# Adaptability of small ruminant farmers facing global change

## A North-South Mediterranean analysis (France/Egypt)

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## Introduction

The Mediterranean basin has seen a doubling of its population during the last 40 years to reach 450 million inhabitants, with one third of its population concentrated in the coastal zone, characterized by a high degree of urbanization. Conversely, during the last century, the hinterland of the Mediterranean coast faced a rural exodus accompanied by a decreasing land pressure that affected landscape dynamics in the North Mediterranean and caused a radical change of collective management in the South Mediterranean, disrupting long-term adaptation practices to climate variability. These changes relate to the urbanization and demographic pressure – with the unavoidable changes of cultural habits and

living conditions – and have direct and indirect impacts on natural resources and human well-being in the hinterlands. Since the last decade, the Mediterranean basin has also been considered as one of the 'hotspots' of climatic change, i.e. areas where temperature and rainfall are (and will be) particularly affected (Christensen et al. 2007) therefore reinforcing uncertainty in human activities. These levels of human pressure combined with the burden of climatic changes make these zones particularly vulnerable to future expected changes.

In this context, livestock activities based on small ruminants remain an opportunity to maintain a socioeconomic activity in the arid and semi-arid Mediterranean hinterlands, which represent around 3.2 and 2.25 million km$^2$ respectively (Le Houerou, 1990). At the farm level, livestock relies on the core functions of production, savings and capital, and also employment. Through the use of rangelands, livestock strengthens the links between Mediterranean cities and their hinterland but also between a multitude of institutions from family to the national or supra-national levels. It also occupies a central place in terms of alternative water uses, food, culture and tourism, knowing that the link between city and hinterlands suffers from the externalities of global change in terms of diet and management of natural resources. Nevertheless, while livestock activities have adapted well to recent changes in the short term, by adjusting their mobility and thus their ability to occupy new lands, their mid- and long-term adaptation to ongoing changes in terms of impact on the environment and the society remains uncertain and presents a challenge for both local and regional decision makers.

The choice of a comparative approach between Provence Alpes Côte d'Azur in France (PACA) and the north coastal zone of western desert in Egypt (CZWD) is based on the idea that analyzing the diversity of adaptive processes according to contrasting historical, cultural and socioeconomic contexts can highlight the magnitude of changes and illustrate whether or not adaptive capacities vary according to the context.

## Case studies

Egypt is located in one of the world's most arid regions: Only 3.4 million ha are arable and more than 95% of crop lands are irrigated with the Nile water. The production system is mainly a mixed crop livestock system based on irrigated fodder and food crops and feed supplementation for animals (Tabana et al. 2000). In the rainfed CZWD, populated mainly by Bedouin breeders, we can distinguish four main systems according to the four agro-ecological zones (Matrouh project, 2002): *"(i) a narrow coastal strip, about 5 km inland, which has good alluvial soils and where horticulture is the main farming activity, with livestock and barley; (ii) a mixed production strip, 5-15 km inland, of lower rainfall and soil quality, where a mixed small ruminant-barley farming system prevails with orchards in the wadis (seasonally dry riverbeds) [photo 1]; (iii) a rangeland strip, 15-50 km inland, of semi-nomadic population, largely based on seasonal transhumance; and*

*(iv) a zone beyond 50 km inland, where a nomadic population lives on animal production, mainly camels*". Our study was based on a farm survey (175 farms) along a west-east gradient, from rainfed and oasis zones with livestock-crop-tree systems to mixed crop-livestock systems in new reclaimed lands. This gradient allows different agro-ecological and sociological zones to be considered according to the tribe composition of the Bedouin society as well as the influence and proximity of urban life.

*Photo 1*
*Wadi bed, Mixed small ruminant-barley-Orchard (Fig trees) system. Marsa Matrouh.*
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In the French North Mediterranean coastal zone, sheep production is the most prominent type of ruminant breeding. This activity is spread along a gradient of increasing density over the distance from the coastal zone with an increasing specialization in livestock activities to benefit the hinterland. In the PACA region, farms managing flocks of more than 750 head increased by 40% between 1993 and 1999. This specialization was initially made possible by an increase of forage cultivation on released land (benefiting from rural depopulation) and the increased productivity of cultivated forage (sometimes associated with the development of irrigation schemes). The use of uncultivated areas encouraged by recent public policies promoting and facilitating the development of pastures on these lands has further increased this trend (PHAE *Prime Herbagère Agro-Environnementale*, AEM Agro-Environmental Measures, and CAP *Common Agricultural Policy*). In the French context, livestock issues primarily focus on reducing environmental risks exacerbated by global change (biodiversity loss, fire). The assumption is that the structuring of the landscape, to which pastoral livestock practices highly contributed, can promote the adaptation and adaptability of ecosystems. Natural hazards such as climatic uncertainties that disrupt the regularity of available feed resources and environmental changes such as reappearance of predators may question these landscape-level processes. Another issue faced by livestock is its ability to respond

to societal expectations in terms of contribution to local development at territorial (local constituency) level. It was thus relevant to analyze and develop the capacity of co-evolution of these livestock systems, paying particular attention to interactions at local constituency level and diversity in management as a resilience factor (Rammel et al. 2003). The research was based on an important data collection system on present and past trends using archived information, and drew up a retrospective and current agrarian description based on interviews.

## Conceptual framework

Figure 1 presents the three 'entities' used in Frazer (2009): (i) the agro-ecological system whose robustness can be appreciated by its natural diversity; (ii) the traditional, formal and informal institutions that increase/decrease the capacities to respond to shocks like climatic ones (drought, flood, etc.); and finally (iii) the family livelihood based on the diversity of assets. This triangular presentation shows the links between each component and explains the whole adaptive process at each level. For instance, traditional or formal institutions can reinforce or reduce the diversity of livelihood or agro-ecological systems by acting on resource distribution (livelihood) and resource use (agro-ecological system). Typically, the south Mediterranean drought policy (feed distribution at low price) has reduced the agro-ecological diversity, leading to over-stocking and desertification on pastureland. The loss of agro-ecological diversity has reduced one of the major adaptive processes of livestock systems based on mobility and has consequently led to an increase in rural exodus. So the question we now face is: *how does the institutional network influence livestock management and, as a consequence, the agro-ecological system?*

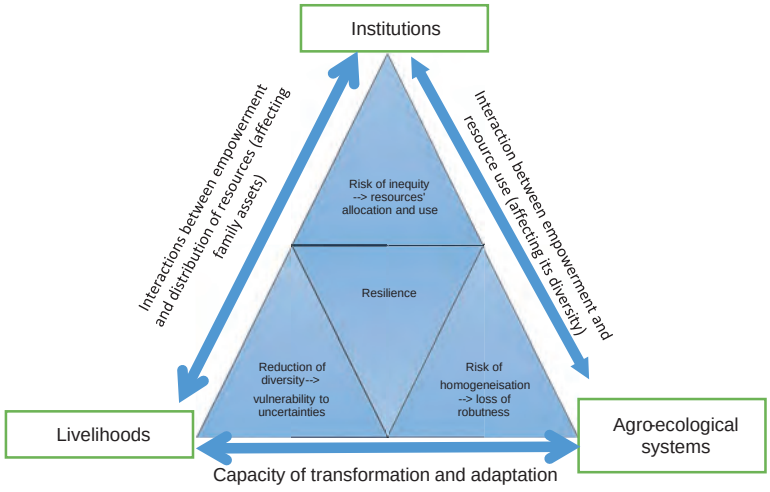


*Figure 1*
*The three entities for analyzing the adaptive process (adapted from Frazer, 2009).*

# Results

Two main groups of institutional stakeholders with direct or indirect impacts on livestock development have been identified in the two countries: (i) the breeders' network in direct link to the livestock activity; and (ii) the local development agencies comprising the local constituency (territory) or government agents.

Breeders' networks consist of similar agents with common objectives (meat production and resource access) but are under different authorities and rules: families and tribes in Egypt *vs.* development-oriented groups in France. At the two sites, this group reflects the objective and power of large breeders. The local development groups (territorial agencies in PACA or development projects and governorate officials in CZWD) are similar from the point of view of 'public policies' but differ in their local involvement. In PACA, the majority of stakeholders involved in these territorial entities are from the region itself, while in CZWD, most of them come from Cairo (at decision level). In PACA the trend is to give more financial autonomy to the region or municipalities, whereas in CZWD, these stakeholders are merely the relay of the central authority. This has had a major impact in terms of local development pathways.

Both countries exhibit dynamic changes in livestock activities in connection with breeders' networks which are the prevalent socio-economic actors. A typology of breeders based on mobility and animal performance in the agro-pastoral region of the CZWD shows that only the largest breeders were able to maintain long transhumance during the last 15 drought-years (1995-2011). The rate of profitability remained low due to high lamb mortality and the degradation of available resources. On the other hand, some small and medium size breeders have reduced feed supplements (mainly grains), adopting a strategy of maintaining a minimum productive livestock (lifesaving strategy; Photos 2 and 3), while others have increased feed supplements for maximizing the profitability per animal during drought periods, depending on other sources of income. In addition, the degree of diversification in off-farm activities is strongly correlated to traditional tribal organization (Alary et al. 2016). In PACA, the main dynamics are related to: i) the market, through the organization of short circuits of animal products (directly from producers to consumers), adapted to the new urban and touristic demand; and ii) a huge increase in labor productivity, taking advantage of grazing large flocks in large areas (Aubron et al. 2016). Large breeders' networks are therefore key-actors in maintaining the socio-economic functions of livestock activities at the two sites. They develop the economy in harsh environments, through the market in the North and through mobility in the South, with the risk of the social exclusion of small breeders that are not able to maintain the transhumance and are not well structured.

The role of local development agencies is more ambiguous. In CZWD, the extension of orchards through *wadi* development by development projects (coupled with the settlement policies of the 60s), has deeply transformed the traditional pastoral system based on mobility towards a settled agro-pastoral system, with a varied impact on the agro-ecological system and family livelihoods. This

development has favored private land tenure and increased farm diversity income, to the detriment of the collective management of natural resources which used to be a safety net for small farmers. It has also deeply affected the traditional tribal power that was based on social land management at a local level. The weakening of tribal power due to land ownership is inescapably reducing its social security role in the Bedouin community in the face of hazards including drought. This process has also been favored by recent social changes in connection with demographic growth and widespread urban life-style. In PACA, while local authorities may have a significant social role in helping small breeders make a living, their role is modest for the majority of medium and large breeders who benefit from national and European subsidies. This has favored the re-emergence of transhumant models (summer and winter mobility) within different environmental programs (brushing and biodiversity; fight against fire; tourism development), including mobility beyond administrative PACA areas.

*Photo 2*
*Grazing in poorly developed barley field. Marsa Matrouh.*
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*Photo 3*
*Storage of barley straw in dryland area. Marsa Matrouh.*
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# Discussion and conclusion

Results at the two sites show that the local (territorial) perception of development is often far removed from the spatial dynamics of livestock that generally favor a diversity of livelihoods at landscape level. An approach based on the administrative borders of the local constituency prevents mobility-based coherent livestock management, although mobility, driven by agro-ecological conditions and stakeholders' networks, is the main livestock adaptive strategy in the face of climate change. Nevertheless, these networks have favored agricultural development (mainly through irrigation in PACA or wadi development with orchards in CZWD), and consequently the emergence of a new integrated livestock - crop model based on local fodder and concentrate in CZWD and a pastoral model in PACA to face loss of lands newly devoted to high yield irrigated cropping systems. This shows the capacity of livestock activities to reach new agricultural areas (therefore adapting to land pressure) but also to respond to local food demand emerging with new life styles. This permanence, yet adaptability, of livestock confirms its role as a security net in this type of harsh environment.

The use of the Fraser framework has raised questions about the place of an institutional approach in understanding the complex transformation of the livestock system. This framework highlighted the differentiated roles of local development groups to support small farms and of socio-economic groups (such as tribes or breeders' associations) to maintain the spatial adaptive capacity of livestock activities facing Mediterranean challenges, including climate change. The adaptability of small ruminant systems appears to be a social and economic safety net and could be part of an environmental protection strategy, while recognizing the roles of stakeholders' organizations such as tribes or breeder associations. They should be given careful consideration in future local policies.

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