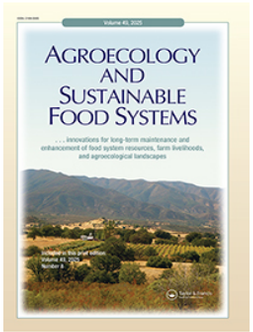

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Agroecological transitions of pastoralism: a discussion of key concepts and investigation of current dynamics using a political economy lens

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ABSTRACT

The paper provides a historical review and a contemporary snapshot of pastoral systems in Tunisia, exploring the dynamics of change in pastoral landscapes and territories and their respective drivers and outcomes. The core idea is to recognize the emerging diversity of pastoral systems in terms of structure and transformation, and thus to approach them analytically from a perspective of dynamic transition. The paper utilizes an agroecological gradient of transformation to illustrate the inherent agroecological nature of pastoralism by examining the different trajectories of these systems. The ongoing "hybridization" of pastoralism in South Tunisia is characterized by the emergence of diverse forms of pastoral activities and contexts. These novel forms of pastoralism occasionally diverge from certain agroecological principles. The paper also elucidates key factors that propel these trajectories and divergences of certain forms of pastoralism from agroecology. To this end, key elements and attributes from the political economy framework, with a particular focus on market and labor dynamics in pastoral areas, social metabolism, organizational structures, policies, institutions, and natural resource management, were discussed. The analysis shows how some of these drivers have contributed to the formation of a novel configuration of pastoralism.

KEYWORDS

Pastoral systems; Agrarian change; agroecological transition; political economy; market and labor dynamics; hybridization

Introduction

The critical juncture in food systems has triggered many significant crises and has led to much reflection on alternative approaches to structural and systemic transformations of farms, landscapes and food systems (Caron et al. 2018). One of the transformative approaches that has recently been widely discussed and taken up on high political and international agendas is agroecology (Kelinsky-Jones, Niewolny, and Stephenson 2023). Agroecology offers

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a holistic system approach to transforming the production, distribution and consumption of food, operating at the food system level, which makes it very attractive for analyzing complex systemic transformative and sustainable transitions (Ewert, Baatz, and Finger 2023). However, the practical implementation and piloting of agroecological transformation is still discussed at a theoretical level, with few concrete cases of successful implementation documented. On the other hand, while much of the focus has been on agroecological practices for cropping systems, pastoralism has often been left out of these discussions, given the complex tenure systems and collective actions required for such systems to operate and function. Thus, there is limited evidence on what such transitions might look like in pastoral landscapes.

Pastoralism is practiced by between 200 and 500 million people worldwide (including nomadic communities, transhumant herders and agro-pastoralist) and accounts for around 25% of the world's land use (Davies and Hagelberg 2014). In Africa, it is estimated to account for between 10 and 44% of the African GDP (African Union 2010). Nevertheless, pastoral communities remain among the most marginalized, with high poverty rates recorded in pastoral areas (ex. 41% of pastoralists across the Horn of Africa live in poverty) (Francesco et al. 2021). Furthermore, pastoral systems are currently undergoing profound structural and social changes, resulting in a wide diversity of adaptations and pastoral identities (Nori 2019). This diversity challenges the traditional homogeneous view of pastoral systems and highlights the need not only to recognize the different trajectories and attitudes of actors in pastoral territories that have emerged in response to the various pressures but also to better understand the factors behind these transitions

In this paper, we explore these dynamic changes in pastoral areas using a framework that combines a political economy lens, the dynamics and diversity of pastoralism, and the overlapping agroecological (AE) trajectories reflected by key agroecological principles. By applying this framework to pastoral landscapes, we can get better understanding of the enablers and barriers to transformative change in these systems. Our analysis focuses on the conflicting interests, values and restrictive policies that shape pastoralist adaptations, with the aim of informing policy makers about how agroecological principles can (or cannot) be applied to the specific case of pastoralism and thus guiding research and development investments toward broader and more sustainable systemic change.

Some argue that pastoralism has historically embodied the key essential elements of agroecology (Garde, Aussibal, and Meuret 2016). However, pastoralism also needs to be reinvented and redefined in the light of local pressures and the profound changes and dynamics that pastoral societies have faced in recent decades. A key narrative shaping pastoralism and research on pastoral dynamics today is its political construction as a marginal system –

economically inefficient and ecologically harmful – due to its reliance on extensive production, its need for large and interconnected spaces (hence informal institutional arrangements) and flows (which are poorly known, valued and documented) rather than intensive and specialized production models (Muhammad et al. 2019). The current context, marked by urgent needs for local food production and climate change adaptation, argues for a necessary shift in this narrative, with decentralization, intensification (or some form of it), institutional change and equity (social and environmental) becoming critical to further develop in such landscapes.

Defining the agroecological nature of pastoralism poses, however, many methodological challenges. The complexity of today's pastoral systems, shaped by increasing social inequalities underlines the need to reinvent concepts, analytical methods and even "research for development" questions (Reid, Fernández-Giménez, and Galvin 2014). Thus, the research question of this paper is why and how can agroecology be a suitable framework to analyze pastoral systems dynamics, and what barriers and opportunities exist for Agro-Ecology Transition (AET) in pastoralist systems? Accordingly, the objective will be to assess the role of pastoralism for agroecological transitions in desertic regions by analyzing existing and emerging pastoral practices in their socio-political context. To do so, the study focuses on a case study from North Africa, in Beni Khedache, Medenine, southern Tunisia, and uses a range of qualitative and quantitative (household) data collected between 2019–2021 on agropastoral farm characteristics and structure, pastoralist attitudes toward rangeland management, governance and resting, collective action for restoration, and other enablers of good rangeland governance.

Pastoralism vs agroecology: intersections, divergences, and conceptual challenges

Definition of agroecological transition

Agroecology is defined as an integrated approach to agricultural development that combines ecological principles with broader social, economic, and environmental dynamics at the territorial and landscape levels (Bezner Kerr et al. 2023; Nicholls et al. 2020; Wezel et al. 2020). Accordingly, numerous scholars posit that agroecology is firmly embedded in landscape approaches, as it profoundly relates to coordination across local actors, sectors, and the social and institutional dynamics that support learning and co-creation of knowledge (Nicholls et al. 2020),innovations and transformative innovations (Côte et al. 2019) as well as transformative approaches that help coping with food, climate, and ecosystem crises (Bezner Kerr et al. 2023; Wezel et al. 2020)

Gliessman's (2007, 2016) transition pathway framework for agroecological transitions provides five stages or "levels" that are typically required to move

toward a full agroecological transition. These levels start with incremental change and progress to deeper levels of change. The first three levels proposed by Gliessman focus on agroecological practices at the farm level, where initial goals such as increasing the efficiency of conventional practices to reduce the use of costly, scarce or environmentally damaging inputs; substituting with alternative natural inputs and practices; and redesigning the agroecosystem to function more on ecological processes. The last two levels of this framework are expanded to focus on broader food system attributes and changes with support to more direct connections between food producers and consumers; and building a restorative and favorable environment, including enabling policies and institutions, for the food system based on equity, participation, democracy, and justice (Gliessman 2018). Despite the fact that this framework is one of the most expressive and illustrative of transition milestones, it is still yet difficult to find in literature well-documented and evidenced approaches that can guide the governance of such a transition.

Agroecology and pastoralism, a paradoxical relationship

A key question for discussion in this paper is whether pastoralism is already agroecological. We argue that pastoralism is consistent with agroecological principles for several reasons. Pastoral societies rely on diverse crop species and locally adapted livestock breeds. They also rely on multiple forms of mobility (seasonal, commercial, labor) and community-based rangeland restoration arrangements to cope with uncertainty and variable rangeland biomass resources. As such, pastoral systems support key agroecological principles such as the promotion of biodiversity and natural cycles. In addition, pastoralists combine traditional knowledge with new innovations to support long-term resilience. For example, in drought years, they change the composition of their herds to include animals that feed on plants and shrubs rather than annual crops. This is very much in line with the agroecological principles of "adapting to local conditions." Pastoralists also rely on social capital, relationships, power relations and reciprocity to cope with uncertainty and variable climatic conditions, thus gaining access to resources in times of shortage (e.g. exchanging fodder for organic manure with crop farmers, etc.), reflecting an emphasis on agroecological principles such as circular solutions and linkages. Pastoralists also contribute to the conservation of important and adapted livestock genetic resources through conserving and prioritizing local breeds of animals. In recent decades, pastoralism is continuously shifting toward hybrid configurations of agropastoral and commercial pastoral as well as "intensified/capitalist pastoralism" (Notenbaert et al. 2009; Robinson et al. 2011), which makes its inherent agroecological character sometimes questionable.

A key entry point for mapping pastoralism to agroecological values and principles are the ecological dynamics and social equity aspects inherent in traditional pastoralism. By examining the ecological relationships inherent in pastoral systems (see Figure 2), agroecology can support a more holistic view of livestock management as a driver of biodiversity (Wezel et al. 2020) and soil health (Botreau et al. 2014), for example, thereby improving the resilience of pastoral socio-ecological systems to climate change. Such a holistic approach often challenges the reductionist perspective of conventional agriculture and the dominant idea that pastoralism is an extensive activity that is marginal to food security and food system transformation.

Nevertheless, defining the agroecological nature of pastoralism poses several methodological challenges, particularly in identifying the right indicators, tools and approaches to capture its internal diversity, spatial specificity and its complex relationship with resources, tenure and collective action for rangeland management. Given the current dynamic changes and the inherent diversity of pastoral systems, a critical question would be whether a "gradient" of agroecological intensity can be established, given that not all pastoral systems are at the same stage of transition, with some even undergoing negative transitions. While there is a conceptual correspondence between pastoralism and agroecology, this relationship is difficult to assess, especially given the collective dimensions and mobility that are difficult to quantify and thus characterize by using specific metrics. The lack of attention, assessment and valuation to the core multifunctionality aspect in pastoral areas further complicates the matter. In addition, there is considerable diversity within pastoral systems and their respective transition pathways, as dictated by external and internal drivers from the pastoral areas; a simple illustration is the difference between small and large herders, pastoral and agropastoral, commercial and family pastoralists, etc.

Finally, some argue that pastoralism has historically embodied agroecology (Blanco, Michon, and Carrière 2017), rooted in local knowledge, adaptability, collective action (social networking and co-creation) and mobility, thriving in marginal areas with limited resources through family-based activities. Its logic emphasizes flexibility, circularity and food sovereignty, contrasting the complementarity of spaces with the specialization of production and harmful intensification. However, under the current pressures and dynamics, pastoralism requires a reinvention that takes better account of different agroecological status of pastoral systems and their respective diversity, combining old practices with new settings and well documenting the hybridizing systems in terms of adaptation to current challenges and also future transformations.

A growing diversity and mosaic of structural and behavioral changes of pastoral systems and their contexts

Pastoralism is becoming increasingly diversified as a result of various socio-economic and environmental factors. This diversification is manifested in a number of ways, such as increased decentralization, where sedentary pastoralism has increased because of political boundaries, increasing land tenure restrictions and insecurity, and the expansion of agriculture (and other extractive and economic activities) into traditional pastoral areas where mobility was previously practiced. In addition, many pastoralists are now adopting mixed farming practices, integrating crop and livestock production to increase productivity, income and resilience to growing climatic challenges. Livelihood diversification is another feature of diversified pastoral systems and typologies, where pastoral communities today increasingly pursue livelihood diversification through engagement in non-pastoral activities, especially among households facing environmental pressures or resource scarcity. For example, pastoralists in regions such as northern Kenya and Kyrgyzstan are adopting alternative livelihoods such as tourism and small-scale agriculture as coping strategies to mitigate risks associated with climate change and market fluctuations (Sabyrbekov 2019; Watete et al. 2016). Diversification not only helps maintain food security but also reduces dependence on livestock alone (Watete et al. 2016).

The diversification of pastoral systems is also induced by the diverse adaptations of pastoralists and pastoral communities to environmental change (Coutinho 2021), which are highly dependent on the capital and resource endowment of communities and individuals, resulting in a diversity of adaptation pathways and situations and systems. Many pastoralists are changing their livestock composition or exploring new income opportunities from sources other than traditional herding practices (Sabyrbekov 2019). For example, in Kyrgyzstan, pastoralists are engaging in tourism-related activities while still managing their herds, illustrating a mix of old and new livelihoods, and thus enhancing their cultural heritage and capital to build resilience (Coutinho 2021). Finally, existing national and sub-national policies and governance structures also influence the transformation of traditional pastoral systems, thus further shaping their diversification. National and sub-national policies have played a pivotal role in transforming traditional pastoral systems. This transformation has been achieved through changes and reforms in land tenure rules, social and economic incentives for pastoralists, conservation agendas and priorities, and governance frameworks. Conversely, inclusive land planning and community-based resource management have demonstrated potential in enhancing the resilience of these systems. Nevertheless, numerous studies have indicated that policies often favor agriculture or conservation over pastoral livelihoods.

Conceptual framework: explaining the transition pathways of pastoral systems through political economy

It is recognized that systems transformation is a dynamic and integrated process that results from different internal and external drivers. A transition pathway of a system explains the key milestones which this system has gone through and highlights the major events that were instrumental drivers of change. In Figure 3, the black arrow illustrates a broad transition pathway with two extremes, one representing pastoral systems with autonomy, self-restoration of ecosystems and high levels of collective action and investment in sustainability. The other end represents a system that is more dependent on external inputs and the extraction of rangeland resources and ecosystem services, and where individualism is a dominant feature. In reality, given that pastoral systems are dynamic, as argued earlier, we believe that there are a variety of hybrid forms of pastoral systems that exist everywhere along the black arrow, combining different levels of characteristics from both extremes. This section explains these ideas in more detail and sets the scene for the use of agroecological principles and political economy domains (McKay, Nehring, and Catacora-Vargas 2024) to measure and explain pastoral system transitions.

Pastoral systems are confronted with numerous ecological, social, political, and market-related challenges. Among the policy constraints experienced are restrictions on land tenure, leading to tenure insecurity; the prevailing political construct on pastoralism and pastoral societies, perceiving them as marginal and unproductive territories; and the absence of equitable policies and institutions to support good governance. The ongoing diversity of pastoralism is also highly related to labor dynamics in a given context, with the need in some cases for flexibility and sedentarization of labor, when mobility is not possible. In other instances, such diversification can result in labor inequality between genders, among different herd size holders, between landowners and users, and so on.

Pastoral systems from autonomy and collective action to dependency and extractivism

A dichotomy of agroecological trends in pastoral systems

Rangelands are nowadays facing significant trends in terms of ecosystems degradation and loss of biodiversity, loss of traditional knowledge and informal community-based organizations, which have been key for regulation of access, use and sustainability, as well as significant increase of social pressure and demand on land privatization and new agricultural expansions (Hovick, Duchardt, and Duquette 2023; Sabyrbekov 2019; UNCCD 2024; Wiethase et al. 2023). Some studies suggest that approximately 50% of rangelands

globally are currently degraded, due to habitat loss, fragmentation, overuse, mismanagement, and climate change (Hovick, Duchardt, and Duquette 2023; UNCCD 2024), thus indicating additional threat to food security, especially in the drylands. The significant decline in traditional knowledge and practices has reduced the resilience and autonomy of pastoral communities to climate shocks, making them more vulnerable to changing conditions (Wiethase et al. 2023). Increasing social pressure for land privatization and agricultural expansion has often taken place in communal rangeland systems, leading in many cases to conflicts over land use and further degradation of rangeland ecosystems (UNCCD 2024). Translated into agroecological principles (see Figure 1),

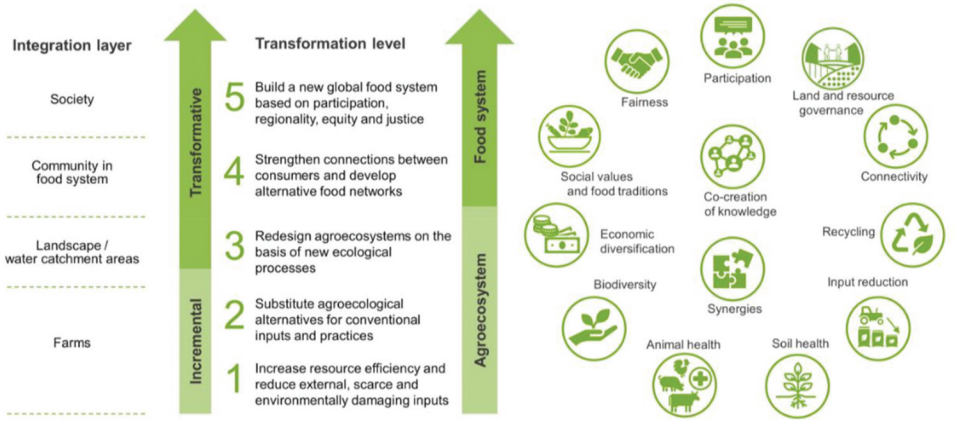

Figure 1. Levels and layers of agroecology transition according to Gliessman (2016).

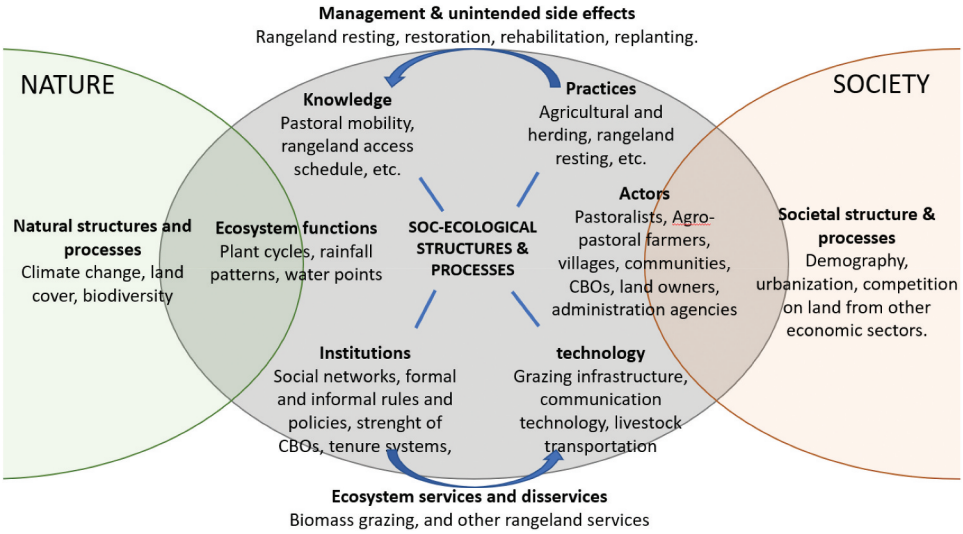

Figure 2. Conceptualization of the role of rangeland management within a SES context (Frija et al. 2023).

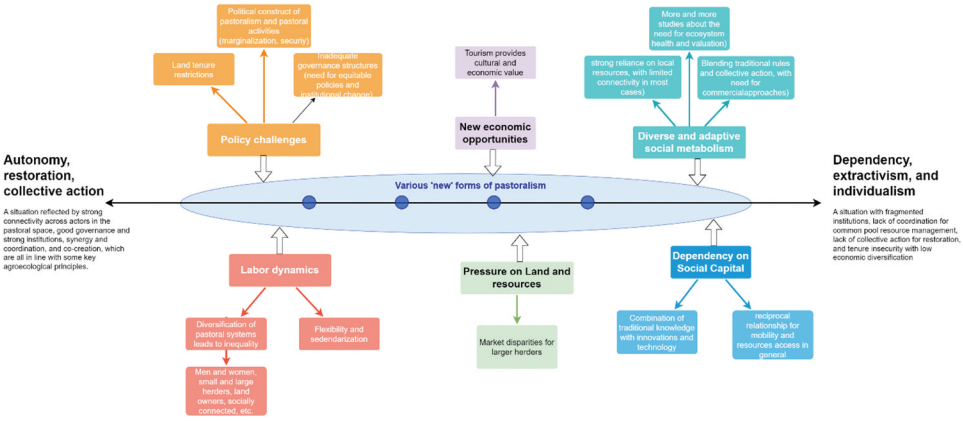

Figure 3. Conceptual framework: explaining pastoral systems transition using a political economy lens (source, own elaboration based on (McKay, Nehring, and Catacora-Vargas 2024).

these trends show that pastoral systems are indeed moving further away from key principles such as biodiversity (loss of traditional arrangements for restoring and maintaining biodiversity and biomass, such as grazing, etc.), synergies (between livestock production as part of its rangeland ecosystem) (Wezel et al. 2020), co-creation (or rules and governance mechanisms) (Nicholls et al. 2020), landscape governance (as illustrated by local leadership and authority), fairness and equity (as land demand and privatization mostly lead to inequality).

On the other hand, new configurations and characteristics of pastoral systems indicate that some agroecological principles and aspects have been further strengthened. Examples include connectivity through roads and telecommunications infrastructure (FAO 2001; Leeuw et al. 2019), economic diversification through activities such as tourism and recreation (Jose and Dollinger 2019; Leeuw et al. 2019; Timmermann and Félix 2015), participation of additional actors from the wider food systems in pastoral areas fostering co-creation of new knowledge (Nicholls et al. 2020) through the involvement of NGOs, researchers and other actors (FAO 2001; Jose and Dollinger 2019; Leeuw et al. 2019; Traoré et al. 2019), recycling through the sale of manure to sedentary farmers (Leeuw et al. 2019; Traoré et al. 2019), animal health through greater involvement of government veterinary services and related markets (Botreau et al. 2014; FAO 2001; Pastoral 2003).

Agroecology principles and elements of transition pathways in pastoral systems

As suggested in Section 2.2, agroecological principles can be reflected in many of the practices, rules, management and knowledge of pastoralists and pastoral societies, and are consistent with them. However, the question is whether agroecology can be used to generate metrics for measuring agroecological transformation in these pastoral systems and capture the political dimensions

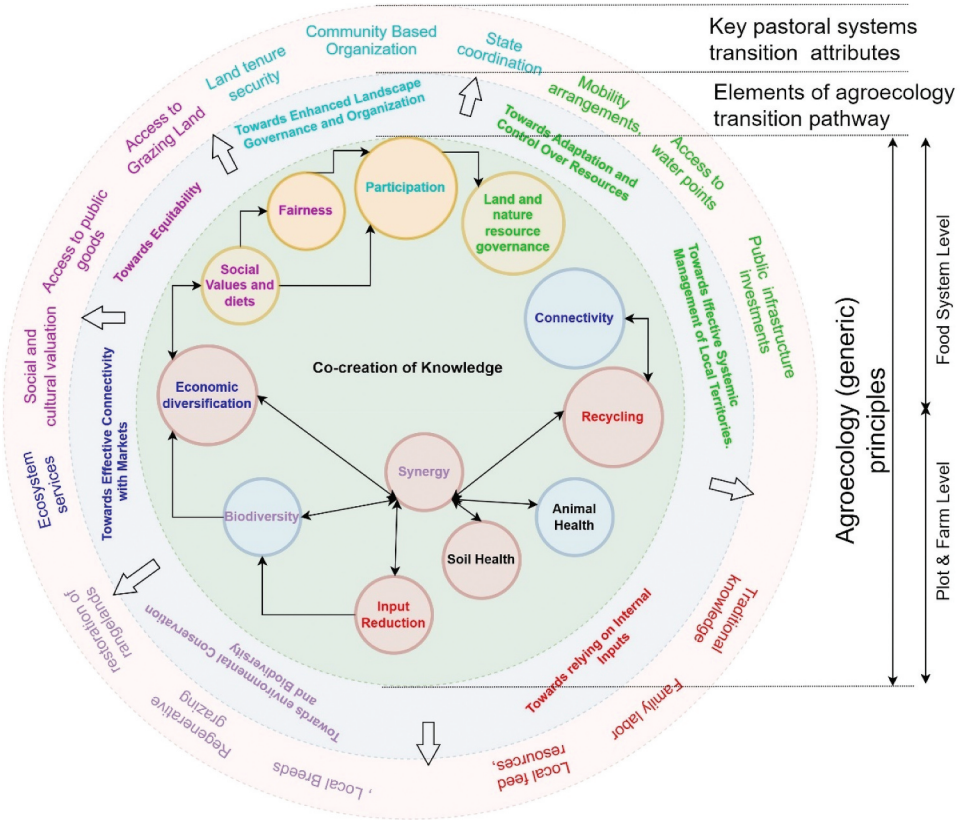

Figure 4. Agroecology principles and elements of transition pathways with key features and attributes from pastoral systems and territories (own elaboration, as adapted from: HLPE 2019). (legend: the color indicates the mapping between agroecological principles and the corresponding elements of the agroecological transition and the attributes of pastoral systems.).

of such a transformation. Figure 4 further summarizes all the principles of agroecology in a new framework based on seven elements of a transition pathway (Gliessman 2016; Gliessman and de Wit Montenegro 2021; Wezel et al. 2020) of food systems toward agroecology.[1] A keynote from reading Figure 4 is the issue of scale of action, where pastoral systems are socially complex; a landscape analysis approach is needed given the many interactions that pastoral societies undertake and structure together with neighboring tribes and other actors in the system. Informal arrangements between tribes for fluid and flexible mobility across each other's land during years of drought are an example of this complexity. Nevertheless, despite the absence of the plot-farm level in pastoral systems, the relevant agroecological principles as defined for this level in the HLPE (2019) framework remain valid, except for soil health and recycling. While soil health and recycling are not highly relevant for pastoral systems based solely on grazing, they may be more relevant for "hybrid" forms of agro-pastoralism. Figure 4 also shows that key

attributes of pastoral systems can be suggested for each element of the agroecological transition characteristics.

In fact, based on Figure 4, agroecological transition pathways in pastoral systems can be measured by progress on the seven key elements such as reliance on internal inputs (where we assess the extent to which pastoral systems rely on locally available resources rather than external inputs such as feed, seed, fertilizer in the case of agropastoralism, etc.); shift toward equity (considering equity in access to land and resources and benefits among pastoralists); conservation of biodiversity (collective action for rangeland resting and related management aspects); environmental conservation and biodiversity (where we can assess and evaluate how and whether pastoral systems contribute to or undermine the ecological sustainability of rangelands); progress toward local adaptation (where we can examine how well pastoral systems adapt to local and changing socio-environmental contexts and how these adaptations affect access, use, restoration and sustainability of natural resources); and the transformation of governance systems and mechanisms (where we can measure and examine collective governance mechanisms for landscape and resource management and their degree of adaptation to changing contexts).

Why political economy is a suitable framework to explain pastoral transformations and dynamics

The term "political economy" has been, and still is, applied in a variety of ways. It is a comprehensive analytical approach that integrates a range of political, economic, social and environmental factors into coherent, comprehensive frameworks to explain the dynamics of change and transition in systems. Such a framework helps to understand the complexity embedded in pastoral socio-ecosystems, which are usually influenced by many interrelated factors of different kinds, such as political and government regulations, general ideas and perceptions about pastoralism, power relations in pastoral areas and societies, economic values and the market, social equity and inclusion, and environmental degradation (African Union 2010, Byiers, Vanheukelom, and Kingombe 2015, Hatfield and Davies 2006)).

Understanding power dynamics: one of the problems of rangelands, as a common pool resource requiring collective action and participatory management, is one of governance. The governance of rangelands, and pastoral resources in general, involves different actors such as governments, local communities and external stakeholders, making it typically a political economy problem of power relations that shape policies (Nandi, Krupnik, and Kabir 2023) and decision-making for resource use and control (African Union 2010) at different levels. In this context, political economy frameworks can also help to understand the processes of resource control (especially land,

biomass and water points), explaining how control over resources is often contested among different actors and affects the livelihoods of pastoral communities (African Union 2010).

There is also a constructed common idea (or confusion) about the value of rangelands, with a lack of consideration of non-values associated with pastoralism, ecosystem services, biodiversity, cultural heritage and knowledge, etc (Byiers, Vanheukelom, and Kingombe 2015; Hatfield and Davies 2006). Rangelands are often perceived as being marginal lands that are useful for grazing, with the idea that pastoral areas are poor areas that need support because of the extensive farming practices that take place (Sandhage-Hofmann 2016). By better emphasizing holistic economic analysis, political economy supports the development of rangeland policies that are better based on evidence and holistic assessment (Hatfield and Davies 2006) and that support the empowerment of pastoralists (African Union 2010). In the same line, political economy also supports looking at how actors are (or can be) connected to broader markets and in an efficient way (Byiers, Vanheukelom, and Kingombe 2015). This helps to better recognize their contributions. Similarly, political economy can also support the analysis of social metabolisms, especially in relation to resource sustainability, including understanding how the ecological dynamics of rangeland (and other) resources are adequately taken into account in resource management (Nandi, Krupnik, and Kabir 2023). This also includes analyzing how policies can support adaptation strategies for pastoralists facing climate vulnerability (Byiers, Vanheukelom, and Kingombe 2015).

An illustrative case of pastoral systems dynamics from the Dhaher pastoral area in south Tunisia

Shift of policy mindset for pastoral areas in Tunisia during the previous five decades

In Tunisia, semi-arid and desert regions account for around 77.6% of the country's total area. Rangelands cover 4.3 million hectares (Frija et al. 2023) and are primarily located in arid zones. They are vital source of livelihood for rural pastoral communities who rely on livestock farming. Historically, rangelands in Tunisia supplied up to 65% of livestock feed, but this figure has dropped to 10–20% today due to degradation and changing feed sources (Fetoui et al. 2021; Frija et al. 2022, 2023).

Since independence, four main periods have marked the evolution of Tunisian pastoral policies and experience in rangeland development. A top-down approach, from the 1950s to the 1970s, that prioritized state-led resource management and modernization: This is a first period in which state policies aimed to centralize control over rangelands through land

demarcation, settler access and sedentarisation of pastoralists. Rangelands were integrated into the overall development policy of watershed management to reduce water erosion. The legal and regulatory framework for rangelands in Tunisia during this period was characterized by a land policy aimed at demarcating and clarifying land ownership to facilitate access to land for settlers and the sedentarisation and control of pastoral populations. Recognition of socio-economic and tenure dimensions during the 70's to the end of 80's, with underlying failure of purely technical or legal interventions in managing complex socio-ecological systems. This period was marked by the attempt of extension of state control over rangelands through privatization of collective lands and integration into forest regimes, thus attempting to formalize land tenure and align rangelands with broader agricultural development objectives. During this period, there was a desire on the part of the government to integrate and intervene in the collective lands with a vision of silvopastoral development (law establishing the regime of collective lands in 1964, law on agricultural and pastoral development in 1963). This was the reason for changing the legal status of these areas to "forest status." This period was also marked by the recognition of the importance of the socio-economic and land tenure dimension in the success or failure of pastoral rehabilitation projects, and of the need for pastoral development to be multi-sectoral and multi-dimensional in order to avoid contradictory interventions, such as the promotion of olive plantations at the expense of grazing land.

The third period, from 1990 to 2011, was characterized by a participatory model as an argument for promoting pastoralist associations and territorial partnerships as a way of decentralizing management and involving local communities in "solving their local problems." This period was marked by a deliberate political priority for the development of rangelands and forests, materialized through the implementation of two national strategies and major pastoral development projects (financed by IFAD and called PRODESUD) in the large rangeland area of the Tataouine Governorate in the south of the country. These projects continued public investment to combat desertification and erosion in rangelands (through the DGF and DGACTA), while recognizing and involving greater participation and partnerships with local communities and territorial units (tribes), with an (early) integrated approach to territorial development. During this period, the government also invested heavily in the creation of pastoralist associations (Sghaier et al. 2025), which are a form of farmers' organizations that bring together all rangeland users in a given collective rangeland and regulate access and management of grazing and other activities in the same region with the help of government technical agencies, mechanisms, and regulations. However, this policy was not highly successful and resulted in mixed performances of these associations (Sghaier et al. 2025).

Finally, a fourth period can be considered as the post-revolution period (2011), with reconfiguration of power dynamics where state authority is tempered by community agency, although significant tensions remain between political, social and environmental objectives. This period experienced profound changes in both political and socio-economic terms. Forests and pastures have suffered serious violations that have seriously threatened their sustainability, given the weakness of state services during the first ten years of the revolution. At the political level, the establishment of the new constitution in 2014 legitimized and further supported the participatory approach and partnership agreements between social actors, particularly for access to and use of rangelands. The year 2016 also allowed the promulgation of the law amending and complementing the one of 1964, which established the system of collective land, emphasizing the collective right and use of rangelands by all community members.

Transformations of institutions and power relations

Rangeland governance in Tunisia is currently characterized by a major effort and a deliberate political will to reduce the dependence of local institutions on the administrative structures of the state. In fact, significant progress has been made in changing the mode of rangeland governance toward new forms of decentralized management that provide more space for the participation of rights holders and users in the planning and implementation of development activities in their territories and more involvement in decision-making processes. This also includes some efforts to establish more flexible legal frameworks for land access and use rights, thus allowing for greater tenure security, which can lead to a shift toward improved and diversified economic activities in these rangelands, more oriented toward further ecosystem valorization and diversified economic activities.

Figure 5 shows the evolution of the institutional framework and rangeland management modes over time. The Miâad, a traditional informal structure within the pastoralist tribes formed by notables, has gradually been replaced by a formal structure called the Collective Land Management Councils (CLMCs). The CLMCs are now responsible for organizing and planning the use of grazing lands, managing the collective land privatization process, implementing resting and other restoration techniques, and addressing land tenure conflicts (Mares and Lahmayer 2019; Sghaier 2010). Since 1999, another form of community-based organization (CBO) has been created (Law No. 99-43 of May 1999[2]), currently called GDA (*Groupement de Developpement Agricole*). GDAs are governed by a general assembly that meets once a year. The GDA is managed by a Board of Directors (GB) consisting of 3 to 6 administrators elected by secret ballot by the General Assembly from among the members. The decision-making structures/

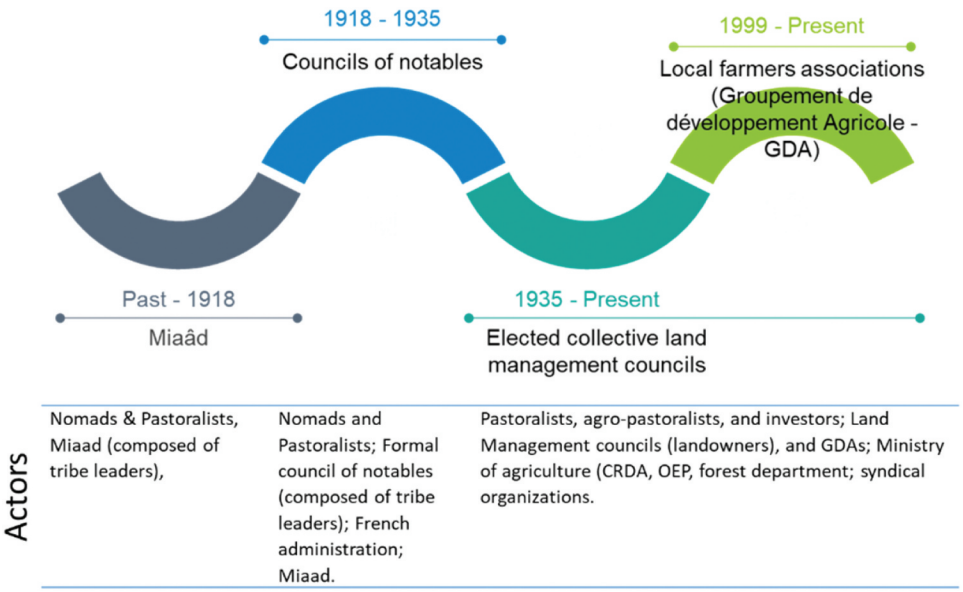

Figure 5. The most significant "rangeland governance" institutions and contributing factors that operated during the previous century in south Tunisia (source: Frija et al. 2022).

processes for the rangeland unit are based on customary institutions and decision-making procedures. In fact, LMCs and GDAs in their current forms are nothing more than the formalization by the state of the traditional informal institution called Miâad. While the Miâad encompasses all social functions and decision-making regarding the management of collective resources (pasture, water, wildlife, etc.) for the tribe, the current institutions are much more specialized in specific tasks, the LMC taking care of the management of collective lands and the GDA covering the agricultural and pastoral development issues in its territory.

Collaborative governance is established between CBOs (GDAs, CLMCs), administration (CRDA/PRODESUD/OEP), local authority (delegate), research (IRA & ICARDA), farmers' association (UTAP) and local NGOs. The administrative actors, such as CRDA and OEP, ensure rangeland management through CBOs (GDAs and CLMCs). Where the technical public agencies such as CRDA and OEP play the role of planning, implementation, monitoring and evaluation of rangeland management and restoration. Recently, a more favorable legal framework has started to emerge (SMSA[3] and CS) to promote farmers' cooperatives, in a more entrepreneurial spirit, compared to GDAs, which are nonprofit entities. SMSAs and CSs (civil societies) are forms of collective entrepreneurship that are promoted by the government through the creation of more favorable legal and financial incentives. The aim is to use market forces to induce private investment in rangeland services and pastoral territorial development in general, including the development of value chains.

However, the political economy of these reforms remains driven and shaped by the government orientations and reforms. State agencies such as CRDA and OEP also remain key in planning, implementation, monitoring and capacity development. The collaboration between government agencies and pastoral communities (as represented by these organizations) suggests a hybrid form of governance, with a combination of bottom-up and top-down interventions. With local actors empowered by the revolution and decentralization, the continued involvement of the government agencies in key action areas suggests a negotiation of power between central authorities and local stakeholders. This reflects a political economy situation where state control is tempered by participatory governance but the balances between these different forces remain dynamic and changing according to the institutional frameworks and context.

Pastoral systems diversity and typology in Dhaher: different resilience strategies and agroecological trajectories

Our case study includes pastoralists from the collective rangeland area called "Dhaher" (Figure 6) covering around 50,000 ha of collective rangelands usually used for animal grazing. The Dhahar area has an exclusively pastoral and grazing vocation, where the rangelands, subject to the forestry regime, are collectively managed and governed through a pastoral farmers' association, called GDA Dhaher. The Dhaher area includes a mountain chain called the mountain Dahar (on the west) and a much broader desertic plan dominated by what is called the "Grand Erg Oriental."

Four types of farms can be identified in the area, distinguished by the structural and technical characteristics of the pastoralists and their recent dynamics and changes. The following description is taken from various literature sources and related data, and in particular from the technical reports of the PRODEFIL and PRODESUD projects (Fetoui et al. 2021; Frija et al. 2022; Frija 2023; Robinson et al. 2021; Sghaier et al. 2020, 2024, 2025). An illustration of agroecological transformations and dynamics of these systems is presented in Table 1. The four types can be described as follows (Alary and Frija 2023, CRDA 2022):

- Diversified agropastoral system: these are sedentary pastoralists who have maintained their livestock activities (mainly sheep and goats) and pasture grazing. Usually, one member of the family is responsible for grazing. The family usually acquires new land in the Piedmont or in the plain, where they begin to diversify their activities. This type owns between 100 and 200 small ruminants and between 25 and 30 hectares of agricultural land. The main crop activity is olive growing, with an average area of between 3 and 12 ha (Selmi and Elloumi 2007).

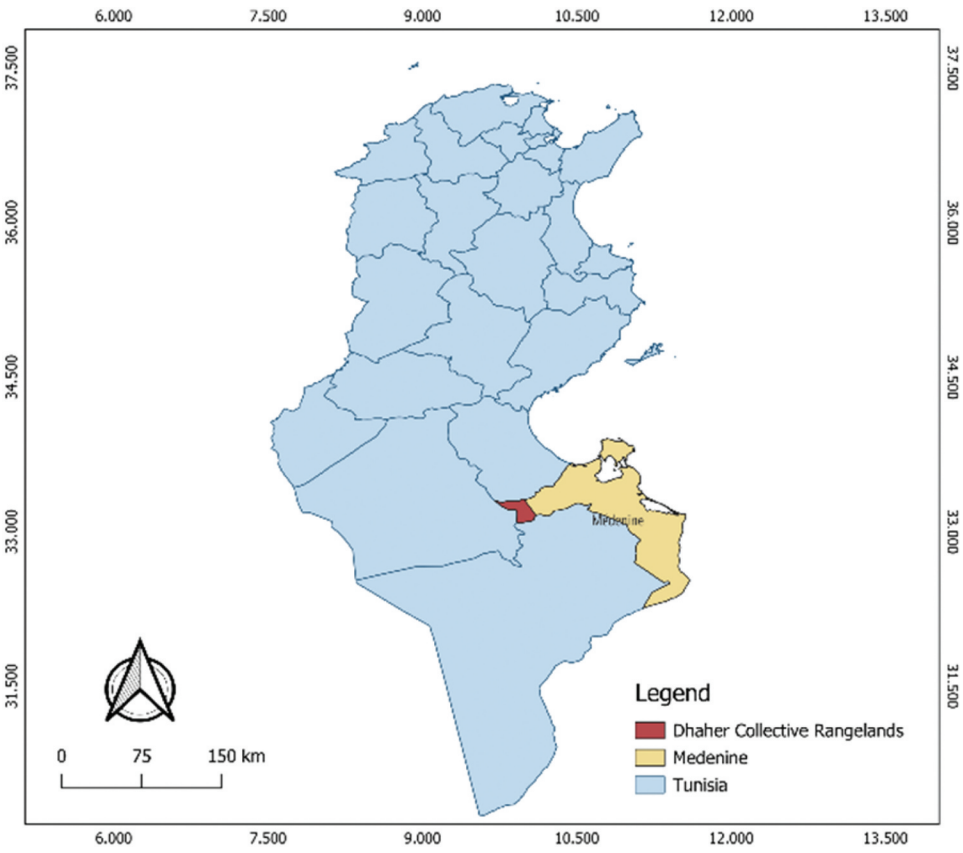

Figure 6. Map of the study area.

- Smallholders based on supplementary irrigation from Jessour-based water harvesting systems, with limited livestock activity. This system has its origins in mountain pastoralism, which has been extended to include the cultivation of olives and figs on plots in the Piedmont or on the plain close to the mountains. Their cultivation systems also include other crops such as pomegranates, certain varieties of dates and almonds. In good years, when irrigation is possible and accessible, these farmers also grow horticultural and vegetable crops. They also intercrop lentils and cereals (mainly barley for food and fodder) between the rows of trees, especially in years with good rainfall. Livestock (mainly small ruminants – sheep and goats) are also integrated into these farms. However, the herd is kept on the farm until spring, a time when the farmers group their herd together and hire a shepherd to take them out to pasture (for an average of three months). herd sizes do not usually exceed 50 head. The average farm size in this category is between 15 and 20 ha (CRDA 2022).
- Specialized pastoral system: this system is represented by those pastoralists who still make considerable use of pastoral resources for grazing

Table 1. Diverse "agroecological" profiles of the current pastoral farm types in Dhaher, south eastern Tunisia, their trajectories, and explicative factors.

Pastoral System Type	Towards Relying on Internal Inputs	Towards Equitability	Towards Environmental Conservation & Biodiversity	Towards Local Adaptation & Control over Resources	Towards Effective Systemic Management of Local Territories & Resources	Towards Enhanced Landscape Governance & Organization	Towards Effective Connectivity with Markets
Diversified Agropastoral System (mainly through additional land acquisition for tree plantation)	Efforts towards diversification means reliance on more external inputs. Need for external capitals, aids, and knowledge (from family, community or state) to support transition towards diversification (Vall,et al., 2023)	Lack of tenure security, access to land is not equal across community members, thus problems of equity and fairness (Telleria, 2014). Change of production systems is not also equitable towards men and women.	Better for the environment as less pressure on grazing resources and rangelands. More diversification at farm level, with conservation of local seeds and biodiversity (Sghier et al., 2020).	Tree cultivation remains dependent on climate and/or access to supplementary irrigation. No control of farmers on water or land as this is under state and collective control (Sghier et al., 2020)	Increasing investments in public goods and services such as water points, resting areas, roads, etc (Daly, 2016).	Farmers are not necessarily better organized collectively for territory planning (as the case for pastoralism). Land titles are private thus leading to induvial decision making (Telleria, 2014).	Better connection with market, especially for olives and fruit marketing (Telleria,2014).
Small-Scale Agropastoral System or Agricultural System with Livestock or Water Harvesting System (Jessour-based)	New configuration of the production system with new opportunities and challenges. But usually these remains system with low level of inputs and good levels of recycling (residues and manure) (Calianno, 2020)	No problem of tenure are these systems are usually established in mountainous areas. Internally, women have more income generating opportunity at farm level.	Protection of landscape against erosion. Cultivation and conservation of local crops and varieties, thus conserving genetic resources.(Genin, D. (2006))	Water harvesting techniques used are strong adaptation technique which fits to context and contribute to the autonomy of the system. Low need for water and land thus available resources remain under control (Jebari et al., 2015)	The used techniques are highly useful for territory management and planning. System management is well documented through crop livestock integration and diversification of activities (Sghaier et al., 2020).	Jessour systems remains farm based, they are not encouraged by the state (Calianno, 2020), and nor involve strong community governance arrangements. Contribution to this transition element is low. However dynamism of local associations, especially worm associations?	Limited but evolving connectivity as traditional systems are usually of low area, productivity, and aim to self-sufficiency.
Specialized Pastoral System: extensive use of pastoral resources	Very low use of external inputs for livestock activities. Highly independent system, as mobility is key and grazing is the main source of feed. (Rjili et al., 2023)	Equitable in terms of access to land, but, nowadays, limited equitability as overuse of resources (by new large investors) can disadvantage smaller pastoralists. Also, dominance of large herders in community for access, use and decision making	Conservation efforts are minimal after dismantling of traditional Miyaad (Sghaier et al., 2024) Situation today is that overgrazing leads to environmental degradation. Many rangelands are fully degraded to an irreversible way in the region. (Louhaichi, et al.,2021)	New technologies allows stronger adaptation to local conditions, feed supplements, communication and mobility through trucks, etc. Control over resources is also growing with more and larger private investments (Rjili et al., 2023)	Increasing public investments in rangeland infrastructure, roads, telecommunication, etc. Pastoralists have access to new technologies that supports planning and coordination (Frija et al., 2023), including digital tools like smartphone.	Attempts are made to enhance governance, but progress remains inconsistent due to conflicting stakeholder interests. Management is often weak due to overexploitation and lack of collective action (Sghaier et al., 2024).	Market is a key element for this system and increasingly important for feed and livestock products. Local demarcation of products is evolving.
Abandoned Pastoralists: Olive Tree Specialized System	High level of relying on external inputs for the different new cropping systems in place.	Access to land is depending on many factors that are not necessarily equitable and/or lead to equitable access and use of land and water.	Increasing use of chemical fertilizers, groundwater depletion, mono-cropping, etc.	Involving innovative knowledge and technical packages for high productivity, local adaptation. Full control over land and water resources.	Systemic management is weak as this system is rather based overuse of water and intensive exploitation of land. State efforts to regulate and manage at territorial level are not always up to the demand.	Local governance is often minimal or fragmented as pastoralists disengage from collective resource management to rather individual farms with independent decision making.	Connectivity with olive oil markets is high, with ongoing development of brands and better marketing channels (Ounali et al., 2019).

Legend: each cell color shows the trend toward the agroecology "transition element", (green: favorable trend toward the element; Orange: unfavorable trend toward the element) with content explaining these trends through political economy factors (Daly 2016).

combined with mobility. According to the latest CRDA statistics (2021), there are about 42 flocks of about 500 sheep and goats grazing permanently in the Dhaher region. Each of these flocks is usually managed by a shepherd who is mobile with his own family (or part of it) throughout the community's grazing land (estimated at around 45,000 ha). The shepherd and his family usually live in a tent during the mobility process.

- Specialized olive tree system: This system has been developed in collective pastures that have been privatized. In total, a few hundred hectares of land are now under olive cultivation, but the same farmers also keep medium-sized herds, averaging around 50 animals each.

Heavy weight of political economy factors in explaining the historical transformation and the current challenges

Overall, from a political economy perspective, the resulting diversified agro-pastoral systems that exist today in the Dhaher region are increasingly

dependent on external inputs, but at the same time continue to create synergies between crops and livestock within the farm and/or landscape. This is the case of some systems that promote short-term seasonal grazing and the use of manure in other complementary crop activities. These systems also remain centered on family labor, land and water resources, and vulnerable to market fluctuations. Access to land and tenure security remain a key threat to the wider expansion and development of some of these agro-pastoral types in the future. Smallholder farming with Jessour water harvesting remains one of the most agroecological systems in the area, as it is also one of the most traditional systems, having accumulated traditional knowledge and local adaptations over centuries (Table 2), but the labor-intensive nature of these systems (usually devoted to subsistence) threatens their further expansion due to demographic changes and rural exodus, especially of youth (Pappagallo 2023). Surprisingly, the resulting new form of "exclusive" pastoral systems, as they have developed

Table 2. Key characteristics of the existing pastoral farm types in the region of Dhaher, Tunisia, as expressed in terms of key political economy attributes (suggested in McKay, Nehring, and Catacora-Vargas 2024) of each type.

Pastoral farm Type	Social Metabolism	Social Organizations	Labor Dynamics	Policies and Politics	Markets and Resources
Diversified Agropastoral System	Moderate dependency on external outputs with synergy between livestock and other cropping activities, and support of ecosystem health due to the short period grazing and use of manure.	Family-based organization as based on private land cultivation and own family resources. Family organization supports diversification and resilience.	Family-based labor division and internal tasks distribution across grazing and farm works.	Limited involvement in political coalitions. Historically benefited from land privatization and titling. Mixed use of private and collective rangelands	Requires markets for access to key inputs, and for marketing crop and livestock products. Vulnerable to market volatility and climate variability.
Smallholder Farmers with Jessour-Based Irrigation	Low to moderate dependency on external inputs as they have access to own water resources, seeds and other inputs. Support ecosystem health through diversification of crops and maintaining local genetic resources, and low periods of spring grazing.	Moderate requirement of collective action for temporary grazing. Farmers are not necessarily organized into community-based organizations (CBOs).	Labor intensive tasks for water harvesting structures preparation. Low labor productivity given the limited areas, and the dependency on rainfall events and supplementary irrigation. Family based autonomy for labor.	Tenure issues and water access rights create inequality among local community members. Limited broad coalitions formation, given the focus on sloped lands in mountain piedmont.	Limited market involvement with mostly focus on local products. Development of string local markets demarcation for olive oil, figs, and goat, based on valuing local genetic resources of trees and livestock breeds.

(*Continued*)

Table 2. (Continued).

Pastoral farm Type	Social Metabolism	Social Organizations	Labor Dynamics	Policies and Politics	Markets and Resources
Specialized Pastoral System	High reliance on collective rangelands for animal grazing; very low dependence on external inputs (except complementary feeding in some periods of the year); continuous mobility which supports ecosystem health.	Strong community organization, both formal and informal to manage access and use of collective rangelands; traditional cooperation networks; reluctance from formal CBOs except for access to feed and watering services.	Labor-intensive and labor sharing for livestock keeping, which depends on mobility of the whole family; labor productivity is dependent on the rainfall events, thus rangeland ecology and livestock productivity.	Collective rights under pressure with increasing demand for additional investments from community members in livestock and grazing; state subsidy for infrastructure development in roads and water points.	Large flock size provides better market weight; social organization for access to inputs and services, but private action for selling livestock products.
Olive Tree Specialized System	Depends on external inputs, with moderate contribution to ecosystem health through integration and circularity with livestock activity (feed from residues and manure as fertilizer)	Farms are privately managed with almost no collective action and aggregation. Very limited community engagement and organization even at value chain level. But link with administrative offices?	Often rely on hired workers. Reliance on labor market for both olives and livestock. Overall, higher productivity compared to other groups.	Land is mostly private, with limited involvement in communal grazing areas. Privatization can lead to exacerbated inequality.	Primary market involvement in terms of olive oil, with limited connection with markets for livestock.

Source: this table is compiled from different relevant sources available in the literature (Fetoui et al. 2021; Frija et al. 2021, 2022, 2023; Sghaier 2010; Sghaier et al. 2020, 2024; CRDA 2022, among other sources cited in Table 1; Sghaier et al. 2025).

and become established today, is one of the least agroecological (Table 2). They face problems of power relations, lack of state-community coordination and external intensive investments by the landowners, who are the most influential in the pastoral area. However, they have a high productivity due to their extractive power of natural resources and strong links to livestock markets.

Conclusion

This paper explores the importance of recognizing the current diversity of pastoral systems, as they have emerged from the different transformations they have undergone in the last few decades. The paper also examines the

transformative dynamics of these systems and their respective challenges within the agroecological framework. It is acknowledged that sustainable transitions in pastoralism require a deeper understanding of socio-political drivers and tailored interventions. In particular, we found that government orientations and reforms, collaboration between government agencies and pastoral communities, combination of bottom-up and top-down state interventions in pastoral territories, power negotiations balance between central authorities and local pastoral actors, as well as state control approaches mitigated by participatory governance were all political economy approaches implemented, tested and piloted in pastoral areas in south Tunisia during the last five decades. Most of these approaches were combined with a narrative construct around pastoral systems and territories qualifying them as marginal, with low profitability, and security sensitive. None of these approaches was really successful in supporting inclusive economic growth and rangelands sustainability.

Many of these political economy approaches and factors (market power, social metabolism, labor dynamics and migration, dependency on social capital) shaped the emergence of different hybrid forms of pastoralism with different agroecological characteristics. The paper shows that a combination of hybrid forms of agro-pastoral systems has emerged, as a result of these dynamics. However, the sustainability and alignment of the emerged systems with agroecological principles is not guaranteed. Some of these systems are far from being agroecological while others, (the most traditional) remain being agroecologically relevant but threatened by the lack of labor and demographic dynamics in the pastoral systems (particularly migration). In fact, the small agropastoral farming system that relies on water harvesting (Joussour) and operates with mixed crop-livestock systems can be considered as the most sustainable (and unchanged) form of mountain pastoralism in the study area in south of Tunisia. Another group of (only) pastoralists (group of pastoralists who continue to operate as mobile livestock grazers in the rangelands with no off farm or other agricultural activity), was found to be the least agroecological group, as they have become deeply involved with liberal markets and large investors, rely on external labor and feed, and thus consider sustainability and ecosystem balance as secondary.

Notes

1. These seven elements are a sort of adaptation (or hybrid) of the Gliessman levels combined with other transition elements.
2. *See more information here: https://www.fao.org/faolex/results/details/en/c/LEX-FAOC016304/.*
3. *"The Law 2005 defines SMSAs as companies with variable capital and shareholders constituted by natural and/or legal persons carrying out an agricultural activity, fishing*

or provision of agricultural services in the area of intervention of the society. The form of company with variable capital and shareholders is a logical consequence of the principle of free membership and withdrawal and open doors that govern societies cooperatives" (citation translated from Rhouma and Ahmed 2018, p 14).

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