

# Livelihood diversification and cropland use pattern in agro-pastoral mountainous region of eastern Tibetan Plateau

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**Abstract:** This study examined livelihood diversification and cropland use pattern in Keerma village, located in Jinchuan County, eastern Tibetan Plateau. Through stratified random sampling survey, participatory rural appraisal, investigation of households' plots and statistical methods, 63 households and 272 cropland plots were systemically investigated and sampled. The results show: (1) Different types of household have variety livelihood strategies, portfolio and income. Livelihood diversification and introducing and expanding off-farm activities can be the future trend, whereas, adverse natural environment, socio-economic conditions and peasants' capabilities together affect sustainable livelihood and land use. (2) Each livelihood strategy has its own impact on land use, mainly affecting land use type and land use intensification level. (3) Diversification into off-farm activities could be the key of building sustainable livelihood and the essential approach of realizing sustainable land use in the region.

**Keywords:** household; livelihood diversification; off-farm employment; land use; Tibetan Plateau

## 1 Introduction

Livelihood diversification in developing countries and regions has been studied extensively (Block and Webb, 2001; Bouahom *et al.*, 2004). Nowadays, many researches focused on relationship between household livelihood strategy and land use change (Barrow and Hicham, 2000; Ellis, 2003; Holden *et al.*, 2004; Eija, 2005; Gina and George, 2005; Bradstock, 2006; McCusker and Carr, 2006), as smallholders, being the primary unit of rural socio-economy, constitute microcosmic foundation of rural economy in many developing countries and regions (Chen, 1994). Farmers' decision-making has significant impacts on land use, for instance, irrational land use of households will be the main and direct causes of land degeneration (Tan *et al.*, 2001). Their land use behaviors are closely related to livelihood strategies, while land use management is affected in turn by different livelihood strate-

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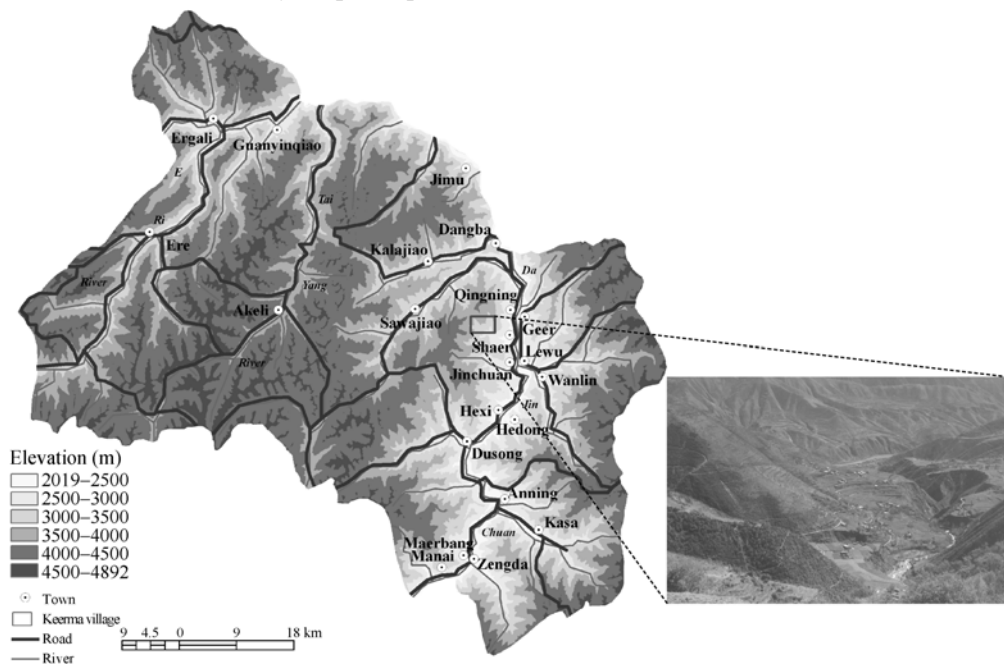
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gies (Holden *et al.*, 2004; Pender, 2004). Farmers' seeking off-farm employment can drive land use extensively, which leads to land degeneration for lacking of management (Tan *et al.*, 2001). Access to off-farm employment also reduces households' incentives to invest in land conservation and leads to more overall soil erosion (Holden *et al.*, 2004). Since the 1980s, livelihood of rural areas in China has experienced great transformation, which drove land use and cover change (Yan *et al.*, 2005a, b). Whereas, there still lack case studies on livelihood diversification and land use change in village scale in rural China.

Located in the transition belt from Sichuan basin to Tibetan Plateau, the upper reach of Dadu River watershed is a typical ecologically fragile region (Figure 1). Previous studies in this region have reported land use and cover change and the driving forces, livelihood diversification in regional scale (Bao *et al.*, 2002; Bai *et al.*, 2004, 2005; Yan *et al.*, 2005a, b, 2006). Yet, livelihood change and land use change on local scale has scarcely been investigated. So, one village in the agro-pastoral mountainous region of eastern Tibetan Plateau is taken as study area. We aim here to explore livelihood strategy of the interviewed households and land use of every cropland plot.



**Figure 1** Location of Keerma village in Jinchuan County

(Note: The data are from USGS/NASA SRTM DEM; there is no official village boundary in Keerma)

## 2 Study area

Jinchuan County is situated in eastern Tibetan Plateau with latitude of  $31^{\circ}08' - 31^{\circ}58'N$  and longitude of  $101^{\circ}13' - 102^{\circ}19'E$ . It has an area of  $5524 \text{ km}^2$  with 104 km in length and 86 km in width, mainly consisting of valley, mountain and highland (Jinchuan Chorography Compiling Committee, 1994; Land Resources Investigation Office, 1995; Yan *et al.*, 2006). Three agro-ecological zones, including agricultural zone, agro-pastoral zone and pastoral zone, can be identified from valleys to highlands. The agro-pastoral zone is situated in the middle, with the livelihood strategies of cultivating, breeding and non-farm employment. Double

crops can be grown in one year or triple crops can be grown in two years in the area with lower altitude and one crop can be grown in one year in the area with higher altitude. The crops are corn, wheat, potato, soybean, horsebean, peas, highland barley, turnips, rape, with corn as the staple crop. *Zanthoxylum bungeanum* is the main perennial tree crop, others include walnut tree, pear tree and apple tree. Driven by rural population pressure, crop and livestock production became integrated in order to intensify output. Livestock consists of pig, yellow cattle, cattle-yak hybrid, dairy cattle, yak, sheep, goat, horse and chicken.

Located in Sha'er township of Jinchuan County and about 4 km away to the north of Jinchuan County seat, Keerma is a typical agro-pastoral village with latitude of 31°30'54.42"—31°34'8.20"N and longitude of 101°59'9.72"—102°2'46.02"E (Figure 1), covering an area of 14.64km<sup>2</sup>. Dominated by a plateau monsoon climate, the village has long sunshine periods with a lot of sunny days, significant temperature difference and obvious vertical differentiation. The physiognomy is mountain gorge with elevation from 2430 to 4170 m a.s.l. Croplands are distributed on terraces, grazing pasture being in highlands. In Keerma village, the Tibetan, Han nationality, Qiang nationality and Hui nationality make up 74%, 20%, 2% and 4% of the total village population, respectively. In 2004 Keerma village had 102 households with 420 inhabitants, 564,800 yuan RMB of agro-pastoral income, or 68.77% of the total income, and net per capita income of 1419 yuan.

### 3 Data and methods

**Household type (HT) classification** Household types are classified on the basis of statistical data, interviews with key interviewees and mini-types meetings with household heads (Yang and Zhao, 1998; Chen and Fang, 1999; Tan *et al.*, 2001; Ouyang *et al.*, 2004). According to indicators such as present living standard, major income sources and labor input orientation, four household types are identified, including pure-agriculture households (I), agriculture-dependent households (II), non-farming-dependent households (III) and non-agriculture households (IV) (Table 1).

**Household sampling and survey** Adopting a stratified random sampling survey (Cramb *et al.*, 2004; Richard and Emma, 2005), 63 households (61.8% of the total) were sampled, accounting for over 60% of each type of the households in Keerma village (Table 1). Participatory rural appraisal (PRA) and its tools (Chambers 1994; IIED, 1995; Cramb *et al.*, 2004; Zhao and Zhao, 2004) are applied, such as observations, semi-structured interview, survey questionnaire, season calendar, memorabilia, mini-type meetings, interviews of key-informant and order and rank. Household investigations were conducted in July and

**Table 1** Household type and classification standard

HT	Classification standard			Samples	Percentage of household to the total type each (%)
	Living style	Family major income source (%)	Main labor investment orientation		
I	Agro-pastoral industry	Agro-pastoral industry 100	Agro-pastoral activities	8	65
II	Agro-pastoral industry, Non-agriculture	Agro-pastoral industry >60	Agro-pastoral activities, Non-farm activities	7	65
III	Non-agriculture, Agro-pastoral industry	Non-agriculture >60	Non-farm activities	40	60
IV	Non-agriculture	Non-agriculture >95	Non-farm activities	8	65

August in 2006 with 2–3 hours by each household on the basis of preliminary investigation in 2005. Household heads and other family members, about 80 people, were interviewed.

**Households plot investigation** Depending on household interviews and key-informant or households’ directing, every plot was investigated on the spot. Fieldwork focused on land use types, input of chemical fertilizer, farmyard manure, pesticide, seed, film and output. 272 plots were invested in Keerma village, accounting for 71% of the total land area, including 34 plots of pure-agriculture households, 30 plots of agriculture-dependent households, 171 plots of non-farming-dependent households and 37 plots of non-agriculture households. Information of households and sample plots are collected by investigation carried out by researchers in 2006.

## 4 Results

### 4.1 Household types and characteristics

The difference of households is mainly reflected by family size, labor division, age and education attainment (Table 2 and Figure 2). The characteristics of pure-agriculture house

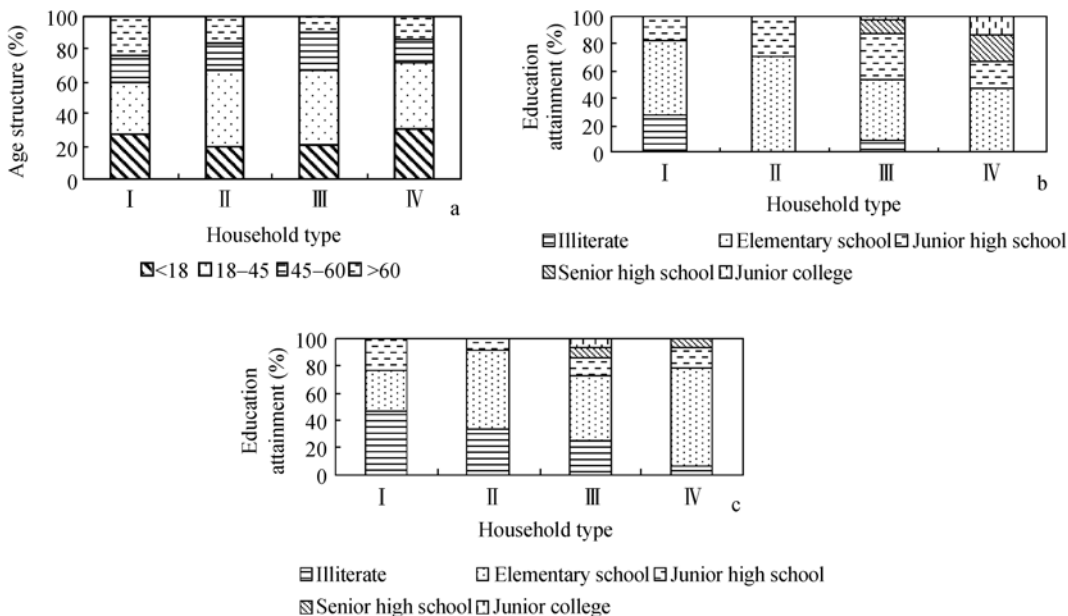
**Table 2** Households’ composition and labor division in Keerma

HT	Total population <sup>a)</sup>	Agriculture	Out working	Trading	Salary-working <sup>b)</sup>	Student	Others <sup>c)</sup>
I	4.00	3.13	–	–	–	0.50	0.38
II	4.29	1.71	0.86	0.43	0.14	1.14	–
III	4.83	1.78	1.30	0.38	0.08	0.95	0.35
IV	5.38	–	1.63	0.50	0.38	1.25	1.63

a) Household size does not include adult children who are married and economically independent

b) Compared with out working, salary-working only indicates working in government department (e.g. township government), enterprise unit (e.g. schools) with formal position and stable wage income

c) Other includes the old and pre-aged children



**Figure 2** Different households’ age structure and education attainment distribution in Keerma (a. Age structure; b. Male labor’s education attainment; c. Female labor’s education attainment)

holds are smaller in size and members are more elderly with lower level of education and higher illiterate rate, especially for female labors. Non-agriculture and non-farming-dependent households have bigger families, younger family members with higher education attainment and are facing higher pressure from education fees for students and pre-aged children.

## 4.2 Livelihood strategies

The differences of livelihood strategies are shown in their participation in agricultural activities (collecting forest products, wild medicinal materials and mushroom included) and off-farm employment (Table 3). Pure-agriculture households are not engaged in off-farm activities. Agriculture-dependent and non-farming-dependent households introduce off-farm activities and their portfolio on the basis of traditional agriculture activities. Non-agriculture households do not work on farms. The off-farm activities of agriculture-dependent household are sidelines, such as processing of agricultural products (e.g. corn, wheat) or out working for 2–3 months, while that of non-farming-dependent households are out working or trading for a whole year with abundant kinds and diverse means.

The participation in and income of major livelihood strategies differed in various household types (Table 4). For example, a small percentage of pure-agriculture and non-farming-dependent households choose food sale. Agriculture-dependent households have higher percentage of income from cattle and sheep products. Pure-agriculture households have the highest percentage of income from medicinal materials.

**Table 3** Different strategies for households' livelihood in Keerma <sup>a)</sup>

HT	Cultivating	Breeding	Collecting	Sideline	Out working	Transporting	Trading	Salary-working	Others
I	+	+	+						
II	+	+	+	+	+			+	
III	+	+	+	+	+	+	+	+	+
IV					+	+	+	+	+

a) '+' is to adopt this livelihood strategy

Cultivating includes crop (corn, wheat, potato, soybean, horsebean, pease), vegetable and fruit trees (apple, pear, *Zanthoxylum bungeanum*, walnut); Breeding includes pig, cattle, sheep, horse, chicken, duck and others (bee);

Collecting includes wild medicinal materials and wild mushroom;

Sideline includes mini-type machine (wheat, corn, alcohol), handicraft (board manufacture, electric welding);

Out working includes whole year employment (major), short time employment;

Transporting includes horse or cattle, tractor, car;

Trading includes buying and selling medicinal materials, keeping small shop;

Salary working includes village cadre (forest protector), teacher, driver and soldier;

Others include renting or renting out land.

**Table 4** Households' participation in different livelihood strategies and income in Keerma <sup>a)</sup>

	HT	Food sale	Fruit sale	Pig sale	Cattle sale	Sheep sale	Medicinal materials sale	Mush-room sale	Bee sale	Non-farm activities	Total
Participation (%)	I	13	88	88	13	–	50	25	13	–	–
	II	–	88	71	29	43	43	29	14	100	–
	III	10	95	95	20	15	33	15	8	100	–
	IV	–	–	–	–	–	–	–	–	100	–
Income (yuan RMB)	I	31	1040	2713	600	–	5225	44	88	–	9741
	II	–	1000	3114	3514	1214	1071	29	57	3949	13948
	III	63	1720	3119	190	158	111	21	23	10635	16040
	IV	–	–	–	–	–	–	–	–	26300	26300

a) % = households' count participating in same activity/household total of each type; Income = income pursuing same activity/household total of each type

Agriculture-dependent households have a range of livelihood activities, with higher average income from agro-pastoral activities, preceding pure-agriculture households, while their total income is still less than that of non-agriculture and non-farming-dependent households, owing to lack of off-farm income. Non-agriculture households have the most total income, however, they confronted with high risk due to dependent on single livelihood strategy. They have expressed their strong worries about livelihood vulnerability. Except income from agricultural activities, non-farming-dependent households also have off-farm income and then their livelihood risk is decreased.

### 4.3 Perception of present living standard, pressure and improving approaches

A majority of households are satisfied with current livelihood standard (Table 5). National rural policies benefited them by exempting agricultural tax and compulsory education fees, and converting agricultural indirect allowance to direct allowance. The satisfaction proportions of pure-agriculture and non-agriculture households are lower, which are related to their income or perception of livelihood risk.

In face of similar pressure, such as education fees, seeking employment, providing for the aged, different households expect to adopt diverse approaches, i.e., cultivating, breeding, out working and trading included (Table 5). As for the helps needed, favorable national policies are mentioned and valued by most households, including price decrease of agricultural production materials, medical treatment, the allowance of rebuilding dangerous houses, and infrastructures (road, electricity and energy supply). The aid mentioned and dependence on national policy reveals the influencing factors or livelihood risk of livelihood improvement and households' passive response.

**Table 5** Subject households' perception of living standard, pressure and improving approaches <sup>a)</sup>

HT	Living evaluation		Living pressure (%)	Improving approaches (%)	Helps needed (%)
	Satisfaction (%)	Non-satisfaction (%)			
I	87	13	No money/100; little education or no technique/88; medical treatment/50	Breeding more cattle, pigs/100; using more farmyard manure and planting better crop/100; collecting more medicinal materials/50; (want) out working/13	Increasing national investment/100; aid or capital/100; means and information of attaining wealth or employment, (children's) technique training/63
II	100	0	Education fees/71; more livestock and less pasture/57	Expanding breeding/100; out working/57	Capital or interest-free loan/86; education fees/71; information of employment or children's technique training/43; technique instructing/43
III	92	8	(Children's) employment/80; education fees/65; building house for children's marriage/3	Out working or increasing members and time/53; expanding breeding (more pigs, cattle, sheep, bee)/38; growing more high price fruit trees /20; trading/10; increasing sideline activities/8; transporting/5; collecting more medicinal materials/3	Capital aid (poverty loans, interest-free loans or loans with low interest)/85; information(employment), technique instructing and training/80; means of attaining wealth or scientific technique/18
IV	87	13	Education fees/88; (children's) employment/63; medical treatment/13	Out working or increasing work time/88; expanding trading/13	Capital aid (interest-free loans or loans with low interest)/88; information, means of attaining wealth and employment/63

a) Households' original saying adapted; % = household's count mentioning a same item/household total of each type

#### 4.4 Households' adjustments of future livelihood strategies

Restricted by various influencing factors, over half of the subject households decide to maintain present livelihood strategies and the adjustment approaches differ among household types (Table 6). As for non-agriculture households, 75% of which have no adjustment. The adjustment of cropland is mostly to plant or expand high value fruit trees (*Zanthoxylum bungeanum*, walnut tree), to cut away low value pear and apple trees as firewood and change to cultivation. A few households want to convert cropland to forestland and wish to convert about half of their cropland which is far away from home with low yield and lack of irrigation if policies allow. In addition, they can get the allowance of converting cropland to forest for the policy of grain for green (3900 yuan RMB/hm<sup>2</sup>). Some households hope to grow medicinal materials or forage grass. The adjustments on livestock husbandry include quantity, breed and methods of rearing. Most households intend to adjust livestock breeding techniques and improve cow and sheep numbers. The adjustments on non-farm activities are mainly to add more laborer and time to off-farm work. This trend is in accordance with other study in this region (Yan *et al.*, 2006).

**Table 6** Subject households' adjustments of future livelihood strategies in Keerma<sup>a)</sup>

HT	Non adjustment on livelihood strategies			Adjustments on livelihood strategies	
	%	Reasons	%	Reasons	How to adjust
I	50	Labor focusing on collecting medicinal materials; aged; feeling safe to maintain status quo	50	Good breed of livestock for higher income; less land; renting out for low income	Renting out land to the breeding field of cattle; improving more livestock breed; buying more milch cow; going out for work after renting out land
II	57	Shortage of labor; aged	43	Increasing income	Vacating 0.03 hm <sup>2</sup> land for medicinal materials; intending to plant grass; increasing 2 well-bred dairy cattle to further develop; more high quality and well-bred cattle
III	58	No or shortage of labor; aged; feeling safe to cultivate crops	42	Increasing income; less income from cultivating; children grew up; emigrating with children after renting out land; lacking land	Emigrating for out working or trading after renting out all land; buying 2 well-bred dairy cattle; buying 2 cattle; developing 4 dairy cattle; breeding more pigs; developing well-bred sheep; increasing time of out working; increase labors pursuing out working or trading; exerting themselves for out working; let other labors engaging in out working or trading except women who are engaged in cultivating, breeding
IV	75	Keeping on out working or trading for making money	25	Less or no money from cultivating	Renting out land to others; learning a skill

a) Households' original saying adopted

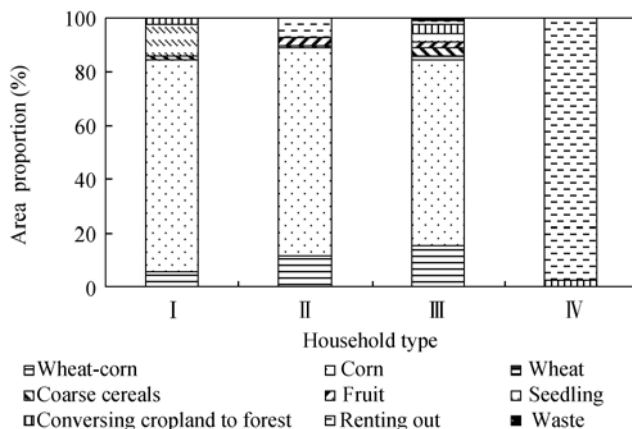
#### 4.5 Cropland use pattern: present and trend

Different households hold various plot number, area per household and area per capita. The plot numbers of pure-agriculture, agriculture-dependent, non-farming-dependent and non-agriculture type are 4.25, 4.29, 4.28, 4.63; areas per household are 0.40 hm<sup>2</sup>, 0.48 hm<sup>2</sup>, 0.44 hm<sup>2</sup>, 0.45 hm<sup>2</sup>; and areas per capita are 0.10 hm<sup>2</sup>, 0.12 hm<sup>2</sup>, 0.09 hm<sup>2</sup>, 0.08 hm<sup>2</sup>, respectively. Agriculture-dependent households have the largest area per capita. Non-agriculture households have the most scattered plots and less area per capita. Non-farming-dependent households have less area per capita. It shows that non-agriculture and non-farming-dependent households are facing higher pressure from population pressure and land

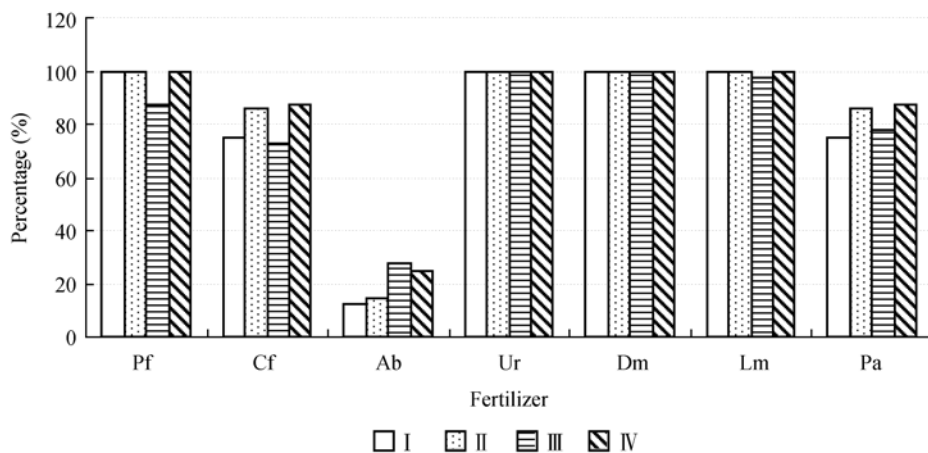
shortage than other types, which is also one of the important determinants to pursue non-farm livelihood strategies.

It can be seen from Figure 3 that corn is the staple crop, accounting for 70% of the total cultivation area. Pure-agriculture households have the highest percentages of corn and economic seedling (include white poplar and forage grass), which are 78.6% and 11.6%, respectively. Non-farming-dependent households have higher percentages of wheat-corn, coarse cereals and converted forest from cropland than that of other household types, being 15.5%, 2.7% and 3.6%, respectively, this type is the only one with abandoned land. 97.3% of the non-agriculture households rent out most plots with higher converted forest from cropland (2.7%).

For land labor input, households which pursue out working, trading and family sidelines have decreased the quantity of the labor input. Young male labors with higher education level are always engaged in off-farm activities, while aged labors with lower education level and females or children (mowing, grazing) undertake farm activities. Many measures are adopted to make up labor shortage in busy seasons, such as labor exchange with relatives,



**Figure 3** Area proportion of different households' land use types in Keerma  
(Note: coarse cereals include soybean, potato, pease and horsebean)



**Figure 4** Percentage of different fertilizers applied for subject households in Keerma<sup>a) b)</sup>  
(Pf—Phosphorus fertilizer; Cf—Compound fertilizer; Ab—Ammonium bicarbonate; Ur—urea; Dm—Dry manure; Lm—liquid manure; Pa—plant ash. a) % = household's count investing same fertilizer/household total of each type. b) For non-agriculture households (IV), fertilizer investment refers to that before the plots are rented out or transformed (from cropland to forest))



friends or neighbors, labor hiring and labor returning to home.

Different households choose various fertilizers types. There is obvious difference in their choice of investing compound fertilizer and ammonium bicarbonate (Figure 4), which are introduced and used in recent years with higher price. Almost all households input traditional fertilizers, including phosphorus fertilizer, urea, dry manure and liquid manure.

By this trend of livelihood diversification, labors transfer to non-agricultural employment and cropland will be changed to simple use type, rented out or converted to forest. There is a trend to add farmyard manure and reduce chemical fertilizer as a result of livestock increase and manure abundance. 89% of the subject households decide to use more farmyard manure and 38% plan to decrease chemical fertilizer on the basis of increasing farmyard manure. Subject households understand that excessive chemical fertilizer can harden soil and the improvement of soil fertility primarily depends on farmyard manure.

## 5 Conclusions and discussion

### 5.1 Factors restricting livelihood diversification

Diversification into non-farming activities can ensure income increase and living standard improvement, as well as decrease of fragility and risky of single livelihood activity (Block and Webb, 2001; Bruce and Saskia, 2007; Charlie *et al.*, 2007). Nowadays, the most prevalent and important livelihood strategy for smallholders of rural China is seeking off-farm employment opportunities. With cultivation and livestock husbandry as complementary activities and non-farm employment as dependent livelihood activity, a virtuous benefit cycle in a family can be realized, as income from off-farm employment can support agricultural production and livestock husbandry, while agricultural production can meet subsistence needs and provide employment for other family members such as elders, women and children.

Off-farm employment is also an alternative livelihood resource pursued by most households in the eastern Tibetan Plateau, whereas, a range of adverse factors still restrict livelihood diversification to off-farm employment in this region. Undeveloped local tertiary industries can not absorb rural surplus labors. Owing to the dual separated rural-urban system, the census register, employment and social security systems have not changed radically. Integrated urban-rural labor market has not yet been set up. Although villagers with higher education attainment can more easily take the chances of non-farm employment and information from the labor market and then be possibly transferred to off-farm industry, labors with higher education level and skills are scarce in the eastern Tibetan Plateau. Furthermore, almost all the villagers lack family social networks and capitals. In addition, local livelihood vulnerability is aggravated due to poor infrastructures, market price rise of production materials induced production cost increase, lower resistance capability to diseases and pests, shortage of forage grass, environmental degradation and lacking of medical treatment security. Some of them had to lay their hopes on national policies, anti-poverty aids or other assistances. Their views and experiences should be studied further to help rural-urban transformation in the eastern Tibetan Plateau.

### 5.2 Suggestions to livelihood improvement

With regard to these adverse factors on livelihood improvement in this region, feasible strategies are put forward at household level and regional level. At household level, based on

the advantages and disadvantages of different household types, the effective configuration of livelihood capitals and reasonable combination of livelihood activities are needed. Pure-agriculture and agriculture-dependent households need to find the potential of income increase from traditional agriculture activities, improving agricultural technique and crop breeds. Non-farming-dependent and non-agriculture household should increase employment competition capabilities and expand income resources and employment approaches. The strategies of region level include improving infrastructures, advancing the level of education and medical treatment, decreasing the price of production materials, updating the variety of crop breeds, preventing pest/disease, controlling livestock quantity, protecting pasture, controlling debris flow, developing high quality and characteristic agriculture, especially creating more employment opportunities to lead the reasonable, regular and sustainable transfer of rural surplus labors to non-agricultural employment.

### 5.3 Land use changes in the process of off-farm transformation of labors

With the transformation of labors to off-farm employment, women and elders had to assume the role of farm management, which would reduce laborers and other input factors. When the households become less dependent on income from agriculture and livestock husbandry, it is inevitable for the cropland plots to change towards single crop system, cash crop or fallows. However, due to special earth-love-knot, non-agriculture households are unwilling to abandon their land and houses after emigrating for out working or trading. This will hinder small plots amalgamation into more efficient plots for mechanized farming. On the other hand, the households with little or no non-farm income can only expand livestock husbandry to increase income, which would drive overgrazing and land degradation, disasters increasing (e.g. debris flow) and environmental deterioration. This is also proved by other study (Yan *et al.*, 2006).

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