

# Sustainable Livelihoods of Farming Herdsmen and Household-Level Livelihood Vulnerability Assessment and the Effect Tobacco Consumption in High-Frigid Ecological Vulnerable Region of the Northern Tibetan Plateau

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**Abstract:** Improving farmers' livelihood diversity is the best way to address livelihood vulnerability and fragile ecological environments . In this study, we used participatory rural appraisal (PRA) multinomial logistic regression models to analyze the affect farmers' conversion effect of farmers' livelihood strategies in northern Tibet. The results indicated(1) that farmers' livelihood capital is relatively low and that the Human capital was the lowest, Results There is considerable difference between in northern Tibet.(2)farmers' livelihood capital and farmers' livelihood diversity differed in their livelihood strategies.(3) human capital was the key factor affecting the transformation of livelihood diversity and farmers' livelihood strategy; the amount of household labor, Education level of labor force, The possibility that relatives and friends can help, Availability of government policy support were the most important factors affect farmers'

**conversion effect of farmers' livelihood strategies, Improving farmers' livelihood diversity. percapita grassland area, grassland quality restrained affect farmers' conversion effect of farmers' livelihood diversity in northern Tibet.(4)In recent years, the expenditures of farmers and herdsmen in northern Tibet on alcohol consumption and tobacco consumption have been continuously reduced. The health risks and medical expenditures of farmers and herdsmen have been relatively reduced. This reduction is related to the increase in health risk awareness and health of farmers and herdsmen. Propaganda is more relevant. Finally, we propose policy changes and suggestions for improving livelihood Level and regional ecological environment in northern Tibet.**

**Key Words:** livelihood capital; Tobacco consumption; LivelihoodVulnerability; high-frigid ecological vulnerable region of the northern Tibetan plateau

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Research on the interrelationship and mechanism between human activities and the ecological environment constitutes one of the core scientific issues in the study of human sustainable development<sup>1</sup>. In the 1990s, the United Nations Conference on Environment and Development determined sustainable livelihoods as an important means to mitigate contradiction between socio-economic activities and ecological environments<sup>2,3</sup>. However, so far, there are still numerous contradictions between human social economic activities and ecological environment. "Protection of the Earth" pointed out that humans have consumed more than 40% NPP (total food resources on the earth) of the earth's terrestrial resources. More than 1.3 billion people on the earth depend on natural resources in their livelihoods, and more than 300 million people are highly dependent on natural resources in livelihoods<sup>4</sup>. In vast villages in developing countries, natural resources provide an important source for maintaining livelihoods, including supply of wood fuel, food, drinking water, and household building materials. As the most basic economic decision-making body in agricultural and pastoral areas, farmers and herdsmen directly determine the way and efficiency of natural resource utilization through household livelihood

strategies, which produces positive or negative feedback to the ecological environment. Therefore, research on the farmers and herdsmen's livelihoods carries great significance for improving the livelihood level and quality of farmers and herdsmen, reducing the incidence of poverty, and alleviating the pressure on the ecological environment<sup>5</sup>.

At present, research on sustainable livelihoods and livelihood vulnerability of farmers and herdsmen has become a hotspot at home and abroad. ZHAOXueyan, SU Fang, and HAOWenyan believe that the magnitude and composition of livelihood capital directly determine the livelihood decision-making behavior of farmers and herdsmen, and different livelihood types are examined. The "exposure-sensitivity-adaptability" analysis model advocated by IPCC carries great significance for regional and household decision-making vulnerability research and has been widely used. LIXiaoyun established a vulnerability evaluation index system suitable for Chinese farmers and herdsmen households based on foreign scholars' models. ZHANGYili established a livelihood vulnerability evaluation system based on livelihood capital, risk and adaptability to assess the eastern region of the

Qinghai-Tibet Plateau. Existing researches on livelihood capital and livelihood strategies mostly focus on correlation analysis, lack research on livelihood conversion under the impact of policy factors and makes insufficient analysis on key factors in the conversion of livelihood strategies<sup>6-8</sup>. In addition, previous studies on livelihood capital simply divided farmers and herdsmen into agricultural households and non-agricultural households. In recent years, it has become common for farmers and herdsmen to conduct by-business in addition to agricultural and pastoral production. Existing livelihood vulnerability assessments mostly focus on individual livelihood risk assessments, lacking comprehensive analysis of multiple risks. In addition, adaptive analysis lacks a comprehensive analysis of external factors.

Northern Tibet region, located in the hinterland of the Qinghai-Tibet Plateau, is a typical high-frigid ecological vulnerable area. In the context of global warming and increased human disturbances, northern Tibet is facing accelerated melting of glaciers, aggravated climate aridification and grassland degradation, which has become a typical area with grassland degradation on the Qinghai-Tibet Plateau and has attracted widespread attention at home and abroad. For farmers and herdsmen who are the main economic decision-making bodies in northern Tibet, degradation of the ecological environment exposes their livelihoods to risk, and results in intensified contradiction between man and land. Reducing the livelihood risks and livelihood vulnerability of farmers and herdsmen is a necessary guarantee for achieving regional sustainable development. In view of this, this paper takes the high-frigid ecological vulnerable region of northern Tibet as the research object, fully considers farmers and herdsmen's livelihood capital diversification and environmental perception, and proceeds from the risk sensitivity

and adaptability of farmers and herdsmen towards ecological environment degradation, constructs the livelihood vulnerability evaluation index system for farmers and herdsmen in northern Tibet to assess livelihood vulnerability characteristics of farmers and herdsmen in northern Tibet, and analyze the key factors influencing the livelihood vulnerability of farmers and herdsmen, with a view to providing reference for the formulation of ecological environment change policies in the high-frigid ecological vulnerable region in Qinghai-Tibet Plateau<sup>9-11</sup>.

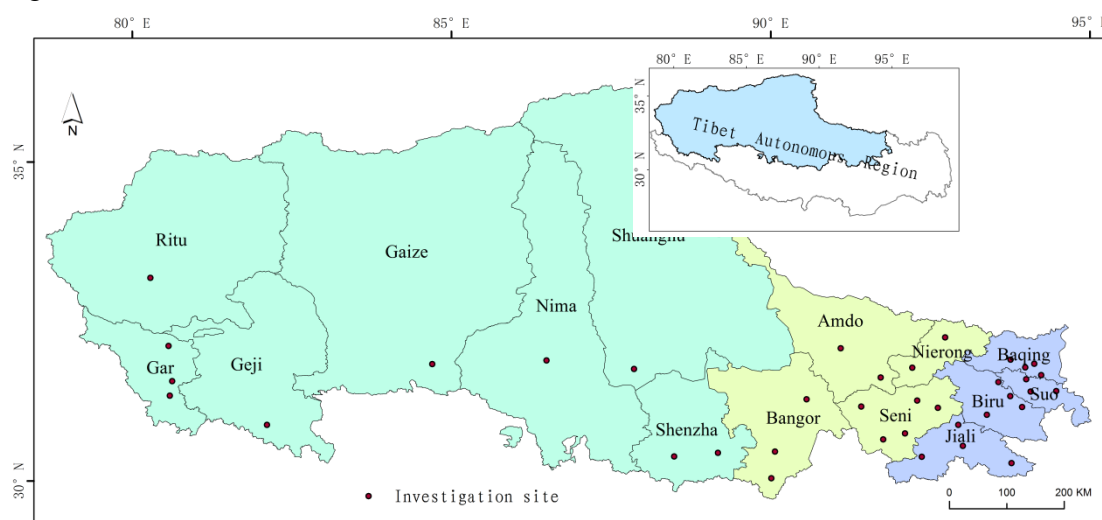
## OVERVIEW OF THE STUDY AREA

Northern Tibet is located in the hinterland of the Qinghai-Tibet Plateau, the northern part of the Tibet Autonomous Region, north of Nyenchen Tanglha Mountains and Gangdisi Mountains, and south of Hoh Xil and Kunlun Mountains. The climate is dry and cold, the terrain is high in the northwest, flat in the middle, and low in the east (in alpine and gorge region, temperature and humidity are higher). Most areas have an altitude of 4000-5000M, an average annual temperature of -2.8-1.6°C, and an average annual rainfall of 247.3- 513.6mm. Many rivers such as the Yangtze River, Nu River and Lantsang River originate here, and there are many rivers and lakes in the territory, demonstrating abundant water resources. Most of the area is dominated by alpine meadow grasslands, alpine grasslands and wetlands, and large areas of forests and shrubs are also distributed in the eastern region<sup>12</sup>. In recent years, the intensified man-land contradiction and unreasonable economic activities have led to ecological and environmental problems such as grassland degradation, wetland area shrinkage, and decline in arableland quality.

According to the resource and environmental conditions of the northern Tibet Plateau and the differences in the livelihoods of farmers and

herdsmen, the northern Tibet region is divided into western pastoral areas in the northern Tibet (Shuanghu County, Shenzha County, Nima County, Gaize County, Ritu County, Geji County, Gar County), central pastoral areas in the northern Tibet (Nierong County, Seni District, Amdo County, Bangor County), and eastern farming-pastoral areas in the northern Tibet (Baqing County, Suo County, Biru County, Jiali County)(Fig.1). At the end of 2019, there were

605,700 permanent residents in northern Tibet, the agricultural and pastoral population accounted for more than 80% and the annual per capita disposable income of farmers and herdsmen was 9,782 Yuan. The farmers and herdsmen in northern Tibet are mainly engaged in agricultural and animal husbandry production activities, developing a high degree of dependence on biological resources on grasslands and under the forest<sup>12</sup>.



**Fig. 1 The study area and investigation sites**

## DATA SOURCES AND RESEARCH METHODS

### Data Sources

The study area data is mainly collected through various participatory rural appraisal methods (PRA) such as observation methods, questionnaire surveys and interviews<sup>13-14</sup>. In August 2019, rural and pastoral villages were selected for preliminary surveys from the central pastoral areas and eastern farming-pastoral areas of the northern Tibet Plateau with good traffic accessibility. Based on the survey feedback information, the questionnaire content was revised. From October 2019 to August 2020, we officially conducted interviews in the agricultural and pastoral areas of the northern Tibet Plateau. Considering the excessive area of northern Tibet

and the relative consistency in natural environment and the livelihoods of farmers and herdsmen in each region, we divide northern Tibet region into western pastoral area, central pastoral area and eastern farming-pastoral area. In October 2019, 10 villages in 8 townships were selected from the western pastoral area of northern Tibet for investigation, with 12 households of farmers and herdsmen randomly selected from each village. In April 2020, 13 villages in 8 townships were selected from the central pastoral area of northern Tibet for investigation, with 12 households of farmers and herdsmen randomly selected from each village. In August 2020, 15 villages in 9 townships were selected from eastern farming-pastoral region of northern Tibet for investigation, with 12 households of farmers and herdsmen randomly

selected from each village. Due to the great differences in Tibetan dialects, we hired Tibetan students who have graduated from our university and are familiar with the production and lifestyle of Tibetan agriculture and animal husbandry to assist in translation during the research period. Northern Tibet has a large area where farmers and herdsmen live scattered, traffic accessibility is poor, and the altitude is too high. In this survey, 454 questionnaires were collected and 454 questionnaires were returned. Despite the small number of interviewed farmers and herdsmen households, a comparison with the statistics of the township ledger reveals that the sample can reflect the basic situation of farmers and herdsmen's households in the study area, and the questionnaire can cover all types of livelihoods of farmers and herdsmen in the high-frigid agricultural and pastoral areas of northern Tibet, which has good representativeness. The time for each questionnaire survey is between 40-50 minutes. At the same time, 187 copies of interview and observation records were acquired. After deleting incomplete and incorrect information, 441 valid questionnaires were finally obtained, with a total effective rate of 97.1%. Where, 115 questionnaires were from the western pastoral area, 154 were from the central pastoral area, and 172 were from the eastern farming-pastoral area. The main survey contents include: (1) Basic information of farmers and herdsmen households; (2) Farmer and herdsmen household livelihoods and various livelihood asset status; (3) Household energy and food consumption status; (4) Household livelihood risks and the government policies etc.

## Research Methods

### The livelihood diversification index of farmers and herdsmen and the classification of livelihood types

According to the existing research results of livelihood classification, considering the livelihood characteristics of farmers and herdsmen in northern Tibet, the labor input of farmers and herdsmen households, family income type and its proportion in household income, we divide farmers and herdsmen in northern Tibet into pure herdsmen (family laborers are all engaged in animal husbandry production), farmers and herdsmen (family laborers are all engaged in agriculture and animal husbandry production), part-time agricultural households ( $0 < \text{non-agricultural income} < 90\%$ ) and non-agricultural households ( $\text{non-agricultural income} \geq 90\%$ ). According to the per capita income, farmers and herdsmen households are divided into high-income farmers and herdsmen (per capita income  $\geq 15,000$  yuan/year), middle-income farmers and herdsmen ( $8,000$  yuan/year  $<$  per capita income  $< 15,000$  yuan/year) and low-income farmers and herdsmen (per capita income level  $< 8000$  yuan/year). According to the average education status of the labor force, farmers and herdsmen households are divided into households with high education level (junior high school and above), middle education level (primary school education) and low education level (without formal school education). According to the diversified livelihood types of farmers and herdsmen in northern Tibet, the livelihoods of farmers and herdsmen are divided into single livelihood type (family labor only engages in one kind of production activity), two livelihood types (family labor engages in two production activities) and multiple livelihood type (family labor engages in three or more production activities)<sup>15</sup>.

### **The livelihood capital index system of farmers and herdsmen**

According to the sustainable livelihood framework provided by DFID and the quantitative index system of livelihood capital established by domestic and foreign scholars, livelihood capital index system is optimized in view of data availability and quantification based on natural resources, humanities and social conditions, production and living conditions of farmers and herdsmen households in northern Tibet. The livelihood capital index framework system is thereby designed for farmers and herdsmen in northern Tibet<sup>[16-17]</sup>. Human capital (H) refers to the skill level, number of labor force and knowledge level of farmers and herdsmen households to earn income. The number of labor force (H1) and labor education level (H2) of farmers and herdsmen households are used as measurement indexes. Natural capital (N) is the economic value service available for farmers and herdsmen households through local natural and social economic resources. Farmers and herdsmen households in northern Tibet are mainly engaged in agriculture and animal husbandry production, and the per capita arable land area (N1), per capita grassland area (N2), arable land quality (N3) and grassland quality (N4) are used as measurement indexes. Material capital (M) is the material assets accumulated in the process of production and life as well as material affordability formed by farmers and herdsmen households in development and reproduction, which are calculated based on the per capita property value (M1), per capita value of means of production (M2), and the number of livestock (M3). Financial capital (F) is the amount of cash deposits owned by farmers and herdsmen households and available loan amount for development and reproduction, which are calculated based on household annual income (F1) and credit capacity (F2). Social capital (S) is the

help available to farmers and herdsmen households in the society, which is calculated based on the possibility of help from relatives and friends (S1) and availability of government policy support (S2) (Tab. 1).

### **Livelihood vulnerability index system for farmers and herdsmen**

The "exposure-sensitivity-adaptability" analysis model advocated by IPCC carries great significance for vulnerability study at the regional and household decision-making levels and has been widely used. LIXiaoyun established a vulnerability evaluation index model system suitable for Chinese farmers and herdsmen households based on foreign scholars' models. Based on livelihood capital, risk and adaptability, ZHANGYili established a livelihood vulnerability evaluation system to evaluate the eastern region of the Qinghai-Tibet Plateau. Existing researches on livelihood capital and livelihood strategies mostly focus on correlation analysis, lacking research on livelihood conversion under the influence of policy factors and there is insufficient analysis of key factors in the conversion of livelihood strategies. In addition, previous studies on livelihood capital simply divide farmers and herdsmen into agricultural households and non-agricultural households. In recent years, by-business has become more common in agricultural and pastoral production of farmers and herdsmen. Existing livelihood vulnerability assessments mostly focus on individual livelihood risk assessments, lacking comprehensive analysis of multiple risks. In addition, adaptive analysis lacks a comprehensive analysis of external factors<sup>18-21</sup>. Based on the above research results, the paper combines the "exposure-sensitivity-adaptability" analysis model with the sustainable livelihood framework model to analyze the status quo of resources and environment in northern Tibet, the ecological

environment and farmers and herdsmen’s perception of the ecological environment, thusbuildinglivelihood vulnerability index system for farmers and herdsmen.

(1) Risk

Farmers and herdsmen households are the basic economic units in agricultural and pastoral areas. The main risks faced by farmers and herdsmen households include health risks, natural risks, and financial risks (Tab. 1). Health risks and financial risks are expressed as the proportion of medical expenses of farmers and herdsmen's family members in household income and the proportion of farmers and herdsmen households borrowing usury. However, the survey data in recent years reflects a surprising phenomenon, that is, whether in pastoral, agricultural, or semi-agricultural and semi-pastoral areas, the expenditure of farmers and herdsmen on alcohol consumption and tobacco consumption is constantly decreasing, and this The reduction has a greater relationship with the increase in health risk awareness of farmers and herdsmen.he larger the index value, the higher the risk level. Natural risks are mainly divided into three risks: resource degradation, livestock loss, and food production reduction. The income of farmers and herdsmen in northern Tibet is highly dependent on grazing and collecting resources. Independent evaluation of

farmers and herdsmen can better reflect the actual risks faced by farmers and herdsmen households.

(2) Livelihood assets

According to the sustainable livelihood framework proposed by the British DFID, the livelihood assets of farmers and herdsmen discussed in the paper are divided into human capital, natural capital, financial capital, material capital and social capital. The indexes of farmers and herdsmen’s livelihood assets are determined based on the actual conditions of the study area and related documents<sup>22-23</sup>.

(3) Adaptability

Adaptability means the measures or strategies adopted by farmers and herdsmen households in the face of risk. This paper selects the livelihood strategies adopted by farmers and herdsmen households in the face of grassland degradation, collection resource degradation, and food production reduction. Livelihood diversification can enable better resistance to household livelihood risks. Seeking help is also an important measure to resist livelihood risks, including seeking help from relatives and friends and government assistance. The higher the index value, the stronger the adaptability of farmers and herder households.

**Table 1 Indicator system and description of livelihood vulnerability assessment at household level in northern Tibet**

Category	First-level index	Second-level index	Explanation
Risk (R)	Health risk	Average medical expenses per household (R1)	The proportion of medical expenses in household incomeaccording to standardized treatment
	Natural risk	Grassland degradation (R2)	Grassland degradation grade, the grassland degradation is assessed by farmers independently and subject to standardized treatment
		collection resource degradation(R3)	Proportion of farmers who recognize the risk of over-excavation and grassland degradation



Livelihood assets (L)	Financial risk	Food production reduction (R4)	Proportion of farmers who recognize the importance of field management
		Abnormal livestock loss (R5)	Proportion of the average annual loss of livestock by accident to the total number of livestock owned by farmers and herdsmen
		loan(R6)	Proportion of farmers and herdsmen households borrowing usury
		Number of household labor force (H1)	1.0 for full labor force, 0.5 for half labor force, and 0 for no labor force
	Human capital (H)	Labor education level (H2)	1 for junior high school and above, 0.5 for primary school, and 0 for illiteracy
		per capita arable land area (N1)	per capita arable land area (hm <sup>2</sup> /person), 0.5 for dry land and 1 for irrigated land
	Natural capital (N)	per capita grassland area (N2)	per capita grassland area (hm <sup>2</sup> /person)
		arable land quality (N3)	1 for high-quality arable land is 1, 0.66 for medium-quality arable land, and 0.33 for low-quality arable land
		Grassland quality (N4)	1 for high-quality grassland, 0.66 for medium-quality grassland, and 0.33 for low-quality grassland
	Material capital (M)	Per capita property value (M1)	Per capita property value (yuan/person)
		Per capita value of means of production (M2)	Per capita value of means of production (yuan/person)
		number of livestock (M3)	1 for yak, 0.8 for cattle/yellow cattle, 0.2 for sheep/goats, and 1.2 for horses
		Family annual income (F1)	Per capita annual income (Yuan-1 year <sup>-1</sup> person <sup>-1</sup> )
	Financial capital (F)	Credit capacity(F2)	0.25 for great difficulty in obtaining a loan, 0.5 for medium difficulty, 1 for low difficulty
		possibility that relatives and friends can provide help (S1)	0.25 for great difficulty in receiving help, 0.5 for medium difficulty, 1 for low difficulty
	Social capital (S)	Availability of government policy support (S2)	0.25 for great difficulty in receiving support, 0.5 for medium difficulty, 1 for low difficulty
		manual grassl planting (A1)	Proportion of farmers and herdsmen with manual grass planting
	Response to grassland degradation and livestock death	Mowing (A2)	Proportion of farmers and herdsmen mowing in the wild for reserves
		Grassland rental (A3)	Proportion of farmers and herdsmen renting others' grassland
		Purchase of forage grass and fodder (A4)	Expenses for farmers and herdsmen to purchase forage grass and fodder
		Purchase of veterinary medicine (A5)	Farmers and herdsmen who understand the principles of livestock diseases and its expenses
Adaptability (A)	Response to resource collection	Go to other places to collect resources (A6)	Proportion of farmers and herdsmen households who go to other places to collect resources
		Village rules and folk agreements	Proportion of farmers and herdsmen households who deemed village rules and folk agreements as valid



Response to grain production reduction	Seeds (A8)	Proportion of farmers and herdsmen households who purchase improved seeds
	Fertilizer (A9)	Proportion of farmers and herdsmen households who purchase chemical fertilizers
	Pesticides (A10)	Proportion of farmers and herdsmen households who buy pesticides
Livelihood diversity	Livelihood diversity of farmers and herdsmen (A11)	Different types of livelihoods for farmers and herdsmen households
Seeking help	Possibility of help from relatives and friends (A12)	The degree of difficulty in receiving help is assessed by the farmer independently and handled in a standardized manner
	Availability of government policy support (A13)	The degree of difficulty in receiving help is assessed by the farmer independently and handled in a standardized manner

DATA PROCESSING AND MODEL

Data standardization

Since the acquired survey data has different orders of magnitude and different dimensions, the research uses positive range standardization method for data standardization<sup>[24]</sup>. The formula is:

$$Y'_{ij} = (Y_{ij} - Y_{\min}) / (Y_{\max} - Y_{\min})$$

$Y_{ij}$  is the quantified value of the  $j$ -th index of the  $i$ -th sample, and  $Y'_{ij}$  is the standardized variable value of the  $j$ -th index of the  $i$ -th sample.

Index weights of the livelihood vulnerability index system for farmers and herdsmen

To prevent index subjectivity when artificially determining the weights and avoid repeated calculation of index information, this paper adopts entropy method to determine each index weight, so that the index weight has a high degree of reliability. During sample data extraction, the higher the data dispersion, the lower the entropy value and the greater the information amount. As a result, impact on the index system is greater, and the weight is higher<sup>[25]</sup>. The calculation results are as follows:

The formula for calculating the livelihood risk of farmers and herdsmen:

$$R=0.2132R_1+0.2733 R_2+0.2106 R_3+0.0972$$

$$R_4+0.1621 R_5+0.0436 R_6$$

The formula for calculating the livelihood capital of farmers and herdsmen:

$$L=0.122H1+0.1381H2+0.0556N1+0.0612$$

$$N2+0.0201 N3+0.0377$$

$$N4+0.0605M1+0.0907M2+0.0872M3+0.0892F1+0.0691F2+0.0927S1+0.0759S2$$

The formula for calculating the livelihood adaptability of farmers and herdsmen:

$$A=0.0322A_1+0.0294A_2+0.0347A_3+0.0373A_4+0.0341A_5+0.0764A_6+0.0897A_7+0.0632A_8+0.0592A_9+0.0601A_{10}+0.2331A_{11}+0.1582A_{12}+0.0924A_{13}$$

Livelihood vulnerability calculation model for farmers and herdsmen

The paper uses a comprehensive index evaluation model to calculate the livelihood vulnerability index (P) of farmers and herdsmen in northern Tibet. The specific calculation formula is:

$$P=R-(L+A)$$

The livelihood vulnerability index (P) of farmers and herdsmen is not measured by absolute values, but just ranks the livelihood

vulnerability of the sample farmers and herdsmen households. Negative index does not mean that the farmers and herdsmen's livelihoods are not vulnerable. The bigger the index (P) value, the more vulnerable the livelihoods of farmers and herdsmen.

### Classification of livelihood vulnerability of farmers and herdsmen

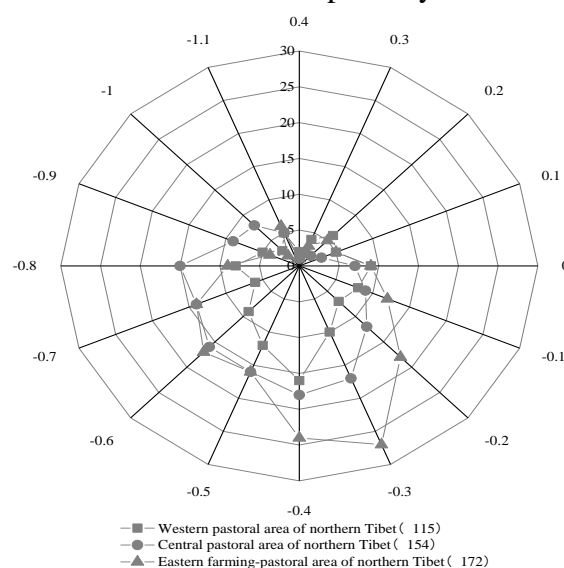
The paper mainly analyzes the livelihood risk, livelihood capital and adaptability of farmers and herdsmen households to explore the differences in different vulnerable households. Clustering method is used to divide farmers and herdsmen households in northern Tibet into high-vulnerability households and low-vulnerability households. Moreover, T test is performed on the sample <sup>26</sup>.

## RESULTS AND ANALYSIS

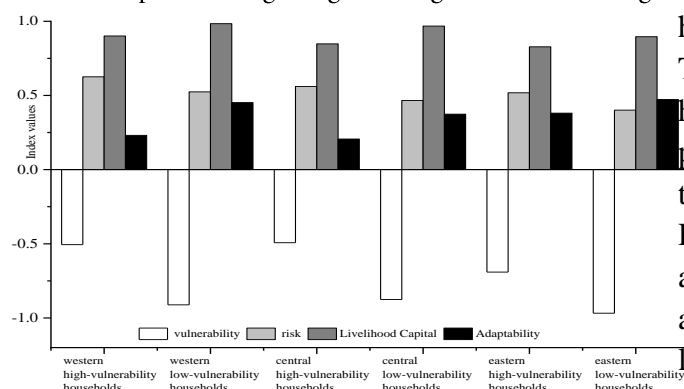
### Vulnerability classification of household livelihoods for farmers and herdsmen in northern Tibet

The household livelihood vulnerability of farmers and herdsmen in northern Tibet is -1.091-0.412 in the western pastoral area, -1.081-0.406 in the central pastoral area, and -1.097-0.401 in the eastern farming-pastoral area. The bigger the value, the higher the vulnerability of household livelihood. The livelihood frequency of farmers and herdsmen households is shown in Fig. 2. The higher the index, the lower the number of samples. The 115 household samples in the western pastoral area of northern Tibet are divided into high-vulnerability farmers and herdsmen households (51 households) and low-vulnerability farmers and herdsmen households (64 households), accounting for 44.35% and 55.65% of the total sample households in the western pastoral areas of northern Tibet, respectively. The 154 household samples in the central pastoral area of northern Tibet are divided

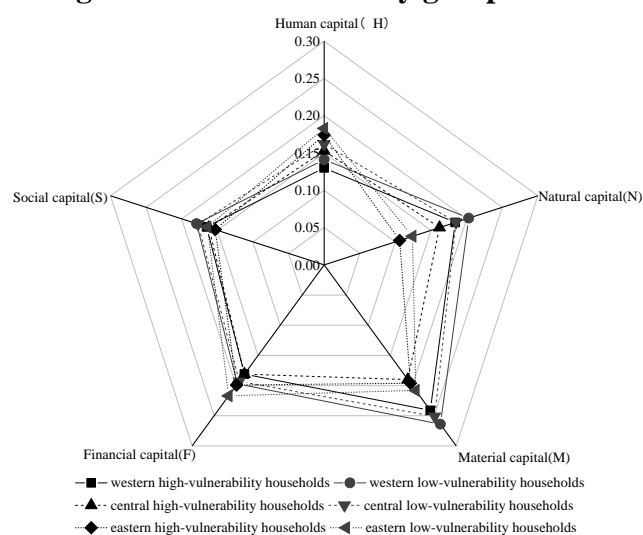
into high-vulnerability farmers and herdsmen households (53 households) and low-vulnerability farmers and herdsmen households (101 households), accounting for 34.41% and 65.59% of the total household samples in central pastoral areas of northern Tibet, respectively. The 172 household samples in the eastern farming-pastoral areas of northern Tibet is divided into high-vulnerability farmers and herdsmen households (56 households) and low-vulnerability farmers and herdsmen households (116 households), respectively, accounting for 32.55% and 67.45% of the total household samples in eastern farming-pastoral areas of northern Tibet. According to Figures 3 and 4, households with high livelihood vulnerability in the entire northern Tibet have higher livelihood risks, low livelihood capital and low livelihood adaptability.



**Fig. 2 Frequency distribution Radar map of the livelihood vulnerability index**



**Fig.3 Comparison of the values of risk, livelihood assets, adaptive capacity and livelihood vulnerability index between the high- and low-vulnerability groups**



**Fig.4 Comparison of the values of five livelihood assets between the high- and low-vulnerability groups**

### The Dimensional Difference in Livelihood Vulnerability of Farmers and Herdsmen Households in Northern Tibet

#### Family Risk

Farmers and herdsmen households in northern Tibet exhibit significant differences in the four indexes of grassland degradation, collection resource degradation, grain production reduction, and abnormal livestock loss. The average values of perceived grassland degradation are 0.72 and 0.58 respectively for high-vulnerability and low-vulnerability farmers and herdsmen

households in western pastoral areas of northern Tibet. As western pastoral areas of northern Tibet have extremely low collection resource and grain plantation ratio, the survey was not conducted in the western pastoral areas of northern Tibet. High-vulnerability and low-vulnerability farmers and herdsmen households in the western pastoral areas of northern Tibet have abnormal livestock loss rates of 11% and 5%, respectively. The high-vulnerability and low-vulnerability farmers and herdsmen in the central pastoral areas of northern Tibet have average values of 0.69 and 0.53 respectively in perceived grassland degradation. As central pastoral areas of northern Tibet has extremely low collection resource and food plantation ratio, this survey was not conducted in the central pastoral area of northern Tibet. High-vulnerability and low-vulnerability farmers and herdsmen households in the central pastoral area of northern Tibet have abnormal livestock loss rates of 9% and 4%, respectively. The high-vulnerability and low-vulnerability farmers and herdsmen households in the eastern farming-pastoral areas of northern Tibet have average values of 0.66 and 0.51 respectively in perceived grassland degradation; 47% and 33% households are aware of collection resource degradation, respectively, the food production reduction rates are 11% and 5%, and the rates of abnormal livestock loss are 7% and 3%, respectively. According to data analysis, high-vulnerability farmers and herdsmen household in northern Tibet generally face higher natural risks. At the same time, farmers and herdsmen households are more dependent on natural resources such as grasslands, arable land, livestock, and natural collections. There is no significant difference in medical expenses between high-vulnerability and low-vulnerability farmers and herdsmen households in the western pastoral areas, central pastoral areas, and eastern farming-pastoral areas of northern Tibet.

However, high-vulnerability farmers and herdsmen households generally have higher medical expenses than low-vulnerability farmers and herdsmen households. High altitude heart disease, arthritis, rheumatism and gastrointestinal diseases are more common in farmers and herdsmen households in northern Tibet. The illnesses of family members will directly increase the vulnerability of household livelihood. However, in recent years, as the tobacco consumption of farmers and herdsmen has decreased year by year, the expenditure on related diseases has gradually decreased, whether it is in high-vulnerability farmers and herdsmen families or low-vulnerability farmers and herdsmen families. In terms of loan (non-bank loans), there is no significant difference between the high-vulnerability and the low-vulnerability farmers and herdsmen households in the western pastoral areas, central pastoral areas, and eastern farming-pastoral areas of northern Tibet, but high-vulnerability farmers and herdsmen households generally have higher loan (non-bank loan) than low-vulnerability farmers and herdsmen households, and loan (non-bank loan) exacerbates the vulnerability of farmers and herdsmen's livelihoods <sup>[27]</sup>.

### Livelihood assets

In the western pastoral area, central pastoral area, and eastern farming-pastoral area of northern Tibet, high-vulnerability and low-vulnerability farmers and herdsmen households show significant differences in the 13 indexes of the number of household labor force, labor education level, per capita arable land area, per capita grassland area, arable land quality, grassland quality, per capita property value, per capita value of means of production, number of livestock, annual household income, credit capacity, possibility of help from relatives and friends, and availability of government policy support (Tab. 1 ).

### (1) Human capital

The education level and professional skill level of the labor force directly affects the family income level and livelihood diversity, leading to significant livelihood differences between different types of households (Fig. 5). Regardless of western pastoral areas, central pastoral areas, and eastern farming-pastoral areas in northern Tibet, high-vulnerability farmers and herdsmen households have significantly shorter education years than low-vulnerability farmers and herdsmen households, and the illiteracy rate is also higher. At the same time, members of high-vulnerability farmers and herdsmen households possess much fewer skills than low-vulnerability farmers and herdsmen households. In addition, the former also has much higher dependency ratio than the latter.

### (2) Natural capital

Since northern Tibet is a traditional agriculture and animal husbandry area, the livelihood of farmers and herdsmen still depends on agriculture and animal husbandry production. Therefore, the magnitude of natural resources directly determines the household income of farmers and herdsmen. Regardless of western pastoral areas, central pastoral areas and eastern farming-pastoral areas of northern Tibet, high-vulnerability farmers and herdsmen households have lower per capita arable land area, per capita grassland area, arable land quality, and grassland quality than low-vulnerability farmers and herdsmen households.

### (3) Material capital

High-vulnerability farmers and herdsmen households generally have fewer means of production than low-vulnerability farmers and herdsmen households. More means of production can better serve production activities. The local government will provide high housing subsidies

to farmers and herdsmen who build houses. Therefore, there is basically no difference in property value between high-vulnerability and low-vulnerability farmers and herdsmen households. High-vulnerability and low-vulnerability farmers and herdsmen households are not much different in the number of livestock in eastern farming-pastoral areas, but certain differences existing the western pastoral areas and the central pastoral areas. The sample data indicates that high-vulnerability farmers and herdsmen households have much lower rate of livestock take-off than low-vulnerability farmers and herdsmen households.

#### (4) Financial capital

High-vulnerability farmers and herdsmen households have much lower per capita cash income than low-vulnerability farmers and herdsmen households, which is largely related to the smaller livelihood diversity and lower rate of livestock take-off of high-vulnerability farmers and herdsmen households. At the same time, high-vulnerability households generally have more difficulty in obtaining loans than low-vulnerability households. Loans include loans from relatives and bank loans.

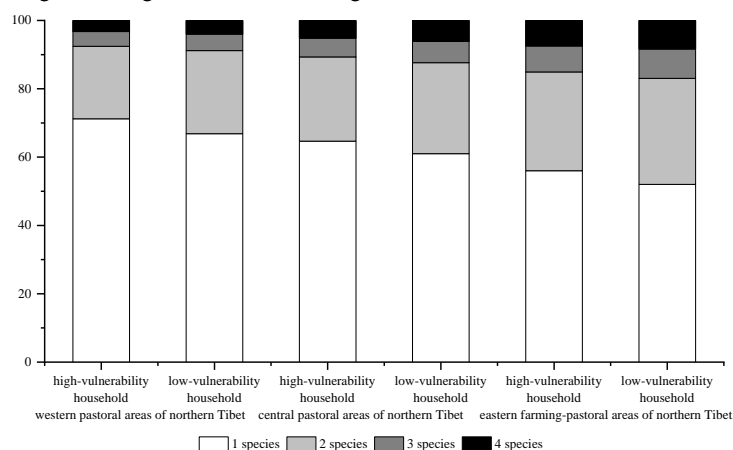
#### (5) Social capital

High-vulnerability farmers and herdsmen households generally have shorter education years than low-vulnerability farmers and herdsmen households. Therefore, the availability of policy support is also lower for high-vulnerability farmers and herdsmen households. High-vulnerability and low-vulnerability farmers and herdsmen

households have little difference in receiving help from relatives and friends.

### Adaptability

Farmers and herdsmen households in northern Tibet take quite different measures to cope with grassland degradation, livestock deaths, collection resource degradation and food production reduction. Low-vulnerability farmers and herdsmen households actively cope with livelihood risks by manually planting grass, mowing, renting grassland, purchasing forage grass, collecting resources from other places, purchasing veterinary medicines, and speeding up rate of livestock take-off. However, relatively few measures are taken by high-vulnerability farmers and herdsmen households. This has a greater relationship with family income status, cognitive status, and the actual difficulties faced by the family. At the same time, low-vulnerability households engage in more livelihood activities, which can effectively reduce livelihood risks. Seeking external support can also effectively reduce livelihood risks. The external support available for farmers and herdsmen households in northern Tibet mainly include: help from relatives and friends, government policy support. In terms of relatives and friends' help, high-vulnerability and low-vulnerability farmers and herdsmen households show no significant difference, but big differences are shown in government policy support. This is mainly because low-vulnerability farmers and herdsmen households have more types of livelihood activities. At present, most government policy support is provided mainly in the form of project support<sup>28</sup>.



**Fig. 5 Comparison of the number of livelihood activities between the high- and low-vulnerability groups**

## DISCUSSION AND ANALYSIS

Studies have shown that high-vulnerability farmers and herdsmen households generally have high livelihood risks, fewer livelihood assets, and weak livelihood adaptability, while low-vulnerability farmers and herdsmen households have lower livelihood risks, more livelihood assets, and stronger livelihood adaptability. This is consistent with the research results of many scholars at home and abroad. LI Xiaoyun<sup>29</sup> et al. believe that high-vulnerability farmers and herdsmen households generally lack a variety of livelihood capital. In his study on livelihoods of Tibetan farmers and herdsmen, HAO Wenyan<sup>30</sup> et al. believe that improvement in single livelihood capital is insufficient to ensure sustainable livelihood of farmers and herdsmen households. With higher stock of human capital and financial capital, farmers and herdsmen households are more willing to engage in non-agricultural industries. With higher stock of natural capital and material capital, farmers and herdsmen households are unwilling to give up agricultural livelihoods.

Seen from the perspective of vulnerability, livelihoods of farmers and herdsmen involve a dynamic process. The method adopted herein classifies northern Tibet according to the

livelihood types of farmers and herdsmen, so as to help farmers and herdsmen households via policies. In the future, time series research can be used to dynamically assess the vulnerability characteristics of farmers and herdsmen households. In addition, it is also a future research trend to combine remote sensing technology and micro-scale research to dynamically assess the livelihood vulnerability of farmers and herdsmen households.

To improve livelihood sustainability and adaptability of farmers and herdsmen households in the high-frigid ecological vulnerable region of northern Tibet, and reduce their livelihood vulnerability, the local government has also taken several measures, but there are still some problems demanding solution. The following suggestions are put forward based on the research results.

(1) Increase the stock of human capital of farmers and herdsmen households in the high-frigid ecological vulnerable areas of northern Tibet by popularizing education, training skills, and improving the basic medical conditions of farmers and herdsmen. In terms of education, focus on strengthening the investment in basic education facilities at the village and township level to increase the enrollment rate of school-age

children. In terms of skills training, non-agricultural employment training should be strengthened in a targeted manner based on the actual social development needs. In particular, increase on-agricultural employment training for young farmers and herdsman to increase the non-agricultural employability of farmers and herdsman. In terms of basic medical conditions, focus on building health infrastructure in township health centers, increase the level of medical care in township health centers, and solve the problem of remote medical care and difficulty in seeing a doctor for farmers and herdsman.<sup>31</sup> At the same time, it is possible to reduce the consumption of alcohol and tobacco by the farmers and herdsman through the publicity of the primary health system, and gradually reduce the expenditure of the farmers and herdsman on the consumption of alcohol and tobacco and medical expenses<sup>32-33</sup>.

(2) Strengthen the construction of communications, roads, and information networks in the vast agricultural and pastoral areas, direct farmers and herdsman to develop professional agricultural and animal husbandry cooperatives. Through the development of cooperatives, improve the degree of organization in agricultural and animal husbandry production, promote large-scale and brand-based operations, increase the number of marketable agricultural and livestock products, and increase the cash income of farmers and herdsman.

(3) Promote scale operation of land as appropriate, increase the income level of farmers and herdsman, and at the same time promote the transfer of employment of farmers and herdsman to secondary and tertiary industries, increase the diversity of off-farm and herdsman livelihoods, and reduce livelihood risks<sup>34-35</sup>.

In summary, the stock of livelihood capital of farmers and herdsman households directly affects their livelihood strategies, which in turn affects

the local ecological environment as livelihood strategies directly affect the use of local resources and the environment. In eco-environmental governance, we should start from the past single surface vegetation restoration and ecological afforestation, gradually guide farmers and herdsman households in terms of livelihood capital and livelihood strategies, which also enhances the ecological adaptability of farmers and herdsman households. In addition, we need further study the relationship between changes in the ecological environment and the livelihood strategies of farmers and herdsman, quantitatively study the impact of the ecological environment and the conversion of farmers and herdsman's household livelihoods, which is essential for lowering the pressure on the ecological environment and adjusting the livelihood strategies of farmers and herdsman.

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