Determinants of Engagement in Off-Farm Employment in the Sanjiangyuan Region of the Tibetan Plateau

Authors: Yan, Jianzhong, Li, Huilian, Hua, Xiaobo, Peng, Kui, and Zhang, Yili

Source: Mountain Research and Development, 37(4) : 464-473

Published By: International Mountain Society

URL: https://doi.org/10.1659/MRD-JOURNAL-D-17-00023.1

Mountain Research and Development (MRD)
An international, peer-reviewed open access journal
published by the International Mountain Society (IMS)
www.mrd-journal.org

MountainResearch
Systems knowledge

Determinants of Engagement in Off-Farm Employment in the Sanjiangyuan Region of the Tibetan Plateau

Jianzhong Yan[1], Huilian Li[1], Xiaobo Hua[1,2], Kui Peng[3], and Yili Zhang[4]*

** Corresponding author: yanjzswu@126.com*

[1] College of Resources and Environment, Southwest University, No. 1 Tiansheng Road, Beibei District, Chongqing 400716, China
[2] Graduate School of Asian and African Area Studies, Kyoto University, Kyoto 606-8501, Japan
[3] The Global Environmental Institute, Liangmahe South Road #14, Chaoyang District, Beijing 100600, China
[4] Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Science, Beijing 100101, China

The Sanjiangyuan region is a typical ecologically vulnerable region. Although environmental initiatives in the region have had positive results, criticism has arisen that one of these, the ecological migration policy, did not achieve the desired results regarding the transition to off-farm employment and livelihoods. This study examined key factors influencing the engagement of pastoralists in the Sanjiangyuan region in off-farm employment. Binary logit and probit models were adopted along with in-depth household surveys in the Sanjiangyuan region to support the quantitative and qualitative analyses. The results indicate that off-farm employment in the region is generally not significant (18.13% of the investigated households had members working in off-farm sectors), and that education and government subsidies have had significantly positive effects on engagement in off-farm employment, while the number of livestock and the distance between house and town have had significantly negative effects. These results suggest that it is necessary to establish more financial support for off-farm employment and livelihood transitions, in addition to strengthening ecological compensation. Promising approaches could include offering different types of skill training and increasing employment opportunities in off-farm industries.

Keywords: *Off-farm employment; grassland degradation; ecological compensation; livelihood transition; Tibetan Plateau.*

Peer-reviewed: *September 2017* ***Accepted:*** *October 2017*

Introduction

The Sanjiangyuan region is located in the heart of the Tibetan Plateau. It is the source area of the Yangtze, Yellow, and Mekong Rivers and is known as the "water tower" of China (Shao et al 2013; McGregor 2016). The region comprises 363,000 km^2 and accounts for 50.4% of the total area of Qinghai Province (Du 2012). With its distinctive ecosystem and biodiversity, Sanjiangyuan plays an important role in maintaining the hydrological and ecological security of China and several Southeast Asian countries (Wang et al 2010). However, it is also a vulnerable area influenced by intensifying climate change and human activity (Zhao, Wu, et al 2011; Li, Gao, et al 2013). Over the past 3 decades, mountain glaciers have been shrinking in and around Sanjiangyuan, directly affecting water supplies to plateau lakes and rivers (Kang et al 2010; Sun et al 2012). Meanwhile, with increased population and human activity, environmental degradation has accelerated; problems have included grassland degradation and desertification, wetland ecosystem deterioration, and weakened water conservation (Du et al 2004; Zeng and Feng 2007; Liu et al 2008; Harris 2010; Yi et al 2014). The primary forms of degradation perceived by local residents include increases in rodent burrows; bare areas; increases in weeds, including poisonous weeds; and desertification of meadows (Yan, Wu, and Zhang 2011). Degradation of Sanjiangyuan's ecosystem threatens not only the ecological security of the river basins, but also the livelihoods of local herders and farmers as well as regional socioeconomic development (Li et al 2014).

To adapt to grassland degradation, adjust resource management, and pursue sustainable pastoralism, some bottom-up strategies have been adopted in pastoral societies. Foggin and Torrance-Foggin (2011) noted that

http://dx.doi.org/10.1659/MRD-JOURNAL-D-17-00023.1

social services can enable partnerships between local herders and conservation authorities to maintain social stability. Foggin (2011) also noted that collaborative management—such as community comanagement and contract conservation in villages in Yushu Tibetan Autonomous Prefecture—can be seen as a new approach to resource management and conservation. Yan et al (2010) noted that farmers and herders diversified their livelihoods to adapt to grassland degradation, while, compared to farmers at low elevations, herders found it hard to seek off-farm employment.

Various measures have been implemented by state and local governments to protect the environment, improve residents' livelihoods, and promote economic development. In 2005, *The Overall Planning for Qinghai Sanjiangyuan Nature Reserve Ecological Protection and Construction* (*Qinghai Sanjiangyuan Ziran Baohuqu Shengtai Baohu he Jianshe Zongti Guihua*), a document approved by the State Council, was published (Lu 2007). Under this document, herders were compensated for migrating out of severely degraded areas to new settlements (Li, Luo, et al 2013; Qi et al 2014). This mechanism is referred to as "ecological compensation," aiming to realize ecological restoration by economic means, and the associated projects are referred to as "the ecological migration project," a policy initiated by the Chinese government (Chang et al 2014; Du 2012). In addition to compensation for the herders who left, subsidies were provided to the herders who remained in the original areas, including subsidies for not grazing in off-limits areas and for buying forage grass seed and means of production. The government also established poverty-alleviation policies to increase employment opportunities (Li, Zhang, et al 2013; Qi et al 2014), such as skill training, the development of a local economy, and self-employment subsidies.

Although the government projects were based on the expectation that herders would increasingly engage in businesses and services when they moved to urban areas, only a small number of migrants undertook off-farm activities, such as knitting blankets for sale, operating small businesses, or working as security guards, taxi drivers, or construction workers (Foggin 2008; Du 2012). According to our observations during fieldwork, most people in the settlements were unemployed, relying on financial subsidies from the government. However, these subsidies were insufficient for meeting daily expenses and did not keep pace with inflation. This can have major social consequences for cities and towns, for example, by increasing their poverty rates (Ptackova 2011). Studies have suggested that the logic, benefits, and costs of ecological migration need careful reexamination in the grassland areas of Sanjiangyuan, where Tibetans have sustained their livelihoods for hundreds of years (Foggin 2008, 2011; Yeh 2010). Furthermore, the ecological migration project weakened the traditional nomadic culture, respect for natural resources, and close connections between religions (Tashi and Foggin 2012; Qi 2015), which were not widely accepted by herders. In fact, some herders continue herding on banned grasslands or place weak or sick livestock on them (Du 2012; Bessho 2015). In addition, there remains the problem of the post-resettlement livelihoods of pastoralists participating in government resettlement projects, where traditional livelihoods have been replaced by a complex web of dependency on the state (Nyima 2014).

Seeking off-farm employment is the main livelihood strategy for poor people in developing countries (Dorward et al 2009). However, case studies in Sanjiangyuan have shown that herders find this difficult, either on their own or with the help of the ecological migration projects. Further quantitative studies are needed on the factors restricting herders from seeking off-farm employment in Sanjiangyuan. Such research can provide evidence for reasonable livelihood-improvement policies, both for ecological migrants and for the remaining pastoralists. This study conducted household surveys in 2014 in 4 parts of Sanjiangyuan and analyzed, using binary logit and probit models, the critical factors influencing herders seeking off-farm livelihoods. The results are reported here, followed by recommendations on ways to support pastoralists seeking off-farm livelihoods in Sanjiangyuan.

Material and methods

Study area

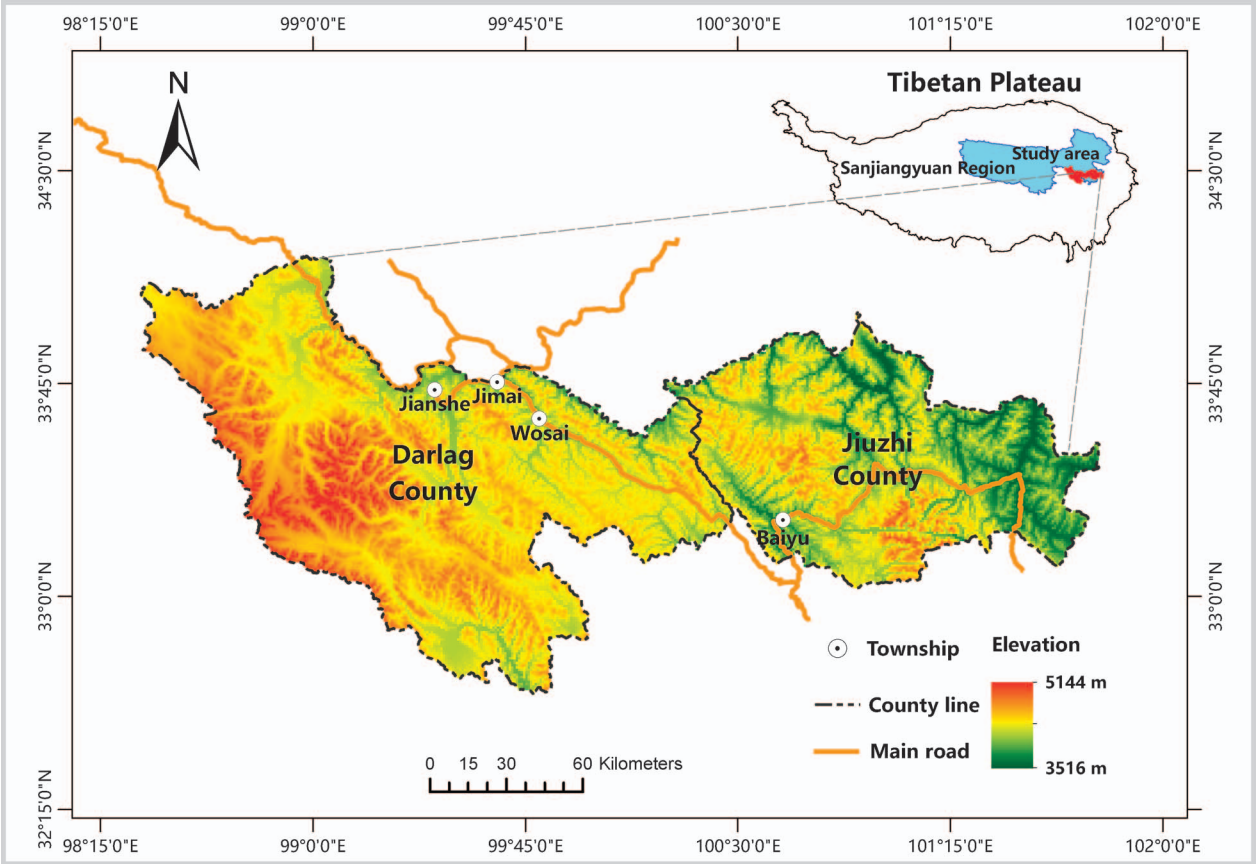
The study area is in southeastern Sanjiangyuan and includes Jimai, Jianshe, and Wosai townships in Darlag County and Baiyu township in Jiuzhi County in the Southeast Golok Tibetan Autonomous Prefecture, Qinghai Province (Figure 1). In earlier studies (Yan et al 2010; Yan, Yu, et al 2011), we found relatively severe grassland degradation in Wosai and Jianshe townships; this study enlarged the scope to examine a broader area.

Moderate-Resolution Imaging Spectroradiometer (MODIS) normalized difference vegetation index (NDVI) remote-sensing data on grassland vegetation indicate that most of these townships face pasture degradation, which challenges the livelihoods of local herders (Yu et al 2010). Ecological migration projects have been implemented in the 2 counties, and most of the migrants have already been resettled. This study focused mainly on herders who did not migrate.

Darlag County runs about 162 km east to west and 126 km south to north, and it is located in the plateau region of the Bayan Har Mountains, where the terrain is higher in the northwest and lower in the southeast. The average elevation is more than 4200 m, and it has a typical alpine frigid semihumid climate with cold and warm seasons. The cold season usually lasts 7 to 8 months, with many snowstorms and windstorms. The average temperature is 0.5°C, and the average precipitation is 595 mm, with an

http://dx.doi.org/10.1659/MRD-JOURNAL-D-17-00023.1

FIGURE 1 Map of the study area. (Map by Huilian Li)



average evaporation of 1205.9 mm. The soil type is alpine meadow soil, and the vegetation is composed of alpine meadow, swamp meadow, and shrub meadow. Grassland degradation is serious in Darlag County; there was 7820 km^2 of deteriorated grassland in 2014, accounting for 69.97% of utilizable areas (Sun 1991; Bai et al 2012; Zhu et al 2014). Animal husbandry is the main industry; in 2014, the total number of livestock was 197,000, including yak, sheep, and horses. At the end of 2014, the gross domestic product (GDP) of Darlag County was 270 million yuan renminbi (CNY; 1 $US = 6.1428 CNY in 2014), of which animal husbandry contributed 97.5 million (Darlag County Government 2014).

Jiuzhi County shares a border with Darlag County. It has a land area of 8,757.25 km^2. The Nianbaoyuze mountain range runs across the territory, with a north–south valley to the south of the mountain range and wide valleys and intermontane basins to the north. The elevation varies from 3568 to 5369 m, with a typical plateau continental climate with 2 seasons, cold and warm. The average annual temperature is 0.5°C, and the temperature is lower than 0°C up to 184 days of the year, including 131 days with temperatures lower than −10°C. Annual sunshine totals 2084.5 to 2509.5 hours, which is the least in Qinghai Province. It rains an average of 171 days per year, and the annual precipitation is 764.4 mm—the highest in Qinghai Province. The main soil type is alpine meadow soil, and the vegetation type is alpine meadow. The area of grassland degradation in 2014 was 25.57% in Jiuzhi County as a whole, but it was 59.27% in Baiyu township, the most seriously degraded area. Animal husbandry is the main industry in this county; in 2014, the total number of livestock was 245,100, including yak, sheep, and horses. At the end of 2014, the GDP of Jiuzhi County was 294 million CNY, of which the animal husbandry contributed 136 million (Jiuzhi County Government 2014).

Livestock and grasslands are the most important livelihood assets for local people. Residents also collect *Cordyceps sinensis* (*dong chong xia cao*) for additional income (Yan et al 2010) and receive subsidies through the ecological compensation mechanisms described earlier.

Data collection

In-depth fieldwork was conducted in August 2014 and included presurveys, formal household surveys, and group discussions. First, we randomly chose 10 households in

TABLE 1 Content of the household survey.

Topic	Questions
Demographics	Education, labor capacity, health condition, and skill mastery of household members
Livelihoods	Employment, reasons for and barriers to working in nonfarm sectors (eg part-time work in the manufacturing or service sector)
Material property	Use of the household's material possessions for agricultural and nonagricultural purposes
Education and development	Attitude toward children's education, economic level of household, methods to improve the quality of life, hope to get help when facing natural hazards
Income and expenditures	Household income and expenditures in last year
Grassland use	Grassland degradation, maintenance (including fencing, seeding, and rodent control), and rent
Livestock production	Grazing methods, number of livestock, disasters in the past 10 years, response to disasters
Other	Collection of *Cordyceps sinensis*, condition of house

Darlag County for presurveys and revised the questionnaire based on those results. Then, we used random sampling to select households for surveys conducted through semistructured interviews, and we held informal discussions with people who were familiar with the rural transformation of the sampled townships. The head of the surveyed household was the main respondent, and other household members also supplied information. Two local Tibetan speakers were employed as translators. We discussed the household questionnaires with the translators and determined how to formulate each question. Table 1 lists the main content of the questionnaire.

Since the herders stayed in summer pastures where the tents were very scattered, investigators drove by car to the general location and then walked to each tent and explained the purpose of the survey. The interview started when the household agreed to answer the questionnaire. Surveys were conducted in tents or houses and lasted 1 to 2 hours. Villages were randomly selected from each township, and approximately 40 households were chosen from each township due to the dispersed nature of the settlements. None of the sample households had taken part in an ecological migration project. In total, questionnaires were administered to 173 households. Of these, 13 did not have a labor force (labor force here means those who have varying degrees of labor capacity); thus, 160 valid responses were analyzed in this study (39 in Wosai township, 40 in Jianshe township, 43 in Jimai township, and 38 in Baiyu township). Of these, 39 households practiced household-based grazing management, and 121 practiced group/community-based grazing management, averaging nearly 8 households per grazing group.

In addition, 3 workshops were organized to discuss the factors influencing engagement in off-farm employment; participants included 6 township officials, 20 village representatives, and 5 rural teachers. After summarizing and identifying the comments from the informants, we drew general conclusions.

Classification of sample households

We divided the sampled households into 2 groups based on whether any household members engaged in off-farm employment. Off-farm employment included self-employment (eg running a store or business, carpet making, or driving a taxi) and wage/salary employment (eg as a teacher, security guard, sanitation worker, or waiter). Collecting *C. sinensis* was not considered off-farm employment, though operating a *C. sinensis*-related business was.

Econometric model

A binary discrete choice model was used in this study to statistically analyze the behavior of individuals and households. Generally, 2 types of binary choice models are used according to the different probability distribution of random errors: The probit model is used when the random error follows a standard normal distribution, and the logit model is used when the random error follows a logistic distribution. Since the distribution of the random error was unknown in this study, we adopted the binary logit model for the regression analyses of the data and the probit model to show the stability of the results.

Many studies have identified factors influencing the livelihood strategies of farmers and herders at the household level. The most frequently studied factors include a variety of livelihood assets, which are influenced by decisions of household resource allocation, and macrosocial and economic factors such as natural disasters, climate change, market opportunities, and policy (Jansen et al 2006; Wassie et al 2007; Nega et al 2009; Oluwatayo 2009; Yan et al 2010; Eneyew 2012;

http://dx.doi.org/10.1659/MRD-JOURNAL-D-17-00023.1

TABLE 2 Key factors influencing farmers' choices to seek off-farm employment.

Factors	Examples	Sources that discuss the factors[a)]
Human	Age of head of household	2, 4–7
	Education of household members	1, 2–5, 7–9
	Household gender distribution	1, 2–4, 6, 7
	Skill training of household members	5
	Dependency ratio	1, 2, 5
	Household size and labor capacity	1, 2–6, 8, 9
Financial	Household income	3, 7–9
	Income from subsidies	8
	Availability of loans	3, 5, 7–9
Natural	Number of livestock	1, 6, 8, 9
	Area of farmland and grassland	1, 2, 5–9
	Wild herbs and other natural products	2, 9
Social	Distance from town	1–5
	Road density	2
	Social organization	5, 7, 8
Physical	Value of agricultural equipment	5–9
	Housing and other assets	4, 8

[a)] Sources: 1—Eneyew (2012); 2—Jansen et al (2006); 3—Oluwatayo (2009); 4—Wassie et al (2007); 5—Khatun and Roy (2012); 6—Nega et al (2009); 7—Kuwornu et al (2014); 8—Zhao, Li, et al (2011); 9—Yan et al (2010).

Khatun and Roy 2012; Kuwornu et al 2014). Table 2 lists the factors that are widely covered in the literature. These can be categorized as human, financial, natural, social, or physical. Obviously, the quantity and quality of human assets determine whether farmers use other assets to pursue different livelihood strategies.

Our model aimed to quantitatively analyze the factors that influence engagement in off-farm employment in Sanjiangyuan. From the factors described in Table 2, 9 were selected to serve as the independent variables for this analysis (Table 3). These factors were tested for multicollinearity to ensure the stability of the model and the reliability of the output. For this purpose, Pearson correlation analysis, tolerance, variance inflation factor, eigenvalue, and condition index were used to test the relationships between independent variables. Pearson correlation analysis showed that the absolute maximum value of the correlation coefficient between the variables was 0.312 (the index for the skilled labor ratio and car ownership), with all less than 0.8. Tolerance was greater than 0.1, variance inflation factor was less than 2, eigenvalue was not equal to 0, and the condition index was less than 30. These test results indicated no multicollinearity between the independent variables.

Results

Characteristics of sample households

In total, 29 households had members engaged in off-farm employment, accounting for 18.13% of the total sample (Table 4). The average size of the labor force in these households was higher than that for other households. The income of households with off-farm work (40,866.89 CNY per household) was much higher than that for households without it (23,181.61 CNY per household). Households with off-farm work depended less on animal husbandry than households without it, owning fewer livestock. Those with off-farm work owned, on average, 94.55 sheep units per household, while those without off-farm work owned 102.91 sheep units (livestock units were calculated as 1 yak = 4 sheep and 1 horse = 5 sheep). Grasslands were significantly degraded for all households, but somewhat less so for households with off-farm employment.

TABLE 3 Variables analyzed in the study.

Variable	Description	Mean	Standard deviation	Expected effect[a)]
Dependent variable				
Engaged in off-farm employment?	1 = yes, 0 = no	0.18	0.39	
Independent variables				
Perceived grassland quality[b)]	1 = good, 2 = relatively good, 3 = degraded, 4 = seriously degraded	2.88	0.85	+
Number of livestock[c)]	Measured in sheep unit equivalents (1 yak = 4 sheep; 1 horse = 5 sheep) (Ministry of Agriculture in China 2002)	4.23	0.98	−
Distance from town[c)]	Distance between house and the nearest town (m)	7.37	3.20	−
Car ownership	1 = yes, 0 = no	0.28	0.45	+
Income from subsidies[c)]	Annual total in CNY[d)] (includes pasture subsidies, elderly subsidies, poverty subsidies, and subsidies for returning grazing land to grassland)	8.53	1.68	+
Household labor capacity	0.5 for household members <16 or >60 years old; 1.0 for household members 16–60	2.20	0.92	+
Labor force education level	Total combined education (none = 1, primary school = 2, junior high school = 3, middle or vocational school = 4, university and above = 5) divided by total household labor force	1.36	0.54	+
Ratio of skilled labor	Proportion of the household labor force that can be considered skilled labor	0.27	0.27	+
Loans[c)]	Total loans from relatives and banks (CNY)	4.31	5.02	+

[a)] Expected effect on decision to pursue off-farm employment.
[b)] Family grassland area was not chosen to reflect the status of natural assets, because we found in the fieldwork that most of the nomads have a fuzzy memory of grassland area. Therefore, we chose "perceived grassland quality" as an alternative.
[c)] Values are presented as logarithms.
[d)] CNY (1 $US = 6.1428 CNY in 2014).

Factors influencing engagement in off-farm employment

The logit and probit model results were consistent and stable (Table 5). The specific results of the regression analysis are described below.

Perceived grassland quality had no significant effect on whether a household engaged in off-farm employment, which differed from our assumptions. A possible reason is that grassland quality was evaluated by herders themselves and thus lacked a unified standard. In addition, the effect of grassland degradation on engagement in off-farm employment may differ depending on the size and type of grassland.

The number of livestock had a negative influence on engagement in off-farm employment, consistent with our expectation. However, Sanjiangyuan has different off-farm employment mechanisms than other pasture areas in China. In other areas, the grazing prohibition and ecological compensation policies have encouraged reductions in livestock, and the animal husbandry labor force has been free to engage in off-farm employment due to the reduced dependency on livestock (Ji et al 2007; Tian 2011; Hou et al 2012; Meng et al 2013). Moreover, off-farm employment is relatively easy to find in other pastoral areas.

Distance between house and town had a negative effect on engagement in off-farm employment; that is, the greater the distance, the lower was the likelihood of engagement in off-farm employment.

Car ownership had no significant influence. This may be because the households in the study area often chose to buy cheap secondhand cars with a low access threshold, and there was no obvious difference between households in this regard.

Amount of income from subsidies had a positive effect on household engagement in off-farm employment. Subsidy income is often used to invest in a new business and create a sustainable livelihood. In households with off-farm employment, 76 people were engaged in off-farm activities, including 32 operating a business (eg livestock and *C. sinensis* businesses, transport services, and stores), 16 part-time workers, and 28 people working for

http://dx.doi.org/10.1659/MRD-JOURNAL-D-17-00023.1

TABLE 4 Characteristics of households with and without off-farm employment.[a)]

	Households with off-farm employment	Households without off-farm employment
Average number of people per household (standard deviation)	5.28 (2.10)	4.73 (1.94)
Average size of household labor force (standard deviation)[b)]	2.52 (1.15)	2.28 (0.91)
Household sex distribution		
Male	49%	47%
Female	51%	53%
Household age distribution		
$x < 16$	3%	3%
$16 \leq x < 30$	34%	30%
$30 \leq x < 45$	37%	41%
$45 \leq x < 60$	21%	17%
$x \geq 60$	5%	9%
Household's highest education level		
None	67%	80%
Primary school	19%	13%
Junior high school	10%	5%
Middle and vocational school	1%	1%
University and above	3%	1%
Skilled labor ratio[c)]	27.40%	25.42%

[a)] Source: Authors' survey in 2014.
[b)] Total household labor force was calculated as described in Table 3.
[c)] Percentage of household labor force that can be considered skilled labor.

governments or corporations (eg village representatives, forest rangers, and epidemic prevention coordinators).

Education had a significant positive effect on engagement in off-farm employment. The ratio of skilled labor (with skills such as driving, agricultural technology, and sewing to diversify their livelihoods) to overall household labor capacity did not have a significant effect, even though the coefficients were positive. Skill training in the area is low, and training projects are often very simple. In the households participating in the study, only 28.49% of the workforce had received any skill training, of which 82.08% consisted only of driver training. Thus, skill training was insufficient to promote off-farm employment.

Though access to loans did not have significant influence, its importance should not be ignored. Illness (mainly pulmonary tuberculosis) was a major reason that households took out loans. This is also a common livelihood risk in the study area and often leads to labor-force reduction. Nomads are susceptible to disease because of the harsh climate, and infectious diseases spread easily in their small tents. We discussed the tuberculosis issue with local doctors, who noted that nomads do not always know when they are infected because they do not have annual examinations. When the disease becomes severe, nomads have to go to large hospitals for treatment and have to borrow money from relatives to pay for it.

Discussion

Factors influencing engagement in off-farm employment

The main factors influencing engagement in off-farm employment include number of livestock, distance between house and town, subsidy income, and education. The finding on the number of livestock is consistent with that of a study in Uxin Banner in the Inner Mongolia Autonomous Region, where the Grain for Green policy and reduction in the number of livestock promoted the

http://dx.doi.org/10.1659/MRD-JOURNAL-D-17-00023.1

TABLE 5 Parametric estimation results of the models.[a)]

Variable	Logit ($n = 160$)		Probit ($n = 160$)	
	Coefficient	Standard error	Coefficient	Standard error
Perceived grassland quality	−0.169	0.260	−0.101	0.151
Number of livestock[b)]	**−0.594****	0.240	**−0.334****	0.139
Distance from town[b)]	**−0.137****	0.067	**−0.082****	0.039
Income from subsidies[b)]	**0.688***	0.363	**0.415****	0.206
Household labor capacity	0.329	0.243	0.181	0.137
Labor force education level	**0.917****	0.397	**0.565****	0.237
Skilled labor ratio	0.309	0.946	0.128	0.549
Owns a car?	0.711	0.548	0.454	0.314
Loans[b)]	0.06	0.047	0.037	0.027
Log likelihood	−63.649		−63.292	
LR chi^2(8)	24.15		24.87	
Prob > chi^2	0.004		0.003	
Pseudo R^2	0.160		0.164	

[a)] Source: Authors' survey in 2014.
[b)] Values are presented as logarithms.
* Significance level 10%.
** Significance level 5%.

transition to off-farm livelihoods, as well as transition from traditional (nomadic and seminomadic) animal husbandry to intensified agricultural management (ie to contract farming in animal husbandry) (Meng et al 2013). Studies in the Gannan areas in the Eastern Tibet Plateau and in Yanchi County, Ningxia Province, have yielded similar findings (Ji et al 2007; Tian 2011; Hou et al 2012). However, the grassland degradation of other pastoral areas is not as serious as in Sanjiangyuan. Our finding on the effect of distance between house and town was consistent with our expectations; it is also consistent with a study of pastoral societies in southern Ethiopia (Eneyew 2012), where shorter distances to the market town resulted in lower costs to engage in nonfarm employment. Our finding on subsidy income was also consistent with our expectations. Ecological compensation was the source of 86.41% of subsidy income. Since financial assets are usually a key factor in livelihood diversification (Wassie et al 2007; Nega et al 2009; Khatun and Roy 2012), ecological compensation provides capital for herders to seek off-farm employment. Our finding on education was consistent with findings in the upper reaches of the Dadu River and Gannan areas (Yan et al 2010; Zhao, Li, et al 2011), which showed the positive effect of basic education on engagement in off-farm employment.

The ratio of skilled labor to household labor capacity did not have a statistically significant effect on engagement in off-farm employment in this study. A possible explanation for this can be found in a study in Zeku County, Sanjiangyuan (Qi et al 2014), which found that the most requested training programs were for driving, the Mandarin language, and Internet use; other studies have found that the training provided by the government cannot meet all the training needs of herders (Sun 1991; Lu and Zhao 2009; Tian 2011).

Policy implications

Empirical studies of resettlement areas in Sanjiangyuan have found that most ecological migrants are families with few or no livestock, giving rise to a pessimistic view of ecological migrants' livelihoods and sharp criticism of government projects. However, our study of herders who still graze livestock indicates that the livelihood situation is not so pessimistic, though there are some factors that prevent pastoralists from shifting to off-farm employment. A reasonable explanation is that ecological migrants are among the most vulnerable herders and lack the assets needed to seek off-farm employment. For those vulnerable groups, a feasible approach would be to improve subsidy standards to cover living necessities.

http://dx.doi.org/10.1659/MRD-JOURNAL-D-17-00023.1

Since the herders in this case study sought off-farm employment, we recommend that the government should adjust its current policies from livelihood maintenance to livelihood promotion in the second phase of Qinghai Sanjiangyuan Nature Reserve Ecological Protection and Construction. First, more effective methods of skills training are necessary to meet herders' needs. Second, to ensure the sustainable development of the regional environment and economy, regional resources and cultural characteristics should be fully utilized to develop plateau tourism and manufacture of distinctive local products, which could increase employment opportunities for local people. Finally, as the ecological compensation policy has already been mentioned, it is important to guide ecological migrant households to return grazing land to grassland and reduce livestock numbers, and to engage in the daily management of natural forests, riverbeds, abandoned land, wildlife, and wetlands in the ecological function conservation areas.

Conclusion

Understanding the drivers of and barriers to engagement in off-farm employment in Sanjiangyuan is crucially important for policymaking regarding livelihood improvements. Based on 2014 survey data for 4 townships in Sanjiangyuan, we used binary logit and probit models to quantitatively analyze the key factors affecting herders' decisions to seek off-farm employment. We aimed to find an effective way to motivate pastoralists to engage in nonagricultural occupations and make policy suggestions for improving post-resettlement livelihoods. The results indicate that education helps to expand the range of employment opportunities, and government subsidies provide capital, both of which promote off-farm employment. Animal husbandry has a stronger demand for labor and thus hinders off-farm employment. In addition, willingness to pursue off-farm employment generally declines with increased distance between the household and the nearest town.

ACKNOWLEDGMENTS

This study was funded by the National Natural Science Foundation of China, Grant No. 41571093, and the Global Environmental Institute. We thank the anonymous reviewers for their helpful suggestions.

REFERENCES

Bai W, Zhang Y, Liu L, Zhang Q, Du C. 2012. Adaptation of Tibetan nomadism to climate change in the source region of the Yellow River [in Chinese with English abstract]. *Journal of Natural Resources* 27(12):2030–2038.

Bessho Y. 2015. Migration for ecological preservation? Tibetan herders' decision-making process in the eco-migration policy of Golok Tibetan autonomous prefecture (Qinghai Province, PRC). *Nomadic Peoples* 19(2):189–208.

Chang I, Wu J, Yang Y, Shi M, Li X. 2014. Ecological compensation for natural resource utilisation in China. *Journal of Environmental Planning and Management* 57(2):273–296.

Darlag County Government. 2014. *Annual Report of Darlag County Government in 2014*. http://www.dari.gov.cn/html/513/3400.html; accessed on 9 November 2015.

Dorward A, Anderson S, Bernal YN, Pattison J, Paz R, Rushton J, Sanchez Vera E. 2009. Hanging in, stepping up and stepping out: Livelihood aspirations and strategies of the poor. *Development in Practice* 19(2):240–247.

Du F. 2012. Ecological resettlement of Tibetan herders in the Sanjiangyuan: A case study in Madoi County of Qinghai. *Nomadic Peoples* 16(1):116–133.

Du M, Kawashima S, Yonemura S, Zhang X, Chen S. 2004. Mutual influence between human activities and climate change in the Tibetan Plateau during recent years. *Global and Planetary Change* 41(3):241–249.

Eneyew A. 2012. Determinants of livelihood diversification in pastoral societies of southern Ethiopia. *Journal of Agriculture and Biodiversity Research* 1(3):43–52.

Foggin JM. 2008. Depopulating the Tibetan grasslands: National policies and perspectives for the future of Tibetan herders in Qinghai Province, China. *Mountain Research and Development* 28(1):26–31.

Foggin JM. 2011. Local communities and conservation on the Tibetan Plateau: Two case studies of collaborative management in the Sanjiangyuan region. *In:* [no editors]. *International Symposium on the Human Dimensions of Ecological Conservation on the Tibetan Plateau*. Xining, China: the Qinghai Academy of Social Sciences, pp 50–60.

Foggin JM, Torrance-Foggin ME. 2011. How can social and environmental services be provided for mobile Tibetan herders? Collaborative examples from Qinghai Province, China. *Pastoralism: Research, Policy and Practice* 1(1):1–22.

Harris RB. 2010. Rangeland degradation on the Qinghai–Tibetan Plateau: A review of the evidence of its magnitude and causes. *Journal of Arid Environments* 74(1):1–12.

Hou C, Zhao X, Zhang L, Jiang J, Li W, Yan J. 2012. The impacts of ecological compensation on regional development: A case of the Yellow River water supply areas of Gannan [in Chinese with English abstract]. *Journal of Natural Resources* 27(1):50–61.

Jansen HG, Pender J, Damon A, Wielemaker W, Schipper R. 2006. Policies for sustainable development in the hillside areas of Honduras: A quantitative livelihoods approach. *Agricultural Economics* 34(2):141–153.

Ji Y, Bao L, Wu L. 2007. Study on the influence of returning grazing to grassland project on the income of herdsmen: Case study of Yanchi County in Ningxia Province [in Chinese with English abstract]. *Northern Economy* 1(4):36–38.

Jiuzhi County Government. 2014. *Annual Report of Jiuzhi County Government in 2014*. http://www.jiuzhixian.gov.cn/html/568/218769.html; accessed on 9 November 2015.

Kang S, Xu Y, You Q, Flügel WA, Pepin N, Yao T. 2010. Review of climate and cryospheric change in the Tibetan Plateau. *Environmental Research Letters* 5(1):75–82.

Khatun D, Roy BC. 2012. Rural livelihood diversification in west Bengal: Determinants and constraints. *Agricultural Economics Research Review* 25(1):115–124.

Kuwornu JK, Bashiru M, Dumayiri M. 2014. Farm households' livelihood diversification into agro-processing and non-agro-processing activities: Empirical evidence from Ghana. *Information Management and Business Review* 6(4):191–199.

Li H, Zhang A, Yang X, Zhuo M. 2013. The ecological protective behavior mechanism of herdsman in response to grassland degradation policy in Sanjiangyuan [in Chinese with English abstract]. *Resources Science* 35(7):1510–1519.

Li XL, Gao J, Brierley G, Qiao YM, Zhang J, Yang YW. 2013. Rangeland degradation on the Qinghai–Tibet Plateau: Implications for rehabilitation. *Land Degradation & Development* 24(1):72–80.

Li XL, Perry GLW, Brierley G, Sun HQ, Li CH, Lu GX. 2014. Quantitative assessment of degradation classifications for degraded alpine meadows (*heitutan*), Sanjiangyuan, western China. *Land Degradation & Development* 25(5):417–427.

Li Y, Luo Y, Zheng H, Yang S, Ouyang Z, Luo Y. 2013. Standard of payments for ecosystem services in Sanjiangyuan Natural Reserve [in Chinese with English abstract]. *Acta Ecologica Sinica* 33(3):764–770.
Liu J, Xu X, Shao Q. 2008. Grassland degradation in the "Three-River Headwaters" region, Qinghai Province. *Journal of Geographical Sciences* 18(3):259–273.
Lu G. 2007. *Sanjiangyuan Nature Reserve Ecological Protection and Construction* [in Chinese]. Xining, China: Qinghai People's Publishing House.
Lu Q, Zhao Z. 2009. Eco-immigration policy for the degraded rangeland and response of herd families: A case study of Maduo County, the source region of Yellow River [in Chinese with English abstract]. *Geographical Research* 28(1):143–152.
McGregor GR. 2016. Climate variability and change in the Sanjiangyuan region. *In:* Brierley G, Li X, Cullum C, Gao J, editors. *Landscape and Ecosystem Diversity, Dynamics and Management in the Yellow River Source Zone*. Cham, Switzerland: Springer, pp 35–57.
Meng J, Amrulla, Liu Y, Xiang Y. 2013. Study on relationship between livelihood capital and livelihood strategy of farming and grazing households: A case of Uxin Banner in Ordos [in Chinese with English abstract]. *Acta Scientiarum Naturalium Universitatis Pekinensis* 49(2):321–328.
Ministry of Agriculture in China. 2002. *Calculation of Proper Carrying Capacity of Rangeland* [*Tianran Caodi Heli Zaixuliang De Jisuan*] (NY/T 635-2002) [in Chinese]. Beijing, China: Agricultural Industry Standards of People's Republic of China.
Nega F, Marysse S, Tollens E, Mathijs E. 2009. *Diversification, Income Inequality and Social Capital in Northern Ethiopia*. Mekele, Ethiopia: Mekele University; and Antwerp, Belgium: University of Antwerp.
Nyima T. 2014. In the name of conservation and harmonious development: The separation of pastoralists from pastures in Tibet. *In:* Brox T, Bellér-Hann I, editors. *On the Fringes of the Harmonious Society: Tibetans and Uyghurs in Socialist China*. Copenhagen, Denmark: Nordic Institute of Asian Studies (NIAS) Press, pp 127–158.
Oluwatayo IB. 2009. Poverty and income diversification among households in rural Nigeria: A gender analysis of livelihood patterns. Paper presented at the *2nd Instituto de Estudos Sociais e Económicos (IESE) Conference on 'Dynamics of Poverty and Patterns of Economic Accumulation in Mozambique*.' Maputo, Mozambique, 22–23 April 2009. Available from the corresponding author of the present article.
Ptackova J. 2011. Sedentarisation of Tibetan nomads in China: Implementation of the Nomadic settlement project in the Tibetan Amdo area, Qinghai and Sichuan Provinces. *Pastoralism: Research, Policy and Practice* 1:1–4.
Qi J. 2015. Study on social adaptation and community cultural reconstruction of ecological migration in Sanjiangyuan area [in Chinese]. *Journal of Minzu University of China (Philosophy and Social Sciences Edition)* 42(3):47–53.
Qi Y, Liu W, Zhang L, Gong B, Xu C, Feng H, Wu Z. 2014. A comparative analysis of herdsmen's and eco-immigrant's livelihood under ecological compensation of the Source Area of Three Rivers: A case study based on household investigation in Zeku County, Qinghai Province [in Chinese with English abstract]. *Pratacultural Science* 31(6):1178–1184.
Shao Q, Liu J, Huang L, Fan J, Xu X, Wang J. 2013. Integrated assessment on the effectiveness of ecological conservation in Sanjiangyuan National Nature Reserve [in Chinese with English abstract]. *Geographical Research* 32(9):1645–1651.
Sun H, Zheng D, Yao T, Zhang Y. 2012. Protection and construction of the National Ecological Security Shelter Zone on Tibetan Plateau [in Chinese with English abstract]. *Acta Geographica Sinica* 67(1):3–12.
Sun Y. 1991. *Tibet: The Development and Reform of the Non-typical Dual Structure: A New Perspective on the Discussion and Report* [in Chinese]. Xizang, China: Chinese Tibetan Press.
Tashi G, Foggin M. 2012. Resettlement as development and progress? Eight years on: Review of emerging social and development impacts of an 'ecological resettlement' project in Tibet Autonomous Region, China. *Nomadic Peoples* 16(1):134–151.
Tian X. 2011. The influence of policies of returning grazing land to forage land on the nomads' living [in Chinese with English abstract]. *Chinese Journal of Grassland* 33(4):1–4.
Wang Z, Song K, Hu L. 2010. China's largest scale ecological migration in the Three-River headwater region. *AMBIO: A Journal of the Human Environment* 39(6):443–446.
Wassie B, David C, Bichaka F. 2007. Diversification and livelihood sustainability in a semi-arid environment: A case study from southern Ethiopia. *The Journal of Development Studies* 43(5):871–889.
Yan J, Wu Y, Zhang Y. 2011. Adaptation strategies to pasture degradation: Gap between government and local nomads in the eastern Tibetan Plateau. *Journal of Geographical Sciences* 21(6):1112–1122.
Yan J, Wu Y, Zhang Y, Zhou S. 2010. Livelihood diversification of farmers and nomads of eastern transect in Tibetan Plateau. *Journal of Geographical Sciences* 20(5):757–770.
Yan J, Yu O, Wu Y, Zhang Y. 2011. Livelihood vulnerability assessment of farmers and nomads in eastern ecotone of Tibetan Plateau, China [in Chinese with English abstract]. *Scientia Geographica Sinica* 31(7):858–867.
Yeh E. 2010. Restoring the grasslands? *China Dialogue*, 26 January. https://www.chinadialogue.net/article/show/single/en/3470-restoring-the-grasslands; accessed on 9 November 2015.
Yi S, Wang X, Qin Y, Xiang B, Ding Y. 2014. Responses of alpine grassland on Qinghai–Tibetan Plateau to climate warming and permafrost degradation: A modeling perspective. *Environmental Research Letters* 9(7):1195–1206.
Yu L, Zhou L, Liu W, Zhou H. 2010. Using remote sensing and GIS technologies to estimate grass yield and livestock carrying capacity of alpine grasslands in Golog Prefecture, China. *Pedosphere* 20(3):342–351.
Zeng Y, Feng Z. 2007. Spatial and temporal changes of desertification in the headwater area of the Yellow River using remote sensing [in Chinese with English abstract]. *Acta Geographica Sinica* 62(5):529–536.
Zhao D, Wu S, Yin Y, Yin Z. 2011. Vegetation distribution on Tibetan Plateau under climate change scenario. *Regional Environmental Change* 11(4):905–915.
Zhao X, Li W, Yang P, Liu S. 2011. Impact of livelihood capital on the livelihood activities of farmers and herdsmen on Gannan plateau [in Chinese with English abstract]. *China Population Resources and Environment* 21:111–118.
Zhu X, Chao Z, Yang Y, Zhang X. 2014. Spatial and temporal variations of Black Soil Type degraded grassland in the Three River Source Region [in Chinese with English abstract]. *Pratacultural Science* 21(9):1628–1636.