin 2003). They also create incentives for other types of illegal land transactions as well, notably forcible takeovers by local officials of land whose owners are unwilling to sell (Cody 2004). Lack of secure tenure inhibits investment in farmland productivity and transfers that could improve operating efficiency.

B. Irrigation Management Institutions

The water shortages China has been experiencing in recent years are due primarily to institutional failings rather than absolute scarcity of water (Lohmar et al. 2003). Three types of institutional inadequacy have been important: (1) lack of clearly delineated and enforce use-rights for water, (2) inadequate financing of water delivery infrastructure, and (3) failure to price water at its opportunity cost.

As in many areas where water was historically not scarce, use-rights are not clearly delineated in China. This lack of clear use-right assignment has created a number of problems. Upstream users typically take too large a share of the water available, leaving inadequate supplies for downstream users—a phenomenon that applies equally at the provincial level, where upstream provinces divert excessive quantities of streamflow, to the farm level, where farmers with land at the heads of delivery canals take excessive amounts, leaving little or nothing for those at the tails of those canals (Lohmar et al. 2003). Pollution, too, is typically conceptualized by economists as arising from a lack of clearly delineated use-rights (Coase 1960). Levels of industrial water pollution are high enough to interfere with downstream agriculture as well as other water uses.

Most irrigation systems in China are not self-financing. Instead, construction, maintenance, and operation of irrigation systems are responsibilities of government bodies at various levels and are financed from general revenues. Without a dedicated funding source, maintenance varies with the overall status of government finances. Anecdotal evidence suggests that neglect of irrigation system maintenance is widespread. According to local officials in Pinghu and Jingzhou, for instance, maintenance of irrigation and drainage systems virtually ceased after the introduction of the Household Responsibility System around 1980. While the emphasis on individual incentives did result in significant increases in agricultural productivity (Rozelle and Swinnen 2004), communal efforts like irrigation systems fell into neglect. Underprovision of public goods of this nature is a well-known failing of market systems. In recent years, local government bodies have been attempting to remedy these years of neglect by investing in repair and upgrades of irrigation systems. Lack of funds, however, restricts these efforts to a less than adequate pace. In Jingzhou, for instance, officials estimate that at current funding levels it will take 50 years to repair all irrigation systems currently in need. Many systems that have been repaired recently are likely to need further maintenance before systems currently in need of repair have been attended to.

The problem of maintenance is compounded by the poor quality of the irrigation infrastructure built prior to 1980. Delivery losses are extremely high, typically 30-40%, exacerbating overall shortages and resulting in a lack of reliability. In response, farmers affected by these problems have switched to groundwater pumped from private wells.

Their pumping rates have been unsustainably high, resulting in declining water tables that frequently fall below the depth from which private wells can withdraw water (Lohmar et al. 2003). Since irrigation systems typically also provide drainage, adequate maintenance of irrigation facilities is important for limiting flood damage which, as noted above, has been a major source of farmland loss.

Experience worldwide over many years indicates that neither markets alone nor governments alone manage irrigation systems sustainably and efficiently. Purely government-run systems suffer either from neglect due to underfinancing (typically due to a lack of dedicated funding) or from overinvestment and subsidies provided to special interests with significant political clout. Private irrigation systems are essentially local monopolies. Irrigation systems run cooperatively by users suffer from unstable finances due to free rider problems. Irrigation systems in much of the United States are essentially hybrids, with local irrigation infrastructure owned and operated by self-supporting user cooperatives that are quasigovernmental. Operating expenses are financed by water charges. The authority to levy property taxes has typically been needed to ensure adequate funding of fixed costs. Similar types of hybrid systems may be suitable for China.

Additional inefficiencies in water use arise in China because water prices are not set to reflect opportunity costs. Many farmers are charged for water according to the amount of land farmed rather than the amount of water used. Charges may be set to raise revenue for the township or provincial treasury rather than to induce economically efficient water use. As a result, farmers have insufficient incentive to adopt water conservation measures. Experiments with water users associations set water charges to defray local operational expenses plus the costs of delivering water to the village have found farmers' use of water conservation methods to be quite price-responsive (Lohmar et al. 2003, Lin 2002). As in other parts of the world, then, water price reform has a significant potential to alleviate water shortages by promoting conservation.

Reform of irrigation institutions has important implications for maintaining China's food production capacity generally and for preserving farmland specifically. As noted above, key sectors of China's agriculture are critically dependent on irrigation; failure to alleviate growing water shortages could seriously undermine China's food self-sufficiency goals. Alleviation of water shortages, increased delivery reliability, and improvements in water quality due to reductions in pollution should help increase agricultural productivity and thus profitability, thereby reducing incentives to convert farmland to non-farm uses and thus slowing the rate of farmland conversion.

C. Crop Marketing Arrangements

China has a long tradition of promoting self-sufficiency at the local and provincial levels. This tradition remains strong. For example, the initial response of the government to Lester Brown's predictions of massive food shortages was the enactment of the Governors' Grain Bag Policy requiring each province to maintain self-sufficiency in grain. Reliance on self-sufficiency can, however, become an impediment to economic growth by limiting the scope for gains from specialization. China has been moving away

from this traditional stance. Grain trading, for example, has been partially liberalized and grain traders are creating more integrated national markets (Rozelle et al. 2000, Gale 2002).

Greater market liberalization could contribute to farmland preservation and the maintenance of food production capacity more generally. More closely integrated national markets should increase average prices and decrease price volatility, making farming more attractive relative to other forms of employment. Greater market integration should be especially beneficial in poorer inland areas where incentives to migrate toward fast growing coastal cities have been especially strong.

Greater market liberalization will require significant investment in infrastructure, however (Gilmour and Gale 2002). China's transportation network has not expanded fast enough to keep pace with the growth of trade volume. China lacks sufficient warehouse and cold storage facilities. Reductions in post-harvest losses can be an important means of augmenting food supplies, especially in developing countries (Lichtenberg and Zilberman 2002). China is estimated to have sufficient cold storage capacity to accommodate only 20-30% of demand, resulting in spoilage losses of perishable freight on the order of 33%. Increases in cold storage capacity could therefore increase food availability substantially by reducing spoilage losses. Increased cold storage capacity can also reduce price volatility, giving farmers an incentive to increase supply. For example, in farmers in areas surrounding Pinghu City are deterred from increasing production of vegetables because of high price volatility. Increases in cold storage facilities would reduce price volatility by smoothing supply; production of horticultural products would likely increase as a result. Expanded provision of electricity could further increase the effective food supply by allowing consumers to reduce spoilage losses by refrigerating produce.

VI. Conclusions and Directions for Future Research

China has been gravely concerned about its ability to meet its food security goals in coming years. Those concerns were triggered originally by an apparent rapid decline in cultivated land, that is, land allocated to major food and feed grains, soybeans, and tubers. They have been exacerbated by declines in area planted and production of the principal food grain crops, rice and wheat, and in an especially rapid pace of farmland conversion in the coastal provinces, which, due to climate and soils, contain the most productive farmland in the nation.

The central government has responded by adopting measures aimed at stabilizing rice and wheat production and at maintaining China's agricultural land base. The Governor's Grain Bag Policy requires each province to maintain self-sufficiency in major food grains. The dynamic balance policy requires each province to keep the area of good quality cultivated land at current levels. Subsequent regulations and legislation have rendered dynamic balance requirements more stringent.

The preceding discussion suggests that China's concerns about farmland preservation have been somewhat misplaced. There is little evidence of a growing threat to China's

ability to meet its food security goals. One reason is that those food security needs have been changing due to income growth and urbanization, which are reducing the importance of food grains and increasing the importance of vegetables, fruits, fish, poultry, meat, and dairy products; conversion of land to the production of these foods accounts for much of the loss of cultivated land China has experienced in recent years. It is by no means clear that efforts directed at farmland preservation are necessary or even important in maintaining China's food production capacity. Other factors of production—in particular, irrigation and water policies, agricultural research, development, and extension, agricultural price policies, and agricultural marketing infrastructure—have had profound impacts on China's food production capacity and likely outweigh farmland preservation as means of ensuring that China's food security goals are met. Maintaining strong agricultural research, development, and extension programs is of paramount importance if China is to keep crop production growth on a par with population growth. Many observers argue that water, rather than land, is the chief limiting factor in Chinese agriculture today. Institutions for irrigation and drainage management have fallen into decay and irrigation and drainage infrastructure has fallen into widespread disrepair as a result. Reforming these institutions so that irrigation and drainage become self-sustaining economically is of critical importance. Lack of transportation and storage infrastructure, especially cold storage, reduces productivity by keeping post-harvest losses high and by creating disincentives for farmers to expand production. Finally, inconsistent government policies have reduced productivity by hampering farmers' ability to plan and by creating conflicting incentives.

While the loss of cultivated land does not appear to be the critical nexus of China's food security problems, the evidence does suggest quite strongly that there are substantial inefficiencies in land allocation generally and farmland conversion in particular that have significant social costs, including—but not limited to—adverse effects on the maintenance of China's food production capacity. The root cause of these inefficiencies appears to be institutional, in particular, a policy structure that seems to encourage excessive conversion of farmland as well as inefficient use of land more generally on the part of municipal and regional governments—even in areas where the central government has made farmland preservation a top priority. Policies influencing government finance, residential construction, and urban land transactions appear to create a high demand for land. Policies governing payment for land make farmland conversion a highly attractive means of meeting that demand. The extent to which this policy environment results in inefficient land use has not been documented empirically, however. Additional research clarifying the extent of these inefficiencies would be useful for guiding policy reforms. Some important areas for further research are discussed below.

A. Impacts of Residential Construction, Industrial Development, and Infrastructure Policies on Farmland Conversion

As noted above, conversion of farmland to urban uses is driven largely by policies governing residential construction, industrial development, and infrastructure development. For example, residential density guidelines and high costs make farmland conversion more attractive than redeveloping existing urban areas for most local governments. The interaction between these policies is not well understood. Moreover,

the separation of governmental responsibilities for these different forms of land use makes coordination difficult. A scoping study of the effects of these uncoordinated land use policies could help begin to clarify the relationships between these land use policies by deriving first-order estimates of the magnitudes of the incentives for farmland conversion created by policies that influence urban land use decisions using case studies of selected urban areas. Such a scoping study would also lay the foundation for further scholarly research by beginning to collect data amenable to formal statistical analysis.

Such an effort would require the collection of data on residential density, industrial land use, infrastructure, farmland, and rural housing in selected areas of special interest, including areas undergoing rapid economic growth like Pinghu (Wu, Ye, and Fang 2004) and areas with less development pressure like Jingzhou (Shi 2004). Those data would need to be supplemented with economic information that could be used to estimate income from farming (crop prices and yields, expenditures on fertilizers and other inputs, etc.), assessed value of land in farming, returns to various industries locating in the area, wages, and information on land transactions such as location, conveyance fee, purpose of conversion and value in new use, etc. Local government budget information (tax revenues from various sources, income from land transactions, and expenses for residential construction, infrastructure, and other operations) would be used to assess fiscal implications of alternative policies. Information on guidelines for residential construction would be used to assess the land use implications of residential construction policies. Information on land set aside for industrial development and its current uses would be used to assess the impacts of industrial development policies on rural land conversion.

Such a project would also set the stage for future scholarly research by (a) generating and refining hypotheses about determinants of land use decisions and (b) beginning to collect more extensive data that could be used to examine the impacts of these policies on land conversion using formal statistical analysis. In particular, we hope to at least begin constructing a cross-section, time-series panel data set containing such information as local government revenues and obligations, conveyance fees, compensation packages, the value of land in farming, wages, returns to various industries, population growth, and the amounts of land allocated to alternative uses for a large sample of municipal areas across China.

B. Land-use Effects of Local Government Competition for Industrial Development

As noted above, many local jurisdictions have set aside land for industrial development speculatively, in the hope of attracting industry in order to promote economic and income growth. Those hopes have often been in vain. A sizeable share of that land sits idle. Much of that idle land can no longer be reconverted to farmland. This kind of speculative behavior is highly reminiscent of competition for major industrial investments among states and localities in the United States, in particular, packages of tax exemptions and infrastructure development offered by state and local governments in order to attract investment.

Theoretical analyses have shed light on conditions under which providing incentives to mobile firms to influence their location decisions can benefit local governments, as well as conditions under which they do not (for recent surveys see Garcia-Mila and McGuire 2002 and Glaeser 2002). These incentives can be beneficial when economies of scale are present in the provision of local public goods and services or in the form of agglomeration economies due to large numbers of firms, large pools of workers to meet shifting employment demand, or diversity of firms that create human capital spillovers. They can also be beneficial when capital market imperfections constrain local governments' ability to provide local public goods and services. Alternatively, when firms do not use the same levels of public goods and services as residents, locational incentives are essentially rebates for services not used that result in the efficient provision of those services. Other theoretical analyses have focused on cases where the aforementioned conditions do not apply, for example, when increasing returns to scale are not present, when governments' ability to finance public goods is not constrained by capital markets, or when firms use as much or more public services as residents. In these latter cases, locational incentives represent transfers of rent to mobile firms that lower overall welfare.

There have been relatively few empirical studies examining either why local governments offer locational incentives or what effects those incentives have on firms' location decisions. Most empirical evidence cited is fragmentary and anecdotal (for a recent survey see Edmiston and Turnbull 2003). The few econometric studies that have been conducted suggest that fiscal distress and competition from neighboring jurisdictions are important determinants of governments' propensity to offer these incentive packages. Other econometric studies suggest that these incentive packages may not have much influence on firms' location decisions.

Theoretical analyses currently in the literature focus on policies that differ from speculative land set asides in one important regard: They become effective only when the firm chooses to locate in the jurisdiction offering them. Speculative set asides of land for industrial development thus impose an option cost on society as a whole, since the land may not be readily convertible to other uses should firms not choose to move to the locality. As noted above, for example, most land set aside for this purpose can not be reconverted to farmland. For this reason speculative set asides of land for industrial development also differ from policies like zoning that do not physically affect the landscape, leaving open the possibility of revision to meet unanticipated future land use needs.

There have also been no comparable empirical studies of the determinants of local governments' decisions to engage in speculative farmland conversion in China or of the effects of speculative farmland conversion on industrial location decisions. The existing literature on tax incentives suggests that factors such as the opportunity cost of land, current income levels, fiscal situation, and competition from neighboring jurisdictions are important determinants of local governments' propensity to engage in efforts such as speculative farmland conversion to attract industry. To carry out such an empirical study, one would need cross sectional data on the opportunity cost of land, per capita income

levels, and municipal revenues and obligations as well as local data on farmland set asides for industrial development. Statistical analysis of these data could be used to determine if these factors are systematic predictors of speculative farmland conversion decisions. These data could be combined with other data on industry location to test whether such set asides do in fact attract industry. The econometric results would help identify factors influencing local governments' propensity to use these incentives, which could help policy makers devise strategies for mitigating any negative effects. The econometric results could be used to draw inferences about the efficiency effects of these incentives as well.

C. Incentive Systems for Farmland Preservation

Farmland conversion decisions have both economic and non-economic components. As noted above, the gap between compensation for farmland conversion and conveyance fees for private development leases makes farmland conversion economically attractive. Reduction or elimination of this financial incentive would be clearly be an important component of any farmland preservation strategy. But because land transactions in China are conducted by government agencies, they are not strictly commercial and may not even be voluntary. Instead, power and authority often determine what transactions occur and how much compensation is paid—or even if compensation is paid at all. Press accounts of forcible land grabs by municipal authorities abound. Legal restrictions on the exercise of governmental authority (like those governing the use of eminent domain in the United States) can be ineffective if there are weaknesses in the judicial system.

The prominent role played by power and authority in farmland conversions suggests that reform of economic incentives alone may not suffice to ensure efficient land allocations. Instead, strategies for farmland preservation may need to combine creation of countervailing power of some form in order to redress imbalances in power between municipal, township, or provincial authorities and rural collectives in addition to restructuring economic incentives. Contracts between rural collectives and the state, for example, purchases of development rights by the state, might be an appropriate means of creating such a countervailing power. Sanctions for illegal transactions severe enough to provide a high level of deterrence might also be useful.

Conceptual and empirical modeling could be used to explore the potential use of alternative incentive mechanisms for farmland preservation in areas with high conversion pressure. The conceptual modeling would draw on the economics literature on law and contract enforcement (for a survey of a closely related body of literature see Cohen 1999) but would encompass political, and legal considerations as well as economic ones. It would also draw on theoretical and empirical finding from the literature on farmland preservation (Lynch, Fulton et al. 2004).

On the empirical side, one could conduct a scoping study of how economic incentives for farmland conversion could be revised to meet farmland preservation goals. Such an effort would need to utilize economic data on income from farming (crop prices and yields, expenditures on fertilizers and other inputs, assessed value of land in farming), data that could be used to estimate returns to conversion for private entities (profitability

of alternative land uses), and data on local government finances (conveyance fees, tax revenues from various sources, income from land transactions, expenses for residential construction, infrastructure, and other operations) to derive rough estimates of compensation rates adequate for meeting farmland preservation goals in different locations. It would need to supplement these data with information on indicators of the efficacy of China's judicial system in different locations (e.g., probability of sanctions being applied under alternative incentive systems) and structural models derived from the theoretical analysis to derive rough estimates of the magnitudes of alternative incentive mechanisms needed for effective enforcement of farmland preservation policies.

VII. References

- N. Alexandratos, "China's Projected Cereals Deficit in a World Context", Agricultural Economics 15(1996), 1-16.
- R.F. Ash and R.L. Edmonds, "China's Land Resources, Environment, and Agricultural Production", The China Quarterly 156(1998), 836-879.
- L. Brown, Who Will Feed China? Wakeup Call for a Small Planet, WW Norton, New York, 1995.
- Y. Cai, "Collective Ownership or Cadres' Ownership? The Non-agricultural Use of Farmland in China", The China Quarterly 166(2003), 662-680.
- R.H. Coase, "The Problem of Social Cost", Journal of Law and Economics 3(1960), 1-44.
- E. Cody, "China's Land Grabs Raise Specter of Popular Unrest", Washington Post, October 5, 2004, A1.
- M.A. Cohen, "Monitoring and Enforcement of Environmental Regulations", in H. Folmer and T. Tietenberg (ed.), The International Yearbook of Environmental and Resource Economics 1999/2000, Edward Elgar, Northampton, MA, 1999.
- K. Deininger and S. Jin, "The Impact of Property Rights on Households' Investment, Risk Coping, and Policy Preferences: Evidence from China", Economic Development and Cultural Change (2003), 851-882.
- C. Ding, "Land Policy Reform in China: Assessment and Prospects", Land Use Policy 20(2003), 109-120.
- Economic Research Service, data on China grain area and production, 1991-2002; cotton and oilseed area and production, 1990-2002; area and production of other crops, 1990-2002; agricultural imports and exports, calendar years, 2000-2003; and urban and rural population, income, expenditures, and food consumption, 1990-2002, <http://www.ers.usda.gov/Briefing/China/data.htm>.
- K. Edmiston and G.K. Turnbull, "Local Government Competition for Economic Development", FRP Report No. 83, Andrew Young School of Business, Georgia State University, January 2003.
- W. Fulton, J. Mazurek, R. Pruetz, and C. Williamson, "TDRs and Other Incentive-Based Land Mechanisms: How They Work and Their Role in Shaping Metropolitan Growth", discussion paper prepared for the Brookings Institution Center on Urban and Metropolitan Policy, Washington, DC, June 2004.
- F. Gale, "Regions in China: One Market or Many?", in F. Gale (ed.), China's Food and Agriculture: Issues for the 21st Century, Agriculture Information Bulletin No. 775,

Economic Research Service, US Department of Agriculture, Washington, DC, April 2002.

T. Garcia-Mila and T.J. McGuire, "Tax Incentives and the City", Brookings-Wharton Papers on Urban Affairs 2002, 95-114.

G. Gilmour and F. Gale, "Transportation and Distribution: Will Bottlenecks Be Eliminated?", in F. Gale (ed.), China's Food and Agriculture: Issues for the 21st Century, Agriculture Information Bulletin No. 775, Economic Research Service, US Department of Agriculture, Washington, DC, April 2002.

E. Glaeser, "Comment on T. Garcia-Mila and T.J. McGuire, 'Tax Incentives and the City'", Brookings-Wharton Papers on Urban Affairs 2002, 115-132.

G.K. Heilig, "Anthropogenic Factors in Land-Use Change in China", Population and Development Review 23(1997), 139-168.

G.K. Heilig, "Can China Feed Itself?", IIASA, Laxenburg, Austria, 1999 (<http://www.iiasa.ac.at/Research/ChinaFood/>).

R. Heltberg, "Property Rights and Natural Resource Management in Developing Countries", Journal of Economic Surveys 16(2002):189-214.

P. Ho, "Who Owns China's Land? Policies, Property Rights, and Deliberate Institutional Ambiguity", The China Quarterly (2001), 394-421.

S.P.S. Ho and G.C.S. Lin, "Converting Land to Nonagricultural Use in China's Coastal Province", Modern China 30(2004), 81-112.

S.P.S. Ho and G.C.S. Lin, "Emerging Land Markets in Rural and Urban China: Policies and Practices", The China Quarterly (2003), 681-707.

H. Hu, W.S. Chern, and F. Gale, "How Will Rising Income Affect the Structure of Food Demand?", in F. Gale (ed.), China's Food and Agriculture: Issues for the 21st Century, Agriculture Information Bulletin No. 775, Economic Research Service, US Department of Agriculture, Washington, DC, April 2002.

J. Huang, S. Rozelle, and M.W. Rosegrant, "China's Food Economy to the Twenty-first Century: Supply, Demand, and Trade", Economic Development and Cultural Change (1999), 737-766.

X. Huang, "Ground Level Bureaucrats as a Source of Intensification of Rural Poverty in China", Journal of International Development 11(1000), 637-648.

Interagency Agricultural Projections Committee, USDA Agricultural Baseline Projections to 2013, Staff Report WAOB-2004-1, Office of the Chief Economist, US Department of Agriculture, February 2004.

- H.G. Jacoby, G. Li, and S. Rozelle, “Hazards of Expropriation: Tenure Insecurity and Investment in Rural China”, American Economic Review 92(2002), 1420-1447.
- S. Jin, J. Huang, R. Hu, and S. Rozelle, “The Creation and Spread of Technology and Total Factor Productivity in China’s Agriculture”, American Journal of Agricultural Economics 84(2002), 916-930.
- J.J. Kennedy, S. Rozelle, and Y Shi, “Elected Leaders and Collective Land: Farmers’ Evaluation of Village Leaders’ Performance in Rural China”, Journal of Chinese Political Science 9(2004), 1-22.
- E. Lichtenberg and D. Zilberman, “Storage Technology and the Environment”, Journal of Agricultural and Resource Economics 27(2002), 146-164.
- G.C.S. Lin and S.P.S Ho, “China’s Land Resources and Land Use Changes: Insights from the 1996 Land Survey”, Land Use Policy 20(2003), 87-107.
- Z. Lin, “Participatory Irrigation Management by Farmers: Local Incentives for Self-Financing Irrigation and Drainage Districts in China”, World Bank, Washington DC, December 2002.
- S. Liu, M.R. Carter, and Y. Yao, “Dimensions and Diversity of Property Rights in Rural China: Dilemmas on the Road to Further Reform”, World Development 26(1998), 1789-1806.
- B. Lohmar, “China’s Wheat Economy: Current Trends and Prospects for Imports”, WHS 04D-01, Economic Research Service, US Department of Agriculture, May 2004.
- B. Lohmar, J. Wang, S. Rozelle, J. Huang, and D. Dawe, “China’s Agricultural Water Policy Reforms: Increasing Investment, Resolving Conflicts, and Revising Incentives”, Agriculture Information Bulletin No. 782, Economic Research Service, US Department of Agriculture, Washington, DC, March 2003.
- L. Lynch, “Protecting Farmland: Why Do We Do It? How Do We Do It? Can We Do It Better?”, in S. Goetz, J. Shortle, and J. Bergstrom (ed.), Land Use Problems and Conflicts: Causes, Consequences, and Solutions, Routledge Economics, London, in press.
- Ministry of Land and Resources, “Communique on Land and Resources of China, 2002”, Beijing, 2003.
- K. Otsuka and F. Place (Ed.), Land Tenure and Natural Resource Management, Johns Hopkins University Press, Baltimore, 2001.
- Y. Shi, “Optimum Strategy on Farmland Preservation: A Case Study in Jiangzhou City, Hubei Province”, Land Resource Bureau of Jiangzhou City, Jiangzhou, July 2004.
- V. Smil, “China’s Agricultural Land”, The China Quarterly (1999), 414-429.

US Embassy, “Can China Feed Itself in the 21st Century: Land Use Patterns May Provide Some Answers”, Environment, Science and Technology Division, Beijing, June 1996.

C. Wu, personal communication, July 3, 2004.

C. Wu, Y.Ye, and B. Fang, “Optimum Strategy on Farmland Preservation: A Case Study in Pinghu City, Zhejiang Province”, College of Southeastern Land Management, Zhejiang University, Hangzhou, July 2004.

Xinhua News Agency, “China Cracks Down on Illegal Land Use”, Beijing, May 25, 2004.

H. Yang and X. Li, “Cultivated Land and Food Supply in China”, Land Use Policy 17(2000), 73-88.