



Determinants of Livelihood Strategy Choice Among Herder Households: Implications for Poverty Alleviation in Southwestern Iran

Authors: Soltani, Hazhir, Mahdavi, Seyedeh Khadijeh, Abdollahzadeh, Gholamhossein, and Souri, Mahshid

Source: Mountain Research and Development, 44(4)

Published By: International Mountain Society

URL: <https://doi.org/10.1659/mrd.2024.00014>

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Determinants of Livelihood Strategy Choice Among Herder Households: Implications for Poverty Alleviation in Southwestern Iran

Hazhir Soltani¹, Seyedeh Khadijeh Mahdavi¹, Gholamhossein Abdollahzadeh², and Mahshid Souri³

* Corresponding author: abdollahzade1@gmail.com, abdollahzd@gau.ac.ir

¹ Islamic Azad University, Nour Branch, Department of Natural Resource, PO Box 4641859557, Nour, Iran

² Gorgan University of Agricultural Sciences and Natural Resources, Department of Agricultural Extension and Education, PO Box 4918943464, Gorgan, Iran

³ Agricultural Research, Education and Extension Organization (AREEO), Research Institute of Forests and Rangelands, Rangeland Research Division, PO Box 1496793612, Tehran, Iran

© 2024 Soltani et al. This open access article is licensed under a Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>). Please credit the authors and the full source.



Understanding the diverse livelihood strategies of herder households, as well as the factors that shape these strategies, is crucial for advancing sustainable development in pastoral areas

and combating rural poverty. This study aims to assess the livelihood strategies employed by herder households, categorize the diverse types of household livelihood strategies, and elucidate the asset factors that influence households' choices of livelihood strategies. Data were collected from a sample comprising 136 herder households, selected through a random sampling method from 7 villages situated within the traditional pasture territory of southwestern Iran. Using a 2-step cluster analysis based on the share of household income, 2 distinct livelihood strategies were recognized: income originating from farm animal-related products and activities (Cluster 1) and diversified livelihoods strategies (Cluster 2). The findings indicated that a majority of households (58.82%) relied exclusively on livestock-related products and activities for their income. Households possessing greater

rangeland and farmland as indicators of natural capital ($\beta = 5.184$, $P = 0.004$) as well as those with more livestock, which serves as physical capital ($\beta = 2.914$, $P = 0.042$), demonstrated a heightened likelihood of adopting livelihood strategies centered on livestock-related products and activities. Conversely, households with higher levels of education indicative of human capital ($\beta = -2.770$, $P = 0.027$) were less inclined to pursue this type of livelihood strategy. The study highlights the prevalence of impoverished households in 2 livelihood strategy clusters, with a notably higher percentage of extremely poor herder households identified in Cluster 1 (27.5%) than Cluster 2 (10.7%). The findings suggest that the government should consider implementing measures to transition nonfarm animal-related products and activities into a sustainable livelihood option. Furthermore, it is recommended that policies supporting diversified livelihood strategies take precedence in efforts to break the cycle of poverty.

Keywords: livelihood assets; livelihood outcome; income diversification; poverty alleviation; herder community.

Received: 23 April 2024 **Accepted:** 16 September 2024

Introduction

Rangelands play a crucial role in conserving water, soil, and genetic resources through their diverse ecosystem services (Havstad et al 2007; Archer 2010; Azevedo et al 2021; Waterhouse et al 2024). Additionally, rangelands play a crucial role in supporting livelihoods, particularly for pastoral communities, by serving as a vital resource and facilitating various economic activities, such as animal husbandry, nomadic herding, and informal mining (Martin 2013; Lahiri-Dutt and Dondov 2017). These ecosystems offer essential grazing land for livestock, a primary source of income for many pastoralists globally (Ykhanbai et al 2004; Mwangi 2017). Beyond sustenance and financial gain, livestock reared on rangelands hold significant cultural and social value within pastoral communities (Tilahun et al 2016).

The burgeoning population has heightened pastoralists' reliance on pastures, exacerbating pasture degradation,

particularly in light of reduced rainfall in recent years, impacting the welfare of herding families negatively (Teng et al 2020; Wang et al 2021). Recognizing the urgency of this issue, several governments, including those of China (Li and Liu 2023) and Mongolia (Gombodorj 2021), have implemented strategies aimed at promoting income diversification among herder households. These initiatives are designed to alleviate pressure on pastures and enhance the livelihoods of herders. Notably, Iran stands out as one of the countries spearheading these concerted efforts (Riahi et al 2012; Soltani et al 2012; Norouzi and Mahmoudian 2016). In Iran, pastures, spanning over 50% of the nation's land and housing approximately 8000 plant species, directly sustain the livelihoods of 169,000 herder households (Rigi et al 2019). A confluence of factors, including dwindling pasturelands and declining interest in livestock husbandry among the younger generation (Tiwari et al 2020), exerts significant livelihood pressures on herder households (Fratkin and Mearns 2003). Despite

regional variations, these evolving trends collectively undermine livestock mobility in pastures, jeopardizing both pasture viability and herder livelihoods (Harris 2010; Tiwari et al 2020).

In response, the Iranian government has introduced a range of initiatives aimed at encouraging herder households to move from a nomadic lifestyle to settled living in rural areas, with the goal of diversifying their livelihood strategies (Riahi et al 2012). Historically, the forced resettlement of nomads in Iran has a long-standing legacy, originating in the 17th and 18th centuries, when rulers employed this strategy as a means to punish opponents and control dissenting subjects (Perry 1975). These policies were implemented without regard for the nomads' rights, history, infrastructure, or livelihood strategies, resulting in a dramatic decline in the nomadic population—from approximately 25% of Iran's total population a century ago to just 1.7% by 2008 (Annamoradnejad and Lotfi 2010). In recent decades, the government has implemented various measures, including the provision of low-interest loans, subsidies for livestock inputs and fuel, nomadic insurance, and veterinary services, to encourage nomadic households to diversify their livelihood strategies (Norouzi and Mahmoudian 2016). Recently, Iran's Natural Resources and Watershed Organization has begun supporting nomadic communities through a new framework.

However, the effect of these measures on the adoption of diversified livelihood strategies remains unclear. Notably, the Chaghakhor region in Chaharmahal and Bakhtiari Province, a historically significant area for nomadic and herding lifestyles, has witnessed substantial efforts to resettle herder households in rural settlements and shift their livelihood focus from livestock dependence to alternative strategies (Soltani et al 2012). While extensive research exists on the correlation between household livelihood capitals and strategies (Hua et al 2017; Paudel Khatiwada et al 2017; Peng et al 2017; Dehghani Pour et al 2018; Ding et al 2018), studies examining the interplay between livelihood diversification strategies among herder households, their different forms of livelihood capital, and the resulting impacts on poverty reduction are notably limited in empirical investigations in Iran. This research aims to fill this gap by addressing these critical relationships and implications within the context of Iranian herding communities.

Materials and methods

Study area

The Chaghakhor watershed, spanning 70.07 km², is located in Iran's Chaharmahal and Bakhtiari Province, around 25 km northeast of Shahrekord city, the province center (Figure 1). Geographically, this region is situated at an elevation of 2270 masl, with geographical coordinates ranging from 31°54'17"N to 31°56'31"N and 50°52'40"E to 50°56'14"E (Ebrahimi and Moshari 2006). The area receives an average annual precipitation of 400 mm, with winter contributing a significant 47.7% (approximately 255 mm), which is crucial for local agriculture. The long-term average temperature is 9.5°C, peaking at 26.1°C. According to De Martonne's method, the climate is classified as semiarid and

arid (Jafarpour et al 2023). In this region, the predominant floral species is *Quercus brantii*, accompanied by several dominant plant species within the *Astragalus* genus, as well as *Cirsium bracteosum* and *Cirsium vulgare*. The total forested area within the province encompasses approximately 300,000 ha, featuring tree species such as Persian oak (*Quercus brantii*), wild pistachio (*Pistacia atlantica*), ash (*Fraxinus* spp.), and juniper (*Juniperus* spp.). However, the Chaghakhor watershed lacks any forested areas, limiting herders' access to forested pastures. The total area of the Chaghakhor watershed is 6679 ha, of which 5381 ha are designated as suitable pastures for grazing. These pastures can support a grazing capacity of only 2200 animal units for a duration of 100 days.

Herding and farming represent 2 fundamental aspects of human connection with nature in this region. Livestock raising, particularly of sheep and goats, constitutes a primary livelihood, with herding practices rooted in traditional communal pasture management. Herding households generate revenue through the sale of milk, cheese, and other dairy products, as well as wool and other fiber products, which are sold in local markets. The wool and hair produced are also used in traditional crafts. Furthermore, herders supplement their income each year by selling male lambs. In addition to livestock farming, agriculture also plays a critical role in the region's economy. Agricultural practices include both rainfed and irrigated farming, with key crops comprising wheat, barley, lentils, safflower, and various fodder plants. Further information about the local context is provided in Appendix S1 (*Supplemental material*, <https://doi.org/10.1659/mrd.2024.00014.S1>).

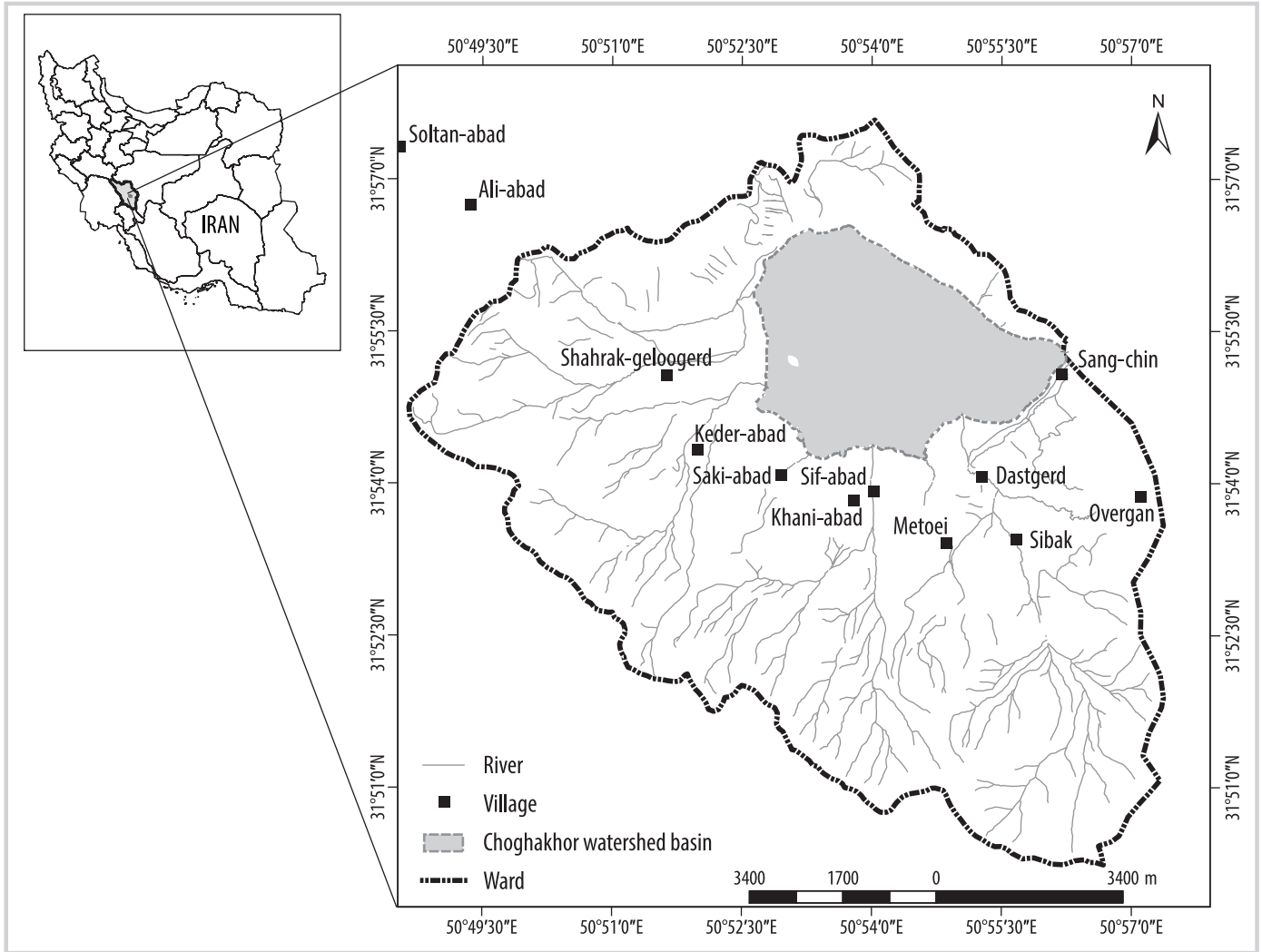
The sustainable livelihoods framework

Assessing the sustainability of impoverished individuals' livelihoods often involves the application of the sustainable livelihoods framework (SLF) (Scoones 1998; Carney 1999), a tool widely used in diverse studies on rural livelihoods (Xu et al 2015; Hua et al 2017; Paudel Khatiwada et al 2017; Dehghani Pour et al 2018; Ding et al 2018; Wang et al 2021). In this study, we focus on 3 specific facets of the framework: livelihood capitals, livelihood strategies, and livelihood outcomes, as depicted in Figure 2. The SLF distinguishes between 5 types of livelihood capital: human, physical, financial, natural, and social capital (DFID 1999; Ellis 2000). Given that a household's selection of a specific livelihood strategy is influenced by its livelihood capitals (Carney 1998; Scoones 1998; Fang et al 2014), we consider households' livelihood capitals as pivotal factors guiding livelihood choices. Further, we regard higher income levels, the proportion of extremely impoverished households, and the extent of income diversification as key indicators signaling improved welfare outcomes and poverty reduction. For more details about the theory underpinning this study, see Appendix S2 (*Supplemental material*, <https://doi.org/10.1659/mrd.2024.00014.S1>).

Sampling and survey

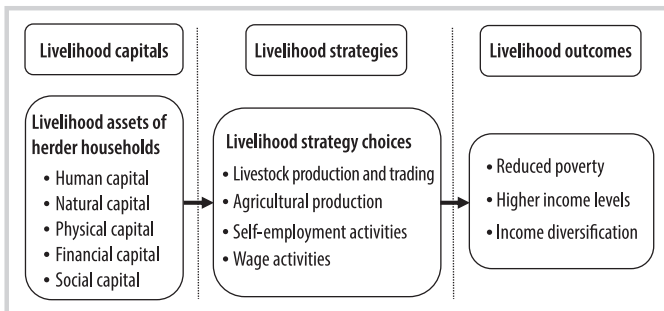
The study's target population encompassed all heads of herder households in the Chaghakhor watershed. As per the Directorate of Nomadic Affairs, Chaharmahal and Bakhtiari Province (DNACBP) 2022 data, the survey area comprised a

FIGURE 1 Geographical location of Choghakhor watershed in Iran. (Map by Hazhir Soltani)



total of 6900 households. To establish a robust sampling framework, a comprehensive list of villages hosting herder households was acquired from the DNACBP. Subsequently, 7 villages, representing over 50% of the total herder households, were selected for inclusion in the study. Herder households were then randomly chosen within these 7 villages to ensure a representative sample. To account for potential nonresponses, additional participants were invited to participate, ultimately leading to the inclusion of 136

FIGURE 2 A framework for selecting livelihood strategies among herder households, adapted from DFID (1999) and Carney (1998).



households in the final dataset after excluding incomplete questionnaires. Data collection commenced in February 2022 and extended through August 2022, with local trained personnel conducting face-to-face interviews at the tent site of each household. Interviews were conducted with household heads or their substitutes, all of whom were men. On average, each questionnaire required 45 to 60 minutes for completion. During the data collection phase, 2 people from the research team supervised the interviews, checked the questionnaires received for accuracy, and ensured data integrity.

The research employed a quantitative methodology to collect cross-sectional data through questionnaires comprising 3 sections: (1) personal and demographic variables, (2) 10 common sources of households' income, and (3) a question to measure proxy indicators of the 5 forms of livelihood capital. Proxy indicators of each form of capital were determined according to the SLF outlined by the UK Department for International Development (DFID 1999), as well as insights from previous studies (Hua et al 2017; Paudel Khatiwada et al 2017; Dehghani Pour et al 2018; Ding et al 2018; Wang et al 2021), and socioeconomic features of the study region. See Appendix S3 (*Supplemental*

material, <https://doi.org/10.1659/mrd.2024.00014.S1>) for more details on the sample size and questionnaire development.

Data analysis

Classifying the sources of household income: This study employed the 2-step cluster method to classify herder households into separate livelihood strategy categories based on the proportion of household income from each source. These clusters were assigned unique names according to the average proportion of income derived from different sources. Variations in income distribution among the different livelihood strategies were examined using the independent sample *t*-test. Additionally, we used Simpson's index to assess the level of income diversification within 2 separate clusters of livelihood strategies (Simpson 1949). The computation of the household income diversification index followed the formula employed by Chilongo (2014).

Measuring livelihood capital: Assets were measured in a structured process comprising 2 distinct steps. First, we standardized the indicators, transforming the original data to a range of [0–1]. Then the indicators were weighted using Shannon entropy (Lotfi and Fallahnejad 2010).

Assessing the influence of livelihood capitals: Finally, we used binary logistic regression to analyze the influence of the different forms of livelihood capital (predictors) on selection of the 2 livelihood strategy clusters (dependent variable) identified using the 2-step clustering technique.

More information about the data analysis methods used is given in Appendix S3 (*Supplemental material*, <https://doi.org/10.1659/mrd.2024.00014.S1>).

Results

Classifying the sources of household income

Building on previous research (Ellis 2000; Paudel Khatiwada et al 2017), our analysis identified 10 key income sources that play a crucial role in evaluating income diversification. Households were classified into 2 distinct categories based on their sources of income, as illustrated in Table 1: (1) herders who relied mainly on earnings from products and activities related to farm animals, and (2) those who pursued diversified livelihoods strategies.

Analysis of income sources in clusters

Table 1 presents a comprehensive breakdown of income sources among the respondents in Cluster 1 and Cluster 2. The columns present the average of the respondents' total income, expressed in US dollars, categorized by each of the 10 income sources. Additionally, the percentage column, provided separately for each cluster, indicates the proportion of respondents' income derived from each income source. Notably, 62.24% of the income of respondents in Cluster 1 is derived from the sale of live animals, highlighting a predominant reliance on this source. In contrast, the corresponding ratio for Cluster 2 is notably lower at 6.82%, indicating a different economic focus within this cluster. Moreover, in Cluster 2, a significant portion of income is derived from diverse economic activities. Specifically, agricultural activities contribute 35.77% of the income, followed by the collection of medicinal plants (15.99%), wage

activities (10.88%), and retail sales (9.99%). This multifaceted income structure in Cluster 2 underscores a greater variety of sources compared to Cluster 1, reflecting a more diversified income portfolio and highlighting distinct economic strategies within the 2 clusters.

Comparative analysis of average incomes across income sources

The *t*-test analyses comparing the average income between the 2 clusters across different income sources indicates a significant disparity in income levels (Table 1). Focusing on the initial 4 income sources, which predominantly revolve around earnings from livestock-related products and activities, Cluster 1 consistently outperformed Cluster 2 in terms of average values. Livestock sales, trading in livestock products, sale of poultry products, and beekeeping and honey sales underscored Cluster 1's emphasis on livestock-based livelihoods, evident through significantly higher mean values in comparison to Cluster 2. In contrast, the subsequent 6 strategies encompassing diverse income sources, such as agriculture, handicrafts, medicinal plant gathering, wage activities, receiving allowances, and retail ventures, showed a divergent trend. Cluster 2 exhibited higher average values across these varied income streams, signifying a more diverse economic portfolio and a stronger inclination toward engaging in a multitude of income-generating activities.

Comparative analysis of income diversity

Table 1 also compares Cluster 1 and Cluster 2 based on the average daily income per individual, Simpson's diversity index, and frequency and percentage of households in each cluster (Table 1). Notably, there was a significant difference highlighted by the *t*-test results for the Simpson's diversity index ($P < 0.05$), indicating differing levels of income diversity between the 2 clusters. Among the 2 clusters of livelihood strategies, the findings demonstrate a prevalence of impoverished households, with a higher proportion of herder households categorized as extremely poor in Cluster 2, involving herders engaged in diversified livelihood activities (27.50%), as opposed to Cluster 1, where they primarily rely on income from farm animal-related products and activities (10.70%).

Evaluation of herder livelihood capitals and their indicators

Table 2 presents the diverse forms of capital and corresponding indicators used in assessing the livelihood assets of herder households. Each type of capital—natural, physical, financial, human, and social—is defined through specific indicators with respective weights assigned for analysis.

As shown in Table 2, an important measure in the context of natural capital is the per capita ownership of rangeland, which was assigned a weight of 0.422. Its average for Cluster 1 (153.98 hectares) is lower than that of Cluster 2 (187.28 hectares). Within the physical capital category, the estimated total value of livestock owned, with a weight of 0.584, emerged as a crucial metric. Cluster 2 demonstrates a significantly higher average value (US\$ 28,243.81) compared to Cluster 1 (US\$ 22,633.11), indicating stronger economic assets among households in

TABLE 1 Assessing the distribution of income, diversity levels, and the intensity of poverty within clusters of livelihood strategies.

Livelihood strategy	Total income		Cluster 1			Cluster 2			t-test
	Mean	SD	%	Mean	SD	%	Mean	SD	
Live livestock sales	5722.93	6862.99	62.24	9196.41	6950.24	6.82	760.82	1899.09	10.32**
Trade in livestock products, including dairy products, meat, oil, skin, wool, and manure	542.04	422.66	11.93	689.23	458.98	4.84	331.77	243.64	5.88**
Sale of poultry products, including meat and eggs	228.41	200.01	4.49	284.21	260.67	3.92	189.35	131.53	2.51*
Beekeeping and honey sales	559.38	430.58	13.26	637.64	456.59	6.24	447.59	366.06	2.58**
Agricultural and horticultural product sales	1395.68	2020.48	1.93	109.21	264.31	35.77	3233.50	2018.33	-11.51**
Handicraft sales, such as carpets and rugs	53.07	60.75	0.47	21.99	23.90	1.42	97.48	69.46	-7.82**
Gathering and sale of medicinal plants	505.90	646.36	1.16	47.01	50.62	15.99	1161.46	527.17	-15.79**
Wage activities, such as laboring or shepherding	380.49	426.72	2.59	89.33	92.48	10.88	796.43	367.71	-14.08**
Receiving allowances from welfare organizations or other governmental support agencies	129.77	133.28	0.49	23.66	29.30	4.13	281.36	50.91	-34.13**
Retail shop activities	310.10	332.38	1.44	57.80	79.19	9.99	670.52	193.15	-22.45**
Average daily income per person	5.28	4.05		5.78	4.14		4.57	3.82	1.75 ^{ns}
Simpson's diversity index	0.627	0.080		0.365	0.209		0.726	0.078	-14.069*
Frequency and percentage of household in each cluster	136	100%		80	58.82%		56	41.18%	
Frequency and percentage of extremely poor households ^{a)}				6	10.70%		22	27.50%	

Note: The unit for all income sources is expressed in US dollars (US\$). The assumption of equal variance is not made in any of the comparisons.

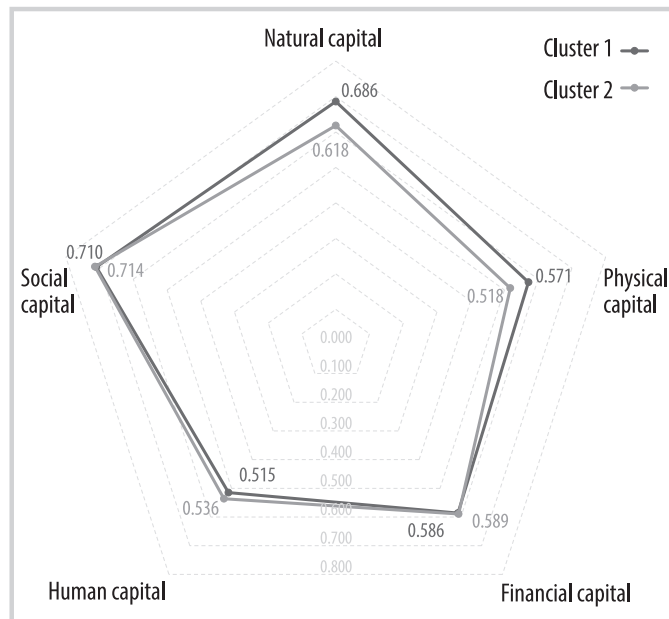
^{a)} The percentage of households living below the poverty line of US\$ 1.9 per capita per day, as determined by the World Bank (Jolliffe and Prydz 2016).

* $P < 0.05$; ** $P < 0.01$; ns, not significant.

TABLE 2 Description of the assessment measures for the livelihood capitals of herder households.

Type of capital	Indicator definition	Weight	Overall mean	Cluster 1 mean	Cluster 2 mean
Natural	Amount of rangeland owned per person, measured in hectares	0.422	173.57	153.98	187.28
	Amount of farmland owned per person, measured in hectares	0.242	13.93	13.23	14.43
	Agricultural production yield per hectare of land (in tons/hectare)	0.212	5.84	5.76	5.90
	Fodder production of pasture (in tons/hectare)	0.124	273.09	275.14	271.65
Physical	Estimated total value of livestock (such as poultry, sheep, cattle, or horses, etc) owned by the household (US\$)	0.584	25,933.52	22,633.11	28,243.81
	Estimated value of housing, yurts, tents, and barns owned by the household (US\$)	0.241	7836.56	7498.36	8073.30
	Estimated value of fixed assets owned by the household, including items such as cars, tractors, shops, motorcycles, power generators, water pumps, and water storage tanks (US\$)	0.175	2598.21	2569.96	2617.98
Financial	Cash income saved in a personal account (US\$)	0.517	36.85	36.82	36.87
	Sum of credit received by the household (US\$)	0.271	100.22	99.57	100.68
	Total subsidy received by the household (US\$)	0.212	295.37	305.09	288.56
Human	Average formal schooling of each family member (years)	0.322	11.19	9.75	12.20
	Labor capacity of the household, which represents the number of household members aged between 15 and 64 years	0.118	4.58	4.64	4.54
	Total number of courses, programs, and training sessions attended regarding livestock and agricultural business, as well as other income-generating enterprises	0.560	3.18	3.68	2.83
Social	Social participation encompassing the number of memberships in local organizations such as rural cooperatives, rural Islamic councils, farmer-based organizations, herders' organizations, and religious groups	0.305	4.23	4.23	4.23
	Social trust assessed by the average degree of trust across four groups, including family members, tribe members, tribe and village leaders, and local government officials (measured using 1–5 point Likert scale)	0.224	4.27	4.25	4.29
	Solidarity and social interaction assessed through the average scores of 6 ordinal items, which include consultation with local leaders and family members, financial assistance to tribe members and other relatives, lending of equipment, tools, and machines, cooperation in farm and livestock production-related activities, and participation in resolving intertribal disputes	0.471	3.29	3.34	3.26

FIGURE 3 Differences in livelihood capitals across 2 distinct livelihood strategies (the values range between 0 and 1).



Cluster 2. In terms of financial capital, the cash income saved in personal accounts is a key item, weighted at 0.517. The average for Cluster 1 is US\$ 36.82, while Cluster 2 is marginally higher at US\$ 36.87, illustrating a slight increase in savings capability for Cluster 2. For human capital, the average years of formal schooling, weighted 0.322, is a significant indicator, with Cluster 2 showing an average of 12.20 years, compared to 9.75 years in Cluster 1. This highlights the enhanced educational attainment in Cluster 2. Last, in the context of social capital, the number of memberships in local organizations, weighted at 0.305, is equal across both clusters at an average of 4.23. Through this analysis, it becomes evident that while Cluster 2 generally exhibits advantages in several factors of livelihood capitals, especially in ownership and financial indicators, Cluster 1 presents unique strengths in areas like training and social interaction, suggesting distinct paths for enhancing the livelihood assets of both clusters.

Comparative analysis of livelihood capital disparities in the 2 groups' livelihood strategies

As shown in Figure 3, Cluster 1 has a notably higher natural capital (0.686) and physical capital (0.571) compared to Cluster 2 (0.618 and 0.518, respectively). This signifies that households in Cluster 1 may possess more considerable environmental resources and better physical assets, which could support more intensive agricultural practices or resource extraction. While both clusters have similar financial capital values, with Cluster 1 at 0.586 and Cluster 2 at 0.589, Cluster 2 has a higher level of human capital at 0.536 compared to 0.515 in Cluster 1. This difference may indicate that households in Cluster 2 possess a higher level of skill development or education, potentially leading to diversified livelihood strategies beyond agriculture. Both clusters exhibit nearly equivalent social capital values, with Cluster 1 at 0.710 and Cluster 2 at 0.714. This suggests that social participation and community networks are consistently strong across both groups, potentially providing support and resources in their respective livelihood strategies. Overall, while Cluster 1 excels in natural and physical capital, indicative of a more resource-dependent livelihood strategy, Cluster 2 compensates with a relatively higher human capital, which may offer enhanced adaptability and diversification in their livelihood approaches.

The role of livelihood capitals in shaping livelihood strategies

Table 3 presents the results of the binary logistic regression analysis used to examine the determinants of livelihood strategy choice. The analysis examined the influence of the explanatory variables, including natural capital, physical capital, financial capital, human capital, and social capital, on the probability of selecting a particular livelihood strategy compared to a diversified livelihood strategy as the reference category. The results indicate significant associations between certain capital assets and the choice of livelihood strategy. Specifically, higher levels of natural capital ($\beta = 5.184, P = 0.004$) and physical capital ($\beta = 2.914, P = 0.042$) are linked to a significantly increased likelihood of opting for a livelihood strategy based on farm animal-related products and activities compared to the reference category of diversified livelihood strategies. In contrast, higher levels of human capital ($\beta = -2.770, P = 0.027$) show a negative association with choosing the farm

TABLE 3 Factors influencing livelihood strategy choice: multinomial logistic regression with diversified livelihood strategy as reference category.

Explanatory variable	β	SE	Wald	Sig	Exp(β)
Natural capital	5.184**	1.794	8.349	0.004	178.367
Physical capital	2.914*	1.434	4.129	0.042	18.430
Financial capital	0.119 ^{ns}	1.732	0.005	0.945	1.127
Human capital	-2.770*	1.256	4.866	0.027	0.063
Social capital	-0.326 ^{ns}	1.084	0.090	0.764	0.722
Constant	-2.905	2.158	1.813	0.178	0.055

Note: Hosmer and Lemeshow test (chi-square) = 14.45, df = 8, significance (Sig) = 0.071, -2 Log likelihood = 161.772; Cox and Snell $R^2 = 0.350$; Nagelkerke $R^2 = 0.406$; overall percentage of right predictions = 79.90%; sample size = 136 respondents.

* $P < 0.05$; ** $P < 0.01$; ns, not significant.

animal-related products and activities strategy. However, the analysis did not reveal any statistically significant impact of financial capital and social capital on decisions regarding the selection of livelihood strategies. The results of the various statistical tests (see table note) suggest that the model adequately captures the relationships within the data.

Discussion

Existing livelihood strategies of herder households

This study delineated 2 distinct clusters of livelihood strategies among herder households in the traditional pasture territory of central Iran: (1) income derived from farm animal-related products and activities and (2) diversified livelihoods. The findings underscore the prevailing reliance of herders on income generated from traditional livestock-based practices, with a discernible sluggishness in transitioning toward diversified income sources, notably agricultural production and other employment-generating activities. In line with these findings, Ding et al (2018) revealed that herder households outperformed nonlivestock households in terms of income, highlighting the prevalence of the continuous grazing livelihood strategy as the preferred option among herders in Inner Mongolia. A study conducted by Soltani et al (2012) in the rural areas of the Zagros Mountains, Iran, demonstrates that different livelihood strategies substantially influence household income. The study reveals a significant transition among households over time, moving from reliance on forest and livestock-based strategies to more diversified practices that include nonfarm and commercial activities. This shift is linked to enhanced income prospects and a reduction in poverty levels.

A majority of households (approximately 58.82%) showed limited diversification in engaging with nonlivestock strategies, such as farm and horticultural production and wage activities. These outcomes align with expectations, considering the inherent challenges associated with transitioning from livestock-dependent livelihoods to nonlivestock strategies. The hesitance among herder households to fully embrace settlement in rural areas due to their vested interest in pasture ownership poses a significant barrier to livelihood diversification and the alleviation of pressure on pastures (Liao et al 2015; Ding et al 2018). While the idea of settlement may offer opportunities for more stable livelihoods, it could also lead to increased concentration of human activities within limited areas, thereby intensifying stress on available pasture resources. Additionally, settling in rural areas does not necessarily entail the abandonment of livestock keeping; many households may continue to maintain their herding practices even while exploring supplementary livelihood options. Pastoral traditions deeply rooted in land ownership further complicate the shift toward alternative livelihood options, impeding progress toward sustainable economic practices (Kabubo-Mariara 2005). Prior research (Paudel Khatiwada et al 2017) has emphasized these challenges, highlighting the need for comprehensive support mechanisms to successfully facilitate the transition to diversified livelihood strategies. This involves improving the value chain of self-employment and entrepreneurial endeavors, and providing

consistent technical and educational support to help households shift toward nonlivestock livelihood options.

The rural livelihood centered on farm and garden production in the study area faces significant instability attributable to high production costs and insufficient productivity. Consequently, herding households exhibit minimal inclination to shift away from livestock-oriented livelihoods toward diversified income strategies. Moreover, previous studies (Karbasioun and Mulder 2004; Koocheki and Ghorbani 2005; Fami et al 2009; Sadati et al 2010) have revealed that traditional agricultural practices in many parts of Iran are executed by an aging, undereducated workforce, casting doubt on the long-term sustainability and profitability of agriculture as a viable livelihood pursuit in these regions. Governmental initiatives aimed at providing agricultural technical training have thus far fallen short in addressing the constraints inherent in current subsistence farming paradigms that hinder the attainment of sustainable livelihoods for herder households. In contrast, the allure of attractive financial incentives from live livestock buyers, food industry companies, and meat producers has bolstered the appeal of traditional animal husbandry practices, perpetuating the unsustainable exploitation of pastures. This ongoing dynamic underscores the urgent imperative to shift toward diversified and market-oriented livelihood strategies to safeguard pastoral livelihoods and preserve rangeland ecosystems effectively. While the gradual emergence of novel livelihood opportunities presents a glimmer of hope, particularly for households engaging in diversified production activities outside the realm of livestock farming (41.18%), concerted efforts are needed to foster a sustainable transition toward resilient and economically viable livelihood models.

The role of livelihood capitals in shaping livelihood strategies

The results of this study indicate that higher levels of natural and physical capital increase the likelihood of selecting livelihood strategies centered on animal husbandry-related products and activities. Conversely, greater human capital diminishes the probability of opting for livestock-focused livelihood strategies while enhancing a move toward diversified livelihood approaches. Globally, the correlation between livelihood assets and strategies has emerged as a focal point in livelihood research, with some findings aligning with the outcomes of this study (Soltani et al 2012; Hua et al 2017; Paudel Khatiwada et al 2017; Peng et al 2017; Dehghani Pour et al 2018; Ding et al 2018). In the context of the studied population, natural capital pertains to landownership for grazing purposes and the capacity to produce fodder within these areas. As expected, when these factors are at optimal levels, the propensity of herder households to adopt grazing-centered livelihood strategies is heightened. Previous studies support the notion that land availability or reduction thereof positively influences the diversity of rural livelihoods (Winters et al 2009; Hua et al 2017). Hence, herder households endowed with ample natural capital are inclined toward livestock-centered livelihood strategies rather than opting for diversified approaches (Liu et al 2018).

Physical capital encompasses livestock ownership and essential infrastructure to enhance livestock product yields. As anticipated, the possession of significant physical capital

may deter the transition toward diverse livelihood strategies beyond livestock production. This outcome resonates with findings from prior research (Ding et al 2018). While the Iranian government offers certain subsidies to herder households based on pasture size and livestock numbers, which can incentivize continued livestock activities (Yasouri and Keshvari 2012), it is important to recognize that, in the current context, the difference between subsidy and market prices in the region is minimal. Thus, relying solely on these subsidies as a reason for the continuation of livestock husbandry is not justifiable. Previous studies in the Zagros region have identified several key factors that contribute to the persistence of animal husbandry. These include a lack of alternative employment opportunities, the high income-generating potential of livestock farming and dairy production, a deep-rooted connection to pastoral lifestyles, emotional attachment to livestock, and the adaptability of local breeds to harsh environmental conditions, as well as spiritual and ancestral values (Plieninger et al 2023).

Ghazanfari et al (2004) noted that in the northern Zagros Mountains of Kurdistan Province, Iran, families with limited resources often depend primarily on livestock farming as their main source of income. In contrast, households with more diverse income streams may pursue alternative strategies, including agricultural practices or other livelihood options.

Furthermore, the study underscores the positive impact of enhanced human capital on promoting nonlivestock livelihood strategies. This observation aligns with findings from previous studies in Iran (Soltani et al 2012; Dehghani Pour et al 2018; Plieninger et al 2023) and elsewhere (Hua et al 2017). Consistent with these findings, Plieninger et al (2023) identified a troubling trend of declining values and practices associated with community, livestock, and landscapes. Forest-related people in the Zagros Mountains of Iran reported a scarcity of positive visions for the future, signifying a deterioration in traditional pastoral land use and a diminishing of relational values. Enhancing human capital, particularly through education and the development of off-farm skill, has been proven to positively impact the adoption of nonlivestock livelihood approaches in rural communities (He 2019). In addition, technical agricultural training empowers herder households to boost agricultural efficiency, shift toward market-oriented agricultural output, mitigate low returns from subsistence farming, and decrease dependence on pasture-related endeavors, thereby elevating income levels (Paudel Khatiwada et al 2017). In recent years, skill-oriented training for herder households has predominantly consisted of brief theoretical presentations, which have proven insufficient in effectively enhancing their skills. Therefore, it is imperative to focus on practical components, with an emphasis on adult education skills, to improve training outcomes. Given that the population examined in this research consisted of elderly individuals, it is essential to focus on adult education methods that are particularly effective for this demographic.

Implications for poverty alleviation

Households that relied on earnings from farm animal-related products and activities had higher daily incomes compared to those following diversified livelihood

strategies. This finding suggests that adopting the strategy associated with livestock goods production is more likely to result in higher incomes. It is important to highlight that livelihood strategies primarily centered around livestock rearing and the use of mountain pastures may not be sustainable in mountainous regions. The pastures in the studied areas are often of low quality and subject to overgrazing, posing significant challenges to achieving sustainable development through reliance on livestock farming alone. Our findings further indicate that while nonlivestock livelihood strategies place less pressure on these pastures and contribute to the sustainable development of mountainous areas, they do not effectively alleviate household poverty. This highlights the need for a balanced approach that incorporates diverse livelihood strategies to ensure both environmental sustainability and economic resilience for communities in mountainous regions.

The findings also indicate that the various livelihood strategies advocated by government organizations have not proven effective enough in alleviating poverty among herder households. Nonlivestock strategies have not succeeded in increasing the income of herder families and enhancing their purchasing power. This finding contradicts the results of most previous studies that have emphasized the effectiveness of diverse livelihood strategies that are not reliant on natural resource exploitation in improving household income and combating absolute poverty (Hua et al 2017; Paudel Khatiwada et al 2017). This situation may be attributed to declining wages, reduced purchasing power in the unregulated labor market, and, significantly, continuous inflationary pressures. Additionally, the failure of diversified strategies can be linked to the lack of a well-developed internal market and inaccessibility to international markets. While enhancing human capital is crucial for addressing these challenges, it is important to recognize that mere improvements in skills and education may not be sufficient to alleviate poverty effectively.

However, it is evident that enhancing income levels is crucial for poverty alleviation and strengthening the resilience of underprivileged households (Daw et al 2011). Our research findings suggest that this outcome was not apparent in diversified livelihood strategies. Therefore, it is imperative to prioritize the enhancement of human capital, a significant factor influencing the selection of diverse livelihood strategies (Bhandari 2013; Hua et al 2017). Previous studies have consistently emphasized the need to enhance household human capital in order to address absolute poverty (Yan et al 2010; Hua et al 2017). Therefore, it is imperative for the government to establish a comprehensive, long-term strategy focused on enhancing the skills and knowledge of households, which serve as critical components of human capital.

Furthermore, the lack of financial resources has been identified as a significant obstacle to investing in entrepreneurial endeavors in numerous previous studies (Zhang et al 2008; Hua et al 2017). In this regard, attention should be focused on implementing programs that offer microcredits for entrepreneurial investments, provide technical and skills training, and improve the supply chain and availability of raw materials for nonlivestock activities.

While the research provides empirical evidence on the association between factors influencing the selection of specific livelihood strategies by herder households, it is crucial to acknowledge that the adoption of a particular livelihood strategy is subject to diverse environmental, cultural, political, social, and economic factors that act as mediators. Taking these complex factors into account is essential for informing policies related to welfare enhancement initiatives and poverty alleviation. Due to the cross-sectional design of our research, we were able to collect data at only one point in time, which restricts our ability to draw conclusions about long-term poverty alleviation. Future research should consider implementing a longitudinal framework that gathers data at multiple points to assess the impact of livelihood diversification on poverty reduction more accurately over time. This would enhance the understanding of the dynamic nature of income sources and their effects on household poverty levels. Additionally, it is worth considering that this study, like many others that focus on livelihood strategies, heavily relies on collecting data through questionnaires, in which respondents self-report their asset positions and chosen livelihood strategies. Since measuring assets often has an economic bias and individuals tend to underestimate their assets, future studies may want to consider incorporating participatory observation techniques or engaging in participatory rural assessments to gather more accurate and realistic data. These approaches can provide a more detailed and reliable depiction of assets and household strategies, thereby enhancing the overall quality and reliability of the research findings.

Conclusion

This study analyzed the main livelihood strategies embraced by herder households in the pasture areas of central Iran. It also examined the impact of these strategies on poverty reduction, as well as the determinants influencing the selection of more efficient livelihood strategies. The results showed that a significant portion of the surveyed households preferred traditional livestock-centered strategies instead of transitioning to diversified income sources. These households believe that livestock production and related activities are more profitable and provide better protection against the risk of poverty. The research also emphasized the relationship between the improvement of natural and physical capital and the inclination toward livestock-centered livelihood strategies. On the other hand, the strengthening of human capital was found to increase the likelihood of adopting diversified livelihood strategies. Therefore, government interventions aimed at promoting diverse livelihood strategies and reducing pressure on pasturelands should prioritize the enhancement of human capital. In conclusion, it is crucial for herder households to diversify their sources of income beyond traditional livestock activities in order to integrate into a modern economy, reduce vulnerability, combat poverty, and establish resilient livelihoods in rural settings that are characterized by uncertainties.

ACKNOWLEDGMENTS

The authors wish to extend their sincere appreciation to all the herder households who voluntarily participated in this research. Their willingness to engage and provide candid responses to the research questionnaires was invaluable to the success of this study.

REFERENCES

- Annamoradnejad R, Lotfi S.** 2010. Demographic changes of nomadic communities in Iran (1956–2008). *Asian Population Studies* 6(3):335–345.
- Archer SR.** 2010. Rangeland conservation and shrub encroachment: new perspectives on an old problem. In: du Toit T, Kock R, Deutsch JC, editors. *Wild Rangelands: Conserving Wildlife While Maintaining Livestock in Semi-Arid Ecosystems*. Oxford, United Kingdom: Blackwell, pp 53–97.
- Azevedo JC, Clark VR, Millar J, Mukwada G, Postigo JC, Wurzinger M, Mathez-Stiefel SL.** 2021. Focus issue: Pastoralism and rangelands in mountains. *Mountain Research and Development* 41(4):1–2.
- Bhandari PB.** 2013. Rural livelihood change? Household capital, community resources and livelihood transition. *Journal of Rural Studies* 32:126–136.
- Carney D, editor.** 1998. *Sustainable Rural Livelihoods: What Contribution Can We Make? Papers Presented at the Department for International Development's Natural Resources Advisers' Conference, July 1998*: London, United Kingdom, DFID [Department for International Development].
- Carney D.** 1999. *Approaches to Sustainable Livelihoods for the Rural Poor*. London, United Kingdom: Overseas Development Institute.
- Chilongo T.** 2014. Livelihood strategies and forest reliance in Malawi. *Forests, Trees and Livelihoods* 23(3):188–210.
- Daw TIM, Brown K, Rosendo S, Pomeroy R.** 2011. Applying the ecosystem services concept to poverty alleviation: The need to disaggregate human well-being. *Environmental Conservation* 38(4):370–379.
- Dehghani Pour M, Barati AA, Azadi H, Scheffran J.** 2018. Revealing the role of livelihood assets in livelihood strategies: Towards enhancing conservation and livelihood development in the Hara Biosphere Reserve, Iran. *Ecological Indicators* 94:336–347.
- DFID [Department for International Development].** 1999. *Sustainable Rural Livelihoods Guidance Sheets*. London, United Kingdom: DFID.
- Ding W, Jimoh SO, Hou Y, Hou X, Zhang W.** 2018. Influence of livelihood capitals on livelihood strategies of herdsmen in inner Mongolia, China. *Sustainability* 10(9):3325.
- DNACBP [Directorate of Nomadic Affairs, Chaharmahal and Bakhtiari Province].** 2022. *Results of the Socio-Economic Census of Nomadic Groups* [in Persian]. Shahrekord, Iran: DNACBP Publications.
- Ebrahimi S, Moshari M.** 2006. Evaluation of the Choghakhor wetland status with the emphasis on environmental management problems. *Publications of the Institute of Geophysics, Polish Academy of Sciences* 1(6):390–398.
- Ellis F.** 2000. The determinants of rural livelihood diversification in developing countries. *Journal of Agricultural Economics* 51(2):289–302.
- Fami HS, Samiee A, Sadati SA.** 2009. An examination of challenges facing peasant farming system in Iran. *World Applied Sciences Journal* 6(9):1281–1286.
- Fang YP, Fan J, Shen MY, Song MQ.** 2014. Sensitivity of livelihood strategy to livelihood capital in mountain areas: Empirical analysis based on different settlements in the upper reaches of the Minjiang River, China. *Ecological Indicators* 38:225–235.
- Fratkin E, Meams R.** 2003. Sustainability and pastoral livelihoods: Lessons from East African Maasai and Mongolia. *Human Organization* 62(2):112–122.
- Ghazanfari H, Namiranian M, Sobhani H, Mohajer RM.** 2004. Traditional forest management and its application to encourage public participation for sustainable forest management in the northern Zagros Mountains of Kurdistan Province, Iran. *Scandinavian Journal of Forest Research* 19(S4):65–71.
- Gombodorj G.** 2021. Exploring livelihood strategies of herder households in Mongolia: Income-based approach. *Applied Studies in Agribusiness and Commerce* 15:109–116.
- 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.
- Havstad KM, Peters DP, Skaggs R, Brown J, Bestelmeyer B, Fredrickson E, Herrick J, Wright J.** 2007. Ecological services to and from rangelands of the United States. *Ecological Economics* 64(2):261–268.
- He RW, Fang F, Liu YW.** 2019. Influence of human capital on the livelihood strategy of farming households in poor mountainous areas: A case study of Liangshan Yi Autonomous Prefecture of Sichuan, China. *China Progress Geography* 38(9):1282–1293.
- Hua X, Yan J, Zhang Y.** 2017. Evaluating the role of livelihood assets in suitable livelihood strategies: Protocol for anti-poverty policy in the Eastern Tibetan Plateau, China. *Ecological Indicators* 78:62–74.
- Jafarpour M, Adib A, Lotfifard M, Kisi Ö.** 2023. Spatial evaluation of climate change-induced drought characteristics in different climates based on De Martonne Aridity Index in Iran. *Applied Water Science* 13:133.
- Jolliffe D, Prydz EB.** 2016. Estimating international poverty lines from comparable national thresholds. *Journal of Economic Inequality* 14:185–198.
- Kabubo-Mariara J.** 2005. Herders response to acute land pressure under changing property rights: Some insights from Kajiado District, Kenya. *Environment and Development Economics* 10(1):67–85.

- Karbasioun M, Mulder M.** 2004. Increasing the competency of farmers and land users: A critical future force for agricultural development and natural resources in Isfahan, Iran. In: Mohammadi S, Soltani A, Ranjbar A, editors. *Proceedings of the Fourth International Iran and Russian Conference: Agriculture and Natural Resources, Shahrekord, 8–10 September 2004*. Shahrekord, Iran: Shahrekord University Publications, pp 854–860.
- Koocheki A, Ghorbani R.** 2005. Traditional agriculture in Iran and development challenges for organic agriculture. *International Journal of Biodiversity Science and Management* 1(1):52–57.
- Lahiri-Dutt K, Dondov H.** 2017. Informal mining in Mongolia: Livelihood change and continuity in the rangelands. *Local Environment* 22(1):126–139.
- Li Z, Liu M.** 2023. Herder households' livelihood strategies as a response to payments for grassland ecosystem services in China. *Land Degradation & Development* 34(5):1375–1389.
- Liao C, Barrett C, Kassam KA.** 2015. Does diversification improve livelihoods? Pastoral households in Xinjiang, China. *Development and Change* 46(6):1302–1330.
- Liu Z, Chen Q, Xie H.** 2018. Influence of the farmer's livelihood assets on livelihood strategies in the western mountainous area, China. *Sustainability* 10(3):875.
- Lotfi FH, Fallahnejad R.** 2010. Imprecise Shannon's entropy and multi attribute decision making. *Entropy* 12(1):53–62.
- Martin R.** 2013. *Livelihood Security of Pastoralists in Semi-Arid Rangelands Under Global Change. A Social-Ecological Modelling Study* [Doctoral dissertation]. Cologne, Germany: University of Cologne.
- Mwangi M.** 2017. Effects of livelihood-diversification on sustainability of natural resources in the rangelands of East Africa: Participatory field studies and results of an agent-based model using the knowledge of indigenous Maasai pastoralists of Kenya. In: Gray S, Paolisso M, Jordan R, Gray S, editors. *Environmental Modeling with Stakeholders: Theory, Methods, and Applications*. Cham, Switzerland: Springer, 189–210.
- Norouzi A, Mahmoudian F.** 2016. A Comparative study of social and economic characteristics of accommodated and non-accommodated nomad (case study: Koohrang township) [in Persian]. *Spatial Planning* 5(4):17–38.
- Paudel Khatiwada S, Deng W, Paudel B, Khatiwada JR, Zhang J, Su Y.** 2017. Household livelihood strategies and implication for poverty reduction in rural areas of central Nepal. *Sustainability* 9(4):612.
- Peng W, Zheng H, Robinson BE, Li C, Wang F.** 2017. Household livelihood strategy choices, impact factors, and environmental consequences in Miyun reservoir watershed, China. *Sustainability* 9(2):175.
- Perry JR.** 1975. Forced migration in Iran during the seventeenth and eighteenth centuries. *Iranian Studies* 8(4):199–215.
- Plieninger T, Shamohamadi S, García-Martín M, Quintas-Soriano C, Shakeri Z, Valipour A.** 2023. Community, pastoralism, landscape: Eliciting values and human-nature connectedness of forest-related people. *Landscape and Urban Planning* 233:104706.
- Riahi V, Ahmadi R, Azmi A.** 2012. Investigating the role of settlement plans in the economic and social development of nomads, case study: Settlement centers of Kohgiluyeh and Boyer Ahmad provinces [in Persian]. *Applied Research in Geographical Sciences (Geographical Sciences)* 13(28): 95–112.
- Rigi M, Barani H, Sepehri A, Abedi Servestani A, Pahlavani M.** 2019. An investigation for identifying of drivers, uncertainties, and strategies on livelihood in range dependents rural communities (case study: Iran's Sistan and Baluchestan turanian pastures) [in Persian]. *Geography and Development* 56:91–118.
- Sadati SA, Fami HS, Sadati SA, Hashemi SM.** 2010. Exploring the solutions for overcoming challenges facing peasant farming system in Iran. *Journal of Agricultural Science* 2(4):244.
- Scoones I.** 1998. *Sustainable Rural Livelihoods: A Framework for Analysis*. IDS Working Paper 72. Brighton, United Kingdom: IDS [Institute of Development Studies].
- Simpson EH.** 1949. Measurement of diversity. *Nature* 163(4148):688–688.
- Soltani A, Angelsen A, Eid T, Naieni MSN, Shamekhi T.** 2012. Poverty, sustainability, and household livelihood strategies in Zagros, Iran. *Ecological Economics* 79:60–70.
- Teng Y, Zhan J, Agyemang FB, Sun Y.** 2020. The effects of degradation on alpine grassland resilience: A study based on meta-analysis data. *Global Ecology and Conservation* 24:e01336.
- Tilahun M, Angassa A, Abebe A, Mengistu A.** 2016. Perception and attitude of pastoralists on the use and conservation of rangeland resources in Afar Region, Ethiopia. *Ecological Processes* 5:1–10.
- Tiwari KR, Sitaula BK, Bajracharya RM, Raut N, Bhusal P, Senge M.** 2020. Vulnerability of pastoralism: A case study from the high mountains of Nepal. *Sustainability* 12(7):2737.
- Wang M, Li M, Jin B, Yao L, Ji H.** 2021. Does livelihood capital influence the livelihood strategy of herders? Evidence from western China. *Land* 10(7):763.
- Waterhouse H, Aburto F, Rees G, Griffin-LaHue DE, Salls WB, Rippner DA, Tian Z, Scow K, O'Geen AT.** 2024. Diversified vegetation types on rangelands promote multiple soil-based ecosystem services. *Land Degradation & Development* 35(3):1011–1028.
- Winters P, Davis B, Carletto C, Covarrubias K, Quiñones E, Zezza A, Azzarri K, Stamoulis K.** 2009. Assets, activities and rural income generation: Evidence from a multicountry analysis. *World Development* 37(9):1435–1452.
- Xu D, Zhang J, Rasul G, Liu S, Xie F, Cao M, Liu E.** 2015. Household livelihood strategies and dependence on agriculture in the mountainous settlements in the Three Gorges Reservoir Area, China. *Sustainability* 7(5):4850–4869.
- 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* 20:757–770.
- Yasouri M, Keshvari Z.** 2012. Examining the economic developments of Qashqai nomadic households: A case study of the Aslanlu tribe [in Persian]. In: Rahimipour MA, Rehbarhashmi M, editors. *Proceedings of the National Conference on Rural Development, 4 September 2012*. Rash, Iran: Guilan University Publication, pp 131–141. <https://sid.ir/paper/820094/fa>; accessed on 10 August 2024.
- Ykhanbai H, Bulgan E, Beket U, Vernooy R, Graham J.** 2004. Reversing grassland degradation and improving herders' livelihoods in the Altai Mountains of Mongolia. *Mountain Research and Development* 24(2):96–100.
- Zhang L, Zhang Y, Yan J, Wu Y.** 2008. Livelihood diversification and cropland use pattern in agro-pastoral mountainous region of eastern Tibetan Plateau. *Journal of Geographical Sciences* 18:499–509.

Supplemental material

- APPENDIX S1** Local context.
- APPENDIX S2** Theoretical framework.
- APPENDIX S3** Methodology.

Found at: <https://doi.org/10.1659/mrd.2024.00014.S1>