Chin. Geogra. Sci. 2009 19(3) 231–240
DOI: 10.1007/s11769-009-0231-9
www.springerlink.com

Livelihood Strategy Change and Land Use Change —Case of Danzam Village in Upper Dadu River Watershed, Tibetan Plateau of China

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Abstract: Land use change in rural China since the 1980s, induced by institution reforms, urbanization, industrialization and population increase, has received more attention. However, case studies on how institution reforms affect farmers' livelihood strategies and drive land use change are scarce. By means of cropland plots investigations and interviews with farmers, this study examines livelihood strategy change and land use change in Danzam Village of Jinchuan County in the upper Dadu River watershed, eastern Tibetan Plateau, China. The results show that, during the collective system period, as surplus labor forces could not be transferred to the secondary and tertiary industries, they had to choose agricultural involution as their livelihood strategy, then the farmers had to produce more grains by land reclamation, increasing multiple cropping index, improving input of labor, fertilizer, pesticide and adopting advanced agricultural techniques. During the household responsibility system period, as labors being transferred to the secondary and tertiary industries, farmers chose livelihood diversification strategy. Therefore, labor input to grain planting was greatly reduced, which drove the transformation of grain to horticulture, vegetable or wasteland and decrease of multiple cropping index. This study provides a new insight into understanding linkages among institution reforms, livelihood strategy of smallholders and land use change in rural China.
Keywords: livelihood strategy; land use change; agricultural involution; upper Dadu River watershed; Tibetan Plateau; China

1 Introduction

Since IGBP (International Geosphere-Biosphere Programme) and IHDP (International Human Dimensions Programme on Global Environment Change) implemented land use/cover change (LUCC) project (Lambin et al., 1999), there were many new findings on the causes of LUCC on the basis of case studies around the world. In 2001, global scientists working on LUCC summarized papers on land use/cover change and found that the simple cause-consequence relationships were difficult to support complicated land use change cases around the world, such as tropic deforestation, agricultural intensification, rangeland modification, influence of urbanization and globalization on regional LUCC (Geist and Lambin, 2001; Lambin and Geist, 2001; Lambin et al., 2001). "Rather, people's response to economic opportunities, as mediated by institutional factors, drove land cover change" (Lambin et al., 2001). Scientists have appealed to enhance the theory and case analysis of man-land relationship, so as to seek synthesis study means of LUCC. IGBP and IHDP then started up Global Land Project to understand man-land coupling system better, to diminish the frangibility of man-land system and enhance sustainable land use (Moran and MacConnell, 2003; Ojima et al., 2005). The new project focused on many important interfaces of man-land systems, such as how changes of social and economic factors affect land use decisions and practices, how land management actions affect natural ecosystem and how changes of ecosystem service value affect livelihood strategy. Therefore, it is necessary to do more ca-

Received date: 2008-05-12; accepted date: 2009-02-10
Foundation item: Under the auspices of National Natural Science Foundation of China (No. 40601006, 40471009), National Basic Research Program of China (No. 2005CB422006)
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se studies to examine these interfaces.

From the 1980s, China has experienced tremendous land use changes (Heilig, 1997; Fischer et al., 1998; Yang and Li, 2000). Many coastal regions of China, such as the Yangtze (Changjiang) River Delta region and Pearl (Zhujiang) River Delta region, experienced a dramatic economic and spatial restructuring, which resulted in the rapid land use change (Streets et al., 1995; Lin, 2001; Weng, 2002; Seto and Kaufmann, 2003; Li and Yeh, 2004; Long et al., 2007). Case studies on regional scale, which are still based on cause-consequence paradigm, show that industrialization, urbanization, population growth of China, and the economic reform measures are four major driving forces contributing to land use change in costal regions, characterized by a serious replacement of farmland with urban and rural settlements, construction land, and artificial ponds (Li and Yeh, 2004; Long et al., 2007). However, as industrialization and urbanization in the western China are comparatively lagged, there are different socio-economic development processes. In the western China, smallholder economy is chronically kept and land use is closely linked with livelihood of farmers. However, there still lack case studies on how policy inducements affect livelihood of farmers and then drive land use change.

The Dadu River watershed, aggregating many natural vegetation types and having important ecological shelter functions, is a typical fragile ecotone and receives much attention on its environmental degradation (Bao et al., 2002; Fei and Yang, 2002; Deng et al., 2003). In the latest five years, RS and GIS measures were used to study land use/cover change patterns, driving forces and responses of local residents of upper Dadu River watershed on regional scale (Bai et al., 2003; Yan et al., 2005a; 2005b; 2006; Zhang et al., 2008). Those studies show that policy inducements are the most important driving forces of land use change in this region. However, from those studies, it is found that the understandings got from the studies on regional scale can not support the cases on local scale and it is hard to link land use change and livelihood change together, especially in smallholder economy system. Cases on policy inducements driving livelihood change and livelihood change driving land use change are still scarce. Nowadays, there is a new trend of focusing on local scale comprehensive study on livelihood diversification and land use change (Reardon, 1997; Elli, 1998; Chen et al., 2001; Escobal, 2001; Bryceson, 2002; Niehof, 2004; Soini, 2005; Zhang et al., 2008), as it could get new insights into man-land system. Therefore, applying paradigm of livelihood strategy, our studies have focused on village scale and tried to link policy induction, livelihood strategy and land use change together since 2005. There are eight villages being studied altogether. In this paper, Danzam Village in Sha′er Town of Jinchuan County in the upper Dadu River watershed is selected as a typical case to examine key interfaces on the local scale. The following issues are examined in this paper: 1) livelihood strategy and land use in collective system; and 2) livelihood strategy and land use change in household responsibility system.

2 Study Area, Data and Methods

2.1 Study area

Situated in Sha′er Town of Jinchuan County in eastern Tibetan Plateau (Fig. 1), Danzam Village (31°30′54″–31°34′08″N, 101°59′9″–102°02′46″E) is a typical valley village, with 2km off Jinchuan Town and covers an area of 340.37ha. Arable land and residential area are distributed in flat valley. A county-level road passes through the whole village. As being near county town, Danzam Village has accesses to the modern infrastructures, such as transportation, electricity, phone, potable water, hospitals, markets and schools. In 2006, the village consisted of 415 households with a population of 1778, with equal number of the Tibetan nationality people, the Hui nationality people and the Han nationality people, respectively.

Danzam Village is dominated by plateau monsoon. Average annual temperature is 11.8℃ and annual active accumulated temperature (≥10℃) is 3942.9℃, with 194 days of non-frost. The village is located in a typical semiarid valley with distinct dry-wet season, average annual precipitation being 606.8mm and mean annual evaporation being 1543.8mm. It is usually drought in winter and spring. Besides drought, the main natural disaster is hailstone[①] (JCCC, 1994).

In the flat valley along the Dadu River, elevation varies between 2148 and 2300m above sea level and the main land use types are arable land, orchard and built-

① Land Resources Investigation Office, Land and Resources Bureau, Jinchuan County of China, 1995. *Jinchuan Land*. (in Chinese)

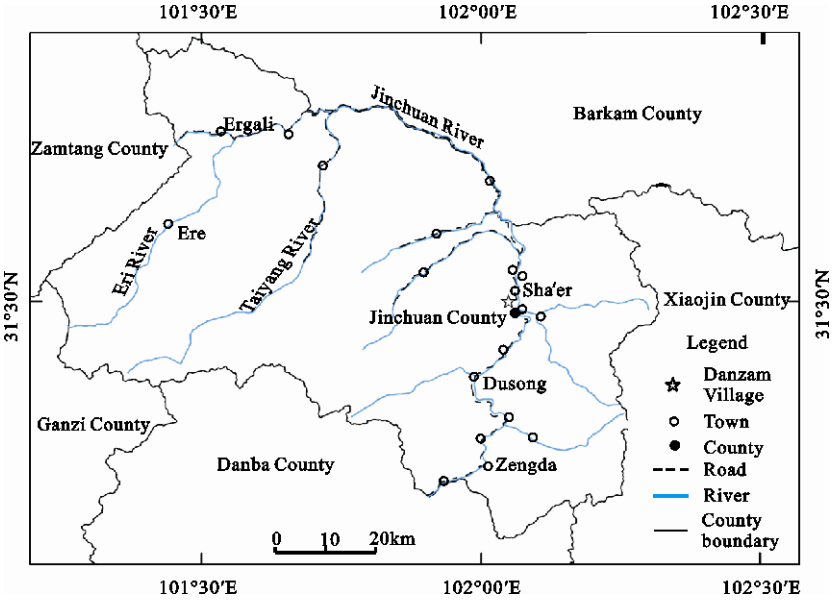

Fig. 1 Location of Danzam Village in Jinchuan County

up land. While in steep canyon above valley, elevation varies between 2300 and 3040m above sea level and the main land use types here are forest, shrub and grassland. Debris flow is easily engendered from steep and fragmentized geomorphology in rainy seasons and always destroys arable land and orchard in lowland, whose main soil types are fluvent soil, dry-cinnamon soil, mountainous cinnamon soil, mountainous brown soil, dark brown forest soil, sub-mountainous meadow soil and mountainous meadow soil. The main cultivation soil is fluvent soil. Vegetation type in Danzam Village varies with elevation. In the areas of 2148–2600m above sea level, there is semiarid valley shrub vegetation, and in those of 2500–3100m above sea level there is broad-leaved mix forest. Orchard plants such as pit-peach, apple and pear are planted below 2300m above sea level. Crop is mainly composed of maize and wheat, with little potato, bean, vegetable and rape, with biannual ripeness.

2.2 Data and method

*Sha'er Agriculture Statistical Annals*① during 1965–2005 and *Jinchuan County Statistical Annals*② were collected from Sha′er Town, Jinchuan Statistical Bureau, and Jinchuan Agriculture and Herd Bureau, respectively. Those data provide background information of the village.

By interviews with the elders and rural cadres of Danzam Village in August 2005, the important information since 1950 were got, such as momentous policy changes, major events they participated, socio-economic variances, main natural disasters and the superior species generalization. Based on those interviews, questionnaire was designed and 88 households were surveyed by four investigators. The interview with each household costs 3–4 hours, with questions being answered mainly by householders or elders in a family, with others' supplements. Questionnaire consisted of firstly basic household information, including family population, labor, real estate property and other belongings, education degree, the condition of engaging in off-farm employment, family income and payout, and household debt; secondly, their land use condition, including input of labor, fertilizer, pesticide and manure, crop structure adjustment, livestock grazed or fed, deforestation and abandonment of arable land and so on.

The National Soil Survey cards of Sha′er Town in 1979 were collected from Jinchuan Archives Bureau. Those cards recorded fertilizer input level, irrigation condition, multiple cropping index and yield of every plot in Danzam Village in 1979. After household responsibility system being put into practice in 1980, a plot was always divided into several small plots among a few households. In August 2006, fertilizer input, irrigation condition, multiple cropping index and crop yield of sample plots of interviewed households were investigated.

① Agricultural Economics Office, Sha′er Town, Jinchuan County, 1965–2005. (in Chinese)
② Jinchuan Statistical Bureau and Jinchuan Agriculture and Herd Bureau, Jinchuan County, 1965–2005. (in Chinese)

3 Results

3.1 Livelihood strategy and land use during collective system period

3.1.1 Collective system implement

Jinchuan County was peacefully liberated in 1950 and land reform was carried out and the feudal land tenure was abolished in 1956. In the 1950s, a series of policies were implemented up-down, led by the governments, and then collective system was built up in Danzam Village, which determined grain production of the village. As land reform being carried through, the village originated cooperation and developed mutual-aid teams simultaneously in 1956, and Jinchuan County brought forward the slogan of the Great Leap Forward of agricultural production in 1958. Construction of irrigation system, collecting manure and "three changes" (slope land altered to terrace, infertile land altered to fertile land, fragmentized patches altered to big block land) were the central assignments for collective organizations. During the period of Great Leap Forward, private-owned land was cancelled, and private pig, cattle and sheep were also forbidden. Food supplies were uniformly purchased, and the governments prescribed planting grain since 1959. Apart from remaining enough grain rations, seeds, feed and public grains, 80%–90% of surplus grains were uniformly purchased by the governments. The assignment of purchasing remaining grain was carried out by collectivity organization. Since then, food demand of the governments determined crop arrangement of the village, while farmers completely had no right to choose.

At the end of 1958, administrative village was the basic checking unit and working team was the basic production organization unit, at the same time, working point system was put into practice. With the implement of working point system, many females took part in agricultural production, which almost doubled number of labors. The quantity of labor also increased because of population explosion. During 1965–1979, the number of labors increased from 274 to 547. At the beginning of the 1970s, people born during the bearing pinnacle days after liberation also promoted increase of labors. As a result, population pressure of the village got higher.

3.1.2 Livelihood strategy

During commune system period, working teams in Danzam Village had to choose agricultural involution as their livelihood strategy. As collective working, constituted by working teams, restricted the rural-urban migration of farmers and reduced the employment opportunities from the secondary and tertiary industries, farmers had to live on agriculture. Furthermore, the village had to plant more crops as control from the governments on grain production and trade.

Apart from policy factors, another important factor driving agricultural involution is population pressure. The commune system ensured that everybody had meals, and the cheap medical treatment system popularized in the rural area was improved rural medical treatment level, inducing relative rapid population increase at this period. During 1965–1979, population in Danzam Village increased from 951 to 1431, and household number increased from 203 to 269 (Fig. 2). As surplus labors could not be "fired" like a capitalism industry, they could only be input into agriculture production. The surplus labors in Danzam Village actually had approximately no opportunity costs in this labor organization form. Under the pressure of food uniformly purchased mission, living subsistence and surplus labors, working teams could only constantly input labors into agriculture till marginal products inclined to zero.

Furthermore, commune system is the organization guarantee for land reclamation, irrigation system construction, introducing new cultivation technology and fine breeds. The elders took part in land reclamation recalled that nearly 33% of labors in valley villages were prescribed by government to reclaim wasteland in 1956. With livelihood strategy of agricultural involution, labor inputs in 1ha of farmland reached the climax of 2021 working points. In 1981, there were 547 labors in Danzam Village with working points amounting to 176,236, and average working point of every labor was 322.18 annually. As income of farmers were from working points, and more working points, more income, farmers never resist agricultural involution.

With an increase of cropland area and growing inputs of labor, fertilizer, pesticide and fine seeds, total grain yield increased steadily, especially after 1972 (Fig. 3). Wages of farmers were calculated by working points in a year. However, the growth rate of income was less than that of working points, because the working point was very cheap. Old farmers recalled that in the 1960s and the 1970s, daily wage was only 0.5–0.9 yuan (RMB), which included grain ration of the farmers. At the end of a year,

there was hardly any cash income after grain ration being deducted. Some households with less labors but more children had to borrow grain from commune and repay it by working points of the coming year. Until carrying out household responsibility system in 1984, when grain harvested, the farmers started to pay off their owed grain.

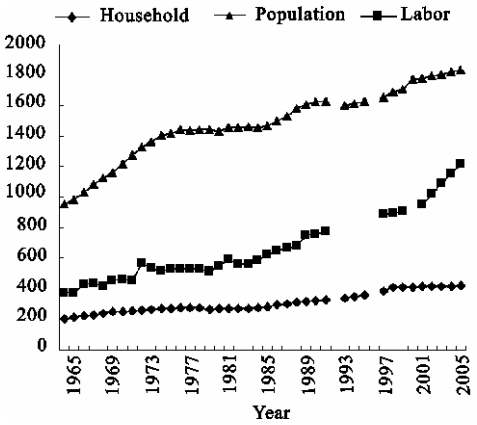

Fig. 2 Change of households, population and labor in Danzam Village in 1965–2005

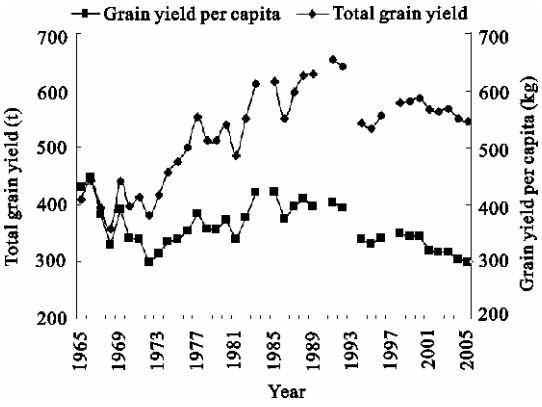

Fig. 3 Total grain yield and grain yield per capita in Danzam Village in 1965–2005

3.1.3 Land use pattern

(1) Reclamation. Statistic data show that during 1964–1966, every plot of cultivatable land was reclaimed, with cropland area increasing from 65ha to 87.17ha. The highest plot was located in Paotai of 3010m above sea level, 3km away from residential area and 2–3 hours needed to walk. However, crop yield of this plot in 1979 was only 1t/ha, accounting for 12.5% of average crop yield in flat valley, with labor input five times more than cropland plots in flat valley. There are 12ha of newly reclaimed cropland with slope more than 25 degree, which caused seriously soil and water loss and then changed to wastelands under threatens of debris flow. In 1975, the wastelands were cultivated again under more severe population pressure.

(2) Rebuilding moderate- and low-yield cropland. As the village has limited cultivable land resources, moderate- and low-yield cropland had to be rebuilt to produce enough grains. During the collective system period, large-scale cropland irrigation systems were constructed, terrace being built by slat-rock, soil layer being thickened, and irrigation channels being constructed, to ensure stable yields even in drought or excessive rainfall.

(3) Increase of multiple cropping index. To produce more grain, traditional cultivation system also changed. After 1960, the former cultivation system of wheat-corn was converted to wheat-corn intercropping with soybean. Though gaining small harvest of soybean, labor intensity level was apparently enhanced. In heat summer, farmers always needed to harvest soybean, cut and insolate soybean stalk to store firewood for cooking and heating.

(4) Increase of chemical fertilizer, pesticide, and fine seeds inputs. Before the 1950s, many regions on the upper Dadu River watershed had never adopted manure as fertilizer. After 1956, the village began to input manure into cropland with 1.5–2.0t/ha. After 1971, working teams increased fertilizer input, and established a manure and chemical fertilizer input system for every plot. Average manure input was 45t/ha and average chemical fertilizer input 225t/ha. In the newly cultivated plot on high elevation, manure input was up to 23t/ha. At the same time, Agriculture Management Department of Jinchuan County continually introduced fine seeds. In the 1960s, maize seed called “Bairihuang” with a yield of 3.75–4.50t/ha was introduced, then “Chengdan 4” and “62110” with the yield of 5.25–6.00t/ha in 1976. The wheat breeds since the 1960s including “Tianxuan”, “Datouhuang”, “Landamai” and “Huanghuamai” with the yield of 4.5–5.2t/ha had been introduced, then converted to “Liulengmai” with the yield of 5.25–6.00t/ha in 1968. Since 1976, pesticide began to be used. Lime-sulphur-solution (LSS), dichlorvos and powder-rust-phosphor were applied to wheat. Dichlorvos and dimethoate were applied to maize. According to Second National Soil Survey in 1979, annual yield of best cropland was 10t/ha, yield of moderate arable land was 6–8t/ha. Low yield cropland mainly planted horsebean or highland barley, with the yield of only 1t/ha.

3.2 Livelihood strategy and land use change during household responsibility system

3.2.1 Inducement of household responsibility system

During 1979–1982, household responsibility system was induced from up to bottom in Danzam Village, namely, household cultivated the farmland of commune with a certain proportion of yield handed in to the commune and governments. The objective of this system arrangement was to correct equalitarian abuses in management and distribution of collective system and to boost agriculture yield increase (Robert, 2000). In the household responsibility system, administrative control on rural production decreased step by step. For example, the commune did not restrict farmers to seek off-farm employment any more and ceased crop production according to the uniform plan of country. The working team, ever exerting national controlling power upon agriculture production, no longer intervened in agricultural production any more. The grain requisition ration was gradually reduced and contract agriculture was put into practice in 1985. In 1986 and 1987, requisition assignment in Jinchuan County was 1180t, but the number actually achieved was only 39.8t and 43t, respectively. The abolishment of grain purchasing system boosted the growth of rural market, then agricultural production was directly linked with market. Crop types were then decided by market, not by the plans of governments any more (Robert, 2000).

3.2.2 Livelihood strategy

In the period of household responsibility system, farmers in Danzam Village generally chose the livelihood diversification strategy and labor forces were transferred to the secondary and tertiary industries. Apart from policy induction, there are other factors driving livelihood strategy change.

The first factor is still population pressure. After 1982, population and labors increased greatly, and till 2005, population reached 1820 and labors of 1158. The young labors transferred to the secondary and tertiary industries such as factory, local transportation industry, business, etc., which reduced population pressure. The second factor is the increase of labor wage. During the period of collective economy, it was undoubtedly logical to input more labors to increase a little grain yield because of zero marginal cost of labor. But labor wage of farmers rose gradually through undertaking secondary and tertiary industries, and the daily wage of 3–5 yuan in 1985 was improved to 25 yuan in 2006. Thus, there were no benefits to input more labors into cropland and agricultural involution was abandoned quickly. For farmers, their goal of agriculture production was only to satisfy their own needs of grain and vegetable. Agriculture became sidelines and only women and elders engaged in agricultural production. It was very popular in rural China since the 1980s (Tan et al., 2001; Fang et al., 2003; Ouyang et al., 2004).

Many livelihood diversification strategies of the farmers existed. The first is diversification in agriculture. As grain production had few profits, farmers began to plant vegetable and horticulture and adjust the variety according to the market needs. The investigation on 88 households shows that grain crop area per household was 0.10ha, vegetable 0.02ha, and 70 households planted fruit trees, covering about 0.08ha per household. The second diversification strategy is integrating livestock. Almost every household bred 1 to 3 pigs for self-consumption and market needs. Milk cows, goats, chicken, ducks and horses were also bred. The third and most important diversification strategy is off-farm employment. The agriculture statistic data showed that 130 out of 513 labors transferred to the secondary and tertiary industries in 1982. In 2002, 334 out of 950 labors engaged in secondary and tertiary industries, of which 200 persons perennially worked off-farm, and others were more seasonal out-working labors.

Based on their livelihood assets, farmers always chose more than one livelihood strategy. By farmers' views, there were four types of livelihood strategies in the village, namely agriculture, agriculture plus off-farm employment, off-farm employment plus agriculture, off-farm employment (Table 1). In the 88 households interviewed, the proportion of four types was 9∶17∶53∶9. Those households choosing agriculture as their livelihood strategy had property of small family, low education level, high age, with one more persons being ill.

As labors being transferred to the secondary and tertiary industries, income of farmers improved. During 1982–2006, total income in Danzam Village increased by more than 14.57 times, and income per capita increased from 126 yuan to 1202 yuan. In 1982, income from grain production contributed to 48.99% of gross income, which indicated that at the initial stage of household responsibility system, grain was still the main source of farmers' income. After 1998, the fall of grain

Table 1 Livelihood strategy of sample farmers of Danzam Village in 2006

Livelihood strategy	Household number	Average population (person)	Livelihood activity				Student (person)	Elder (person)
			Farmer (person)	Worker (person)	Businessman (person)	Officer (person)		
Agriculture	9	2.78	1.67	—	—	—	0.78	0.11
Agriculture plus off-farm employment	17	4.12	2.00	0.82	0.18	0.06	0.88	0.18
Off-farm employment plus agriculture	53	4.06	1.28	1.26	0.30	0.04	0.89	0.30
Off-farm employment	9	3.78	—	0.89	1.44	—	1.22	0.22

price resulted in the decrease of crop income, while income from fruits increased from 41×10^3 yuan in 1982 to 249.5×10^3 yuan in 1988, and then decreased for price falling. Income from animal husbandry increased faster after 1996 as villagers bred more pigs. The most significant change was more and more youths engaging in transportation, construction, catering and serving industries. The income from transportation industry in 1985 was 44.1×10^3 yuan, then up to 354×10^3 yuan in 2006, and the income from construction industry fluctuated, while increased faster after 1998. The income from catering and servings industry increased steadily. The investigation of income and production outcome of 88 households showed that their main income source was from the secondary and tertiary industries.

3.2.3 Land use changes

(1) Crop structure adjustment. In 2005 and 2006, we investigated land use pattern of the plots of 88 households. There were 194 plots with area of 10.02ha altogether, averagely 0.05ha per plot. One household had 1–4 plots on the basis of its population. In 1979, almost all plots planted wheat-corn intercropping soybean. In 2006, 148 plots with the area of 7.84ha plant wheat-corn, with soybean being cancelled. In the changed plots, 20 plots with 0.92ha were rent out, 10 plots with 0.58ha were changed to vegetable, 10 plots with 0.43ha were changed to orchard, five plots with 0.23ha were changed to woodlands or brush for high elevation and low-yield, and one plot with 0.3ha was changed to built-up land. The driving forces of crop structure adjustment included labor shortage, price change of fruits and vegetable and grain for green policy.

(2) Decrease of labor input. The interviews show that, comparing to 322.18 working days needed in collective system, only 87–99 working days per *mu* (1ha=15*mu*) were needed on crops and 32 working days per *mu* were needed on orchards (Table 2). The climax season of labor spent is harvesting of wheat and maize. Everyday, there are two hours needed to breed livestock. In the spare days, farmers would like to go shopping, resting, etc.

Table 2 Labor spent on farms of 88 households

Month	Crop		Fruit	
	Action	Day/*mu**	Action	Day/*mu*
1	Irrigation for wheat	2–5	Pollard	4
2	Weeding, fertilization and irrigation of wheat	10–12	Preventing and curing plant diseases and insect pests	1
3	Weeding, fertilization and irrigation of wheat	10–12	—	—
4	Preventing and curing plant diseases and insect pests, planting maize	3	Preventing and curing plant diseases and insect pests	1
5	Irrigation	2–6	—	—
6	Fertilization of maize, curing insect pests, harvesting of wheat, threshing wheat	20	Preventing and curing plant diseases and insect pests	1
7	Weeding, fertilization, irrigation of maize	6	Harvesting of wild pepper	10
8	Irrigation for maize	3	Preventing and curing plant diseases and insect pests	1
9	Irrigation of maize	3	—	—
10	Harvesting of maize, planting wheat, threshing of maize	25	Harvesting	10
11	Resting	—	—	—
12	Irrigation of wheat	3–6	Pollard	4

Note: * 1ha=15*mu*

(3) Introduction of fine seeds. After 1982, maize seed named “Jindan 4” with the yield of 7500kg/ha and “Zhongdan 2” with the yield of 9000kg/ha were popularized, and “Chuandan 10” with the yield of 6000kg/ha

and "Chuandan 15" with the yield of 9000kg/ha were introduced after 2000. Wheat seed "Mianyang 11" with the yield of 6000kg/ha and "Mianyang 15" were popularized after 1982, then "Mianyang 19" with the yield up to 8000–8750kg/ha was popularized in 1988. In 2000, wheat seeds "Mianyang 24" and "Mianyang 26" were introduced, having the liability of serious rust disease but better quality. Compared to 1981, single yield increased by 50%–100%. Gross grain yield was up to 654t in 1991, and then decreased continuously as grain crop being transferred to vegetable or fruits (Fig. 3), and grain yield per capita decreased further as population increase. In 1985, grain yield per capita was 422kg, then decreased to 395kg in 1992, and 316kg in 2006.

(4) Chemical fertilizer input increase. Since 1980, fertilizer system also changed. Our investigation in 2006 showed that manure input was decreased by 50%, with only 23t/ha. Chemical fertilizer input increased by 300%, up to 1.05t/ha, with carbamide of 0.3t/ha and phosphor fertilizer of 0.75t/ha. Some households began to use compound fertilizer and carbon ammonium. This change can be seen in other regions of rural China (Fang et al., 2003; Ouyang et al., 2004).

(5) Shrub and grassland change. In 1967, there were 68.57ha of shrub and 39.15ha of grassland in the village. For a long time, shrub and grassland were mainly used for grazing goats and scalpers, or for fuel wood collection. Under pressure of overstocking and fuel gathering, 25.22ha of shrub degenerated into grassland in 1973–1982. As labors transferred to the secondary and tertiary industries in household responsibility system, there were not enough labors to graze scalpers and goats, then the number of goats and scalpers decreased. With a decrease of grazing pressure, grassland and shrub of the village regenerated gradually in 2006. In 2003, 15 grassland samples were sampled in the village and found that the height of grass layer was up to 1m, canopy cover was up to above 95%.

4 Discussion

Land use change in Danzam Village is coincided with cases in rural China and other developing countries. In the context of livelihood diversification, farming activities and off-farm activities inevitably compete in labor quantity and quality, which would drive land use change. Land use changes in rural China are mainly characterized of agricultural structure adjustment and changes of land use intensive level (Tan et al., 2001; Ouyang et al., 2004). Agricultural structure adjustment always takes the forms of transition of low return from grain crop to high return from cash crops, perennial tree crop or fish ponds (Tan et al., 2001; Fang et al., 2003; Fu et al., 2006). Changes of land use intensive level take the forms of low labor input, reduced multiple cropping index, and abandonment of arable land (Han and Xie, 2004; Liu and Li, 2006). Apart from agricultural structure adjustment, livelihood change also resulted in land subcontract, land rent and abandonment of arable land (Han and Xie, 2004; Zhang et al., 2004; Fu et al., 2006). Pender's study (2004) in Honduras, Uganda and Ethiopia and Clay's study (1998) in Rwanda found that, as the competition between non-agricultural employment and crop production became increasingly severer, input of labor forces and fertilizer gradually decreased. Holden (2004) also found that non-agricultural income reduced the motivation to cultivate land and resulted in lower agricultural productivity, even grain production was also affected and the farmers had to buy grain.

However, Danzam Village has its character of land use change patterns—agricultural involution in collective system. With more population with less land and higher cultivation rate, Danzam Village can hardly increase the area of cultivated land like many developing countries such as those in Africa and South America, and only depends on improving land use intensification level. In collective system, agricultural involution is the only appropriate land use pattern. However, many case studies in rural China only concerned land use change on regional scale from the 1980s, the relationship between livelihood strategy and land use pattern of smallholder economy before the 1980s was always neglected. Therefore, it is hard to understand the linkage between livelihood and land use of smallholder in rural China. It is necessary to do more case studies of local scale in western China on more interfaces of man-land system, such as land use patterns and soil fertility management in different livelihood strategy of farmers, cropland fragmentation of smallholders since 1980, and to seek sustainable land use pattern of ecotone regions.

5 Conclusions

This study analyzed the livelihood strategy change and

the land use change from collective economy system to household responsibility system in Danzam Village of Jinchuan County on the upper Dadu River watershed. The results showed that, during the collective system period, as surplus labor forces could not be transferred to the secondary and tertiary industries, the village chose agricultural involution as their livelihood and had to produce more grain by land reclamation, increasing input of labor and other factors and boosting multiple cropping index. During the household responsibility system period, as labors were permitted to transfer to the secondary and tertiary industries, farmers chose livelihood diversification strategy. As a result, labor input into agriculture to grain planting was greatly decreased, which drove the conversion of grain production to vegetable, fruits production and abandonment of arable land and the decrease of multiple cropping index. This study provides a new insight into understanding land use change in rural China and also provides a typical case to examine interfaces in man-land system.

Acknowledgements

The authors would like to thank the Jinchuan County Government and Archives Bureau for supplying the *Sha'er Agriculture Statistical Annals* and other assistances; Mr. Yang Zulie from Jinchuan County; Mr. Xie Daibing from Sha′er Town, and Feng Yingjian from Danzam Village for their helps during the field surveys; and Dr. Adam Nichols and and Dr. Liu Linshan for reading the manuscript and providing helpful advice.

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