Supplemental material for

"Determinants of Livelihood Strategy Choice Among Herder Households: Implications for Poverty Alleviation in Southwestern Iran", by Hazhir Soltani, Seyedeh Khadijeh Mahdavi, Gholamhossein Abdollahzadeh, and Mahshid Souri, published in *Mountain Research and Development* 44(4), 2024. (See https://bioone.org/toc/mred/44/4)

APPENDIX S1 Local context

By signing a memorandum of understanding with the Organization of Nomadic Affairs in October 2016, Iran's Natural Resources and Watershed Organization has committed to designating priority pastures for employment-generating activities. These efforts involve specifying the geographical location and size of the areas, assessing their agricultural potential, and facilitating the restoration and conservation of natural resources. Furthermore, the organization aims to provide education and information to help implement these initiatives, along with training and extension services related to pest management, plant diseases, and fire prevention, specifically tailored for nomadic populations. This comprehensive approach aims to enhance the livelihood assets of herder households while promoting the diversification of income sources beyond reliance on livestock activities and complete dependence on pastures.

The herding communities of Iran, particularly those in the Chaghakhor region, encounter unique challenges that originate in their cultural practices and social structures. Nomadism is an integral aspect of life in this region, characterized by the seasonal migration between summer and winter pastures to identify optimal grazing grounds for livestock, primarily sheep and goats (Neik Kholq 2004; Safinejad 2004; Annamoradnejad and Lotfi 2010). These nomadic communities rely heavily on their herds, not only for food, such as milk and meat, but also for wool and hides. In addition to livestock, these communities practice subsistence farming and create their own tents, clothing, and tools, which fosters a high degree of self-sufficiency. The social organization of the communities is often tribal, with complex kinship networks that govern relationships and responsibilities. Each tribe typically consists of several extended families, known as tents, who collaborate to manage shared resources effectively (Safinejad 2004). Governance within these tribes is usually led by a chieftain or elder, who plays a crucial role in decision-making, conflict resolution, and resource management. Tribal relations enhance economic cooperation among herding households, with practices such as bartering and sharing resources like water and grazing land. However, despite their historical adaptability to the region's harsh climates, nomadic groups face significant challenges, including intense rangeland deterioration, imbalanced livestock and pasture ratios, disputes over land use and grazing rights, and increasing difficulty in accessing water resources (Saboohi et al 2022). Such issues undermine their ability to sustain their traditional livelihoods, highlighting the pressing need for new strategies that better align with the environmental changes confronting these.

APPENDIX S2 Theoretical framework

Livelihood encompasses the essential elements for survival and sustenance, including resources, skills, and endeavors crucial for individuals to secure their means of living (Scoones 1998). It refers to the combination of capacities and both tangible and intangible assets—such as land, labor, knowledge, and social networks—along with activities and engagements that are essential for maintaining one's standard of living (Chambers and Conway 1992). Its sustainability and resilience are evidenced by its ability to withstand and rebound from shocks and stressors while fortifying or amplifying its capacities and assets, including the natural resource base, both in the present and future (Chambers and Conway 1992; DFID 1999).

The sustainable livelihoods framework comprises 5 interdependent elements—vulnerability context, livelihood capitals, mediating variables, livelihood strategies, and outcomes—that collectively shape the livelihoods of impoverished individuals (DFID 1999). This study focuses on 3 of these elements: livelihood capitals, livelihood strategies, and livelihood outcomes (see Figure 1 in article). Households amalgamate their livelihood capitals with activities and decisions, crafting a spectrum of endeavors (such as farming, fruit growing, fishing, beekeeping and other income-generating activities) to realize their livelihood objectives, encapsulated in what is referred to as livelihood strategies (Carney 1999; DFID 1999). Livelihood outcomes delineate the achievements resulting from livelihood strategies, such as increased income, diminished poverty levels, enhanced household welfare, and rangeland preservation, among others. These outcomes exhibit variations contingent on the strategies employed and the unique circumstances of households (Ellis 1998; Carney 1999).

APPENDIX S3 Methodology

Sampling

The sample size of 136 households was determined using the equation proposed by Bartlett et al (2001):

$$n = (Z_{\frac{\alpha}{2}}^2 pq)N/\mathrm{d}^2\,(N-1) + Z_{\frac{\alpha}{2}}^2 pq \qquad (1)$$

where n = sample size, N = population size (in this case N = 6900 heads of household), p = estimated proportion of the herder population (p = 0.9), q = (1 − p) (ie q = 0.1), d = 0.05 (margin of error representing the maximum allowable difference between the sample estimate and the true population parameter), and $Z_{\frac{\alpha}{2}}$= 1.96 (the Z-score corresponding to a 95% confidence level).

Questionnaire development

To elucidate the livelihood strategies employed by herder households in the study area, we undertook an iterative process. This began with 7 in-depth individual interviews, which collectively lasted 450 minutes. The interviews were conducted with herders who possessed higher literacy levels and considerable experience in local work and employment conditions. Subsequently, a focus group session lasting 180 minutes was conducted, which included 9 rural and nomadic herders, comprising local and tribal leaders as well as village council members. This session was further enriched by the participation of 3 experts introduced by the DNACBP: one representative from the DNACBP, one from a nongovernmental organization, and one from the Provincial Natural Resources and Watershed Organization (a specialized governmental organization that aims to preserve, protect, restore, and sustainably manage forests, pastures, and other natural resources). This session was aimed at validating and enhancing the identified strategies. Through a process of elimination of redundant and extraneous elements, a comprehensive set of 10 sources of households' income in the area emerged, forming the basis of the questionnaire framework. A pilot study involving a sample of 30 participants was conducted as a preliminary measure to enhance the clarity and simplicity of the questionnaire items. These participants were subsequently excluded from the final analysis. The questionnaire was refined to align with the socioeconomic characteristics of the study region by removing irrelevant variables and introducing location-specific variables. This revised questionnaire was then used for the final survey.

Classifying the sources of households' income

The 2-step cluster method uses a distance criterion known as log-likelihood distance, which is based on a probabilistic model. This criterion measures the decrease in log likelihood when 2 clusters are merged, allowing the distance between 2 potential clusters to be assessed. By incorporating both categorical and continuous variables, this method determines the optimal number of cluster (Eakin et al. 2012).

Simpson's index

Simpson's index is a measure of diversity that has been applied in various fields, including income diversity and species diversity. It can be used to assess livelihood diversification strategies in rural areas, with a lower index value indicating less diversification (Alemu 2023). The computation of the household income diversification index followed the formula employed by Chilongo (2014):

$$\text{Diversity index} = 1 - \sum_{i=1}^{n}(S_i)^2 \quad (2)$$

where S*i* represents the percentage contribution of income source i to the overall household income, with n denoting the total number of households. The index spans from 0 to 1, with 0 denoting no diversification and 1 denoting maximal diversification. By employing this stringent methodology, the study facilitates reliable comparisons and offers valuable insights into the array of livelihood strategies implemented by households to alleviate poverty.

Livelihood capital measurement

Livelihood capital was measured in two steps, as follows.

Step 1: Standardizing the indicators. Differences in the scales of the individual indicators of different forms of capital required an elimination of scale bias. The normalization process involved the use of the following equation to standardize the measurement indicators, resulting in the transformation of the original data to a range of [0–1].

$$X'_{ij} = (X_{ij} - X_{\min})/(X_{\max} - X_{\min}) \quad (3)$$

where $X'_{ij}$is the normalized value of sample *i* of index *j*; X_{ij} is the value of index *j* of sample *i*; $X_{\max}$ is the maximum value of the of index *j* of sample *I*, and $X_{\min}$ is the minimum value of the of index *j* of sample *i*.

Step 2: Weighting indicators. The significance of different proxy indicators in delineating specific livelihood capitals may vary. Shannon entropy serves as a valuable tool in allotting weights to criteria within multi-attribute decision scenarios, particularly in cases where discerning preferences and conducting decision experiments for weight allocation are challenging (Lotfi and Fallahnejad 2010). The outcomes derived from entropy value analysis are inherently less biased than qualitative analysis methods like the analytic hierarchy process. Therefore, the entropy technique was employed to establish the weighting of different individual indicators. First, the specific gravity p_{ij} of the of index *j* of sample *i* was calculated as follows:

$$p_{ij} = X'_{ij} / \sum_{i=1}^{m} X'_{ij} \quad (4)$$

Second, the entropy value e_j of the *j*th index was calculated as follows:

$$e_j = -\ln m \sum_{i=1}^{m} p_{ij} \ln p_{ij} \quad (5)$$

Third, the weight, *w*, of *j*th index was calculated as follows:

$$w_j = (1 - e_j) / \sum_{i=1}^{m} (1 - e_j) \quad (6)$$

And fourth, the aggregate value of each livelihood capital was computed in the following manner:

$$Wij = \sum_{i=1}^{m} w_j X_{ij}^{'} \quad (7)$$

where W_{ij} represents the aggregate value of each livelihood capital and X_{ij}' and w_j denote the standardized value and the weight of indicator j within the livelihood capital type *i*.

Binary logistic regression analysis

Binary logistic regression is a valuable tool for modeling predictors of a binary (2-group) dependent variable, as outlined by Hair et al (2009). In the context of this study, the dependent variable was binary, reflecting the 2 clusters of livelihood strategies identified through the 2-step clustering technique. All independent variables encompassing human, physical, social, natural, and financial capitals were collectively included in the model. The underlying assumption was that the selection of a livelihood strategy is influenced by a combination of various livelihood capitals. SPSS version 26 was used to analyze the data.

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