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# A comprehensive analysis of pastoral traditional knowledge functions

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**Abstract**
Pastoral traditional knowledge is gaining recognition for its adaptability and role in enhancing the resilience of pastoral communities. To deepen our understanding of how this knowledge system demonstrates adaptive characteristics, we employ a functional lens to examine its dynamic nature in this systematic review. Our analysis, based on insights from 152 case studies worldwide, shows that this knowledge system has various domains and serves diverse functions, including ecological, economic, and socio-cultural functions, with further subfunctions. Ecologically, it primarily boosts climate resilience and adaptation; economically, it supports herd health and productivity; and socio-culturally, it preserves cultural identities and heritage. Furthermore, our findings highlight that each knowledge domain shows multifunctional characteristic. Our analysis also helps identify common functions across eight knowledge domains, each contributing to areas like sustainable resource management and climate adaptation, though to varying degrees.

**Introduction**
Pastoralist communities globally are confronting a myriad of challenges. Climate change is disrupting their traditional lifestyles through unpredictable weather, intensified droughts, land degradation, and poorer pasture quality (Ahmed et al. 2023). Socio-economic factors such as market dynamics and resource extraction are straining their adaptability (Galvin 2009). Additionally, land ownership policies and conflicts limit access to essential resources, compounding these pressures and threatening both the ecological balance and the cultural continuity of pastoral societies (Xie and Li 2012).

Despite these challenges, pastoral communities persistently employ and renew their traditional knowledge, continually learning from and adapting to changing environmental conditions and socio-economic landscapes. To dig deeper into how pastoral traditional knowledge (PTK) helps pastoralists adapt and thrive amid changing environmental and socio-economic pressures, we decided to apply a functional lens in this study. The function of knowledge, within this context, refers to the deliberate use of knowledge to achieve specific objectives as well as the actual impacts or outcomes of the knowledge. Specifically, we review the literature 1) to document the domains of PTK, 2) to explore the diversity of functions PTK serves in the lives of pastoralists, 3) to investigate whether a single PTK domain can serve multiple functions, and 4) to examine whether different PTK domains share common functions.

## Methods

Our review used primary sources from peer-reviewed literature on PTK from the Web of Science and Scopus. The search string used was TS= ((traditional OR Indigenous OR local OR past OR old OR folk OR aborigin) AND (pastoral* OR nomad* OR herd* OR shepherd OR flock) AND (ecology* OR environment* OR rangeland OR grassland) AND (knowledge* OR practice* OR strategy*)) AND TS= (adapt* OR cop*). The initial search yielded 1076 documents (WoS = 432; Scopus = 644). After removing overlapping documents based on DOI, title, and abstract comparisons (n=318), we thoroughly screened 758 publications for relevance to our review, focusing on title, abstract, and methods. We included only peer-reviewed studies that provided empirical evidence of PTK and had a clear focus on PTK. Studies that only partially addressed PTK were included if the relevant section to PTK provided detailed insights. Publications were restricted to those available in English or Chinese. Ultimately, 149 papers met our criteria and were included in the review.

To investigate diverse domains and functions of PTK, we conducted qualitative thematic analysis and coded the verbatim statements referring to PTK, its applications and its outcomes in Nvivo. Additionally, we quantitatively assessed the distribution of the coded functions among different domains using the R program, specifically 'dplyr' for descriptive analysis and 'ggplot2' for data visualization. Using 'dplyr', we evaluated the distribution of different functions across various PTK domains and analyzed how these knowledge domains contribute to various functions by calculating the percentage distribution within each sub-functional group.

## Results

### *Domains of PTK*

Results from our analysis expand upon the initial framework proposed by Sharifian et al. (2022), who identified five key knowledge domains: livestock, forage/plant, landscape, climate/weather, and social-cultural knowledge by adding two new domains to this classification: herd mobility practice and herd diversification practice. The distribution of different knowledge domains across case studies shows a significant variation. More than half of the case studies (84, 55%) reported only one or two knowledge domains, while 39% (59 cases) documented three to four domains. Notably, only 9 cases (6%) documented a range of five to six knowledge domains. Among the knowledge domains documented, herd mobility is a practice most frequently reported, identified in 82% of cases (124 cases) across all climate zones. Climate and weather-related knowledge is the second highest cited knowledge domain, reported in 41% of the cases (n = 63). Knowledge domains relatively less often mentioned in the literature include landscape-related knowledge and herd diversification practice. Landscape-related knowledge was found in 33 cases (22%). Pastoralists routinely observe and learn about their surroundings while herding.

### *Diverse functions of PTK*

Our analysis suggests that PTK covers different ecological, economic, and social-cultural functions in pastoral systems. Within the dataset analyzed, a total of 252 citations are applied to support ecological functions. PTK ecological functions include various subfunctions such as monitoring ecosystem health, preventing unsustainable resource use, predicting weather and climate variations, and maintaining biological diversity in the ecosystem. Upon examining the distribution of these citations among different knowledge domains, it is apparent that the domains of herd mobility practice (78 citations) and climate/weather-related knowledge (55citations) are prominently associated with ecological functions.

PTK's economic functions refer to PTK's role in enhancing the efficiency and sustainability of pastoralists' livelihoods. We identified three different subfunctions in this group: utilizing limited resources effectively, mitigating the impacts of natural disasters, and improving livestock productivity and health. Among all the recorded citations, there are 139 of them which play economic functions among pastoral communities. The domain of herd mobility (43%, 59 citations) emerges as the most prominent within this economic category. Although forage/plant-related knowledge is not prominently featured for its ecological function, this knowledge domain made up 18% (26 citations) of PTK economic functions. Livestock-related knowledge accounts for 11% (16 citations) of the economic functional group.

The social-cultural functions of PTK contribute to the maintenance of pastoral communities' cultural integrity and social structures. This functional characteristic stresses PTK's role in preserving traditional culture but also in enhancing the social bond of the community and promoting cooperation. Among the recorded citations, 59 citations are documented as fulfilling social-cultural functions. Social-cultural functions draw in social-cultural knowledge, which forms nearly half of this functional category (48%, 29 citations). However, it is interesting to note that livestock-related knowledge, accounting for 11% of all social-cultural functions, and landscape-related knowledge, representing 10%, also contribute meaningfully to the social-cultural fabric.

We further analyzed the data to better understand the weight of different subfunctions within the three main functions. The ecological functions of PTK stands out as the most common, with over half (58%) of the recorded subfunctions addressing four ecological functions: ecosystem monitoring, sustainable resource use, climate adaptation and resilience, and biodiversity conservation. Within ecological functions, climate adaptation and resilience is the most often cited subfunction, comprising 35% of all recorded citations. The subfunction of sustainable resource management represents 17% of the citations. Within economic functions, enhancing livestock productivity (14%) and livelihood support (12%) are two subfunctions most often cited. Overall, the social-cultural functions of PTK are the less often cited. Within those, cultural preservation (7%) is emphasized to a larger extent than some ecological and economic functions, including ecosystem monitoring and risk management.

***Multifunctional characteristic of PTK domains***

Our results also reveal that most domains are connected to distinct functions. For instance, social-cultural knowledge covers ten types of subfunctions, ranging from climate adaptation and resilience to social cohesion and community governance. Livestock-related knowledge, which one might expect to predominantly impact areas directly related to herd management, such as productivity, in fact, shows a diverse range of functions.

***Common functions across PTK domains***

In our comprehensive analysis of PTK, a pattern of common functions among various knowledge domains emerged. all the knowledge domains examined collectively contribute to sustainable resource management, and climate adaptation and resilience functions. In terms of knowledge domains contributing to economic subfunctions, all the knowledge domains were found to jointly contribute to improving livestock productivity. Furthermore, herd diversification and herd mobility practices were often intertwined in addressing risk management. Culturally, almost all the knowledge domains contributed to the preservation of cultural identity and heritage. Although social-cultural knowledge played a dominant function in improving social cohesion and community governance, some case studies reported that herd mobility could serve the same purpose.

**Discussion**

Our study reveals significant imbalances in the focus of existing case studies regarding knowledge domains. The fundamental knowledge of pastoralism globally, such as livestock-related (10% of the cases), forage/plant, and landscape-related knowledge are significantly underrepresented. Additionally, we found that more than half of the case studies (55%) investigated only one or two knowledge domains. This underrepresentation is problematic because it fails to capture the full complexity and interconnectedness of the pastoral knowledge system. Global research on traditional pastoral knowledge shows that pastoralists across diverse regions use a complex and common set of principles, including forage/plant, landscape, and livestock knowledge to manage resources efficiently and sustain their livelihoods (Sharifian et al. 2023). By focusing narrowly on certain aspects, research risks oversimplifying the holistic strategies that pastoralists employ. Pastoralists do not view these domains in isolation; rather, they integrate multiple domains to adapt to environmental uncertainties and ensure the sustainability of their resources. Thus, we argue that this narrow focus and fragmented approach risks presenting an incomplete or even distorted understanding of PTK. It fails to capture the holistic strategies pastoralists use to manage uncertainty and ensure the sustainability of their resources.

Moving from the specific domains of PTK to its broader implications, PTK exhibits diverse functions, playing ecological, economic, and socio-cultural roles. In our database, the most common ecological subfunction of

PTK is climate adaptation and resilience, which appears more frequently than the sum of the rest of the ecological subfunctions. This prominence likely stems from pastoralists' direct experience with climate variability, such as droughts, floods, and shifting seasonal patterns, underscoring their adeptness at navigating and mitigating the adverse effects of weather variability, and potentially of climate change. Regarding the economic aspect, PTK is mainly mentioned for enhancing herd productivity, and livelihood support and resource optimization. The findings show that forage/plant-related knowledge and mobility practice are the core for maintaining herd health and productivity. This aligns with the findings of Launchbaugh (2020), who highlighted that livestock could benefit from mobile grazing behavior by taking a variety of forage with different nutritional qualities. In terms of social-cultural functions, we found that livestock-related knowledge and landscape-related knowledge play significant roles in preserving the cultural identity and heritage of the pastoral communities. The landscapes that pastoralists inhabit and manage are imbued with cultural significance. Managing and preserving these landscapes, therefore, becomes an act of cultural heritage conservation. In certain communities, specific practices in landscape management, like controlled burning, are important parts of their culture (Fernández-Giménez 2015).

Building on the understanding of these varied subfunctions, our findings suggest that each domain of PTK serves multiple ecologic, economic, and socio-cultural functions. The significance of multifunctional characteristic within the knowledge system is profound. It enhances community stability by equipping them with a diverse set of strategies to deal with uncertainties and ensures that knowledge itself remains pertinent and flexible, capable of adjusting to evolving challenges. As some case studies show, even when a community is faced with constraints such as privatization, mobility adapts to fulfill other important functions, such as land preservation. This gives reason to believe that the multifunctional characteristic of traditional knowledge systems contributes to their continued relevance and transmission. Therefore, future studies could examine this relation more directly. Additionally, there is a significant opportunity for future studies to explore how these functions evolve and adapt over time, particularly whether knowledge domains develop new functions in response to environmental and social changes.

Expanding on the finding of multifunctional characteristic of each domain, another finding that deserves attention is the substantial common functions present across knowledge domains. The idea that communities utilize alternative knowledge to achieve similar outcomes due to various challenges is discussed in the existing literature. For instance, Gauer et al. (2021) explore how Indigenous communities adapt their knowledge in response to environmental changes, employing alternative strategies when certain knowledge becomes impractical or ineffective. Drawing on these findings, we propose that future studies could interpret this interplay and synergy as a mode of strengthening traditional knowledge systems. We hypothesize that the common functions identified across different PTK domains allow pastoral communities to approach challenges such as climate change from various angles, thereby increasing the likelihood of finding a more effective solution.

Given the diverse range and complex interplay of ecological, economic, and socio-cultural functions within PTK, there is a need for adopting an interdisciplinary approach. By incorporating perspectives from various fields, future studies can achieve a more holistic understanding of traditional knowledge systems and their functions. Additionally, there is a need for future studies to involve and collaborate directly with local communities. In this way, researchers can ensure that their work captures the full depth and interconnectedness of PTK while respecting and valuing the perspectives and lived experiences of these communities.

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