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Climate change-related risks and adaptation strategies as perceived in dairy cattle farming systems in Tunisia

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ABSTRACT

The perception of risks due to climate change by farmers and the measures they take to address those risks are of paramount importance in policy-making if the implementations of targeted adaptation and mitigation strategies are to be economically and environmentally sustainable. This study focused on Tunisian dairy farmers' perceptions of the risks and the actions taken to cope with changes attributable to climate change. Using a bottom-up approach, 566 surveys were carried out randomly among dairy farmers throughout Tunisia. A total of 70 diagnostic variables relating to farm characteristics, resources, management, performances and profit, in addition to climate change risk perception and adaptation strategies, were identified and analyzed. Using multivariate statistical analysis, four dairy farming groups were identified. The largest proportions of farmers belonged to the two above-ground dairy systems: without utilized agricultural areas; and with non-dairy utilized agricultural areas (Clusters 1 and 2). A minority of farmers belonged to medium-sized and large farms that specialized in milk production (Clusters 3 and 4) and has access to sufficient land, water and capital resources. In all the clusters, almost all the farmers perceived that the greatest impact of climate change would be on cow performance and forage production. The attitudes of the farmers towards adaptation to climate change are associated with farm typology. They focused mainly on increasing water capacity for livestock and crop production and improving livestock and housing conditions. The knowledge obtained from this study could be helpful for decision-makers and stakeholders in efforts to develop policies for farm management practices that address climate change and can be adapted to the country's diverse farming systems.

1. Introduction

Against a background of rapid demographic growth and considerable urbanization, since the 1960s many policies have sought to improve self-sufficiency in food production, including milk production (Sraïri et al., 2013). In Tunisia, policies have tended to focus on promoting intensive dairy systems, mainly in the north, and have relied on the import of exotic high-yielding selected breeds and the progressive substitution of local and cross breeds. The proportion of pure breeds increased from 6 to 29% between 1975 and 1992

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(MARH, 2006). The failure of the collectivization system led to the establishment of semi-private company-run large farms, in addition to the many small and medium-sized dairy farms in the Sahel peri-urban regions with zero-grazing systems and other private farms in irrigated regions (Elloumi and Essamet, 1997). Recent decades have been characterised by the spread of dairy farms across the whole country and a huge rise in the number of small farming units. The dairy sector is therefore characterised by a wide diversity of systems in the different agricultural areas.

North Africa, particularly the areas bordering the Mediterranean, has been classified as a climate change 'hotspot' (Giorgi, 2006). The location of Tunisia between the inter-tropical regions and the temperate regions of the northern hemisphere makes its climate particularly variable, and therefore particularly vulnerable to climate change. Tunisia is among the top 10 countries likely to suffer the greatest climate change impact in terms of population and gross domestic product losses (Dasgupta et al., 2009). A report by the German Technical Cooperation Agency showed that the climate change impact in Tunisia will include an increase of 1.1 °C in annual average temperature and a considerable decrease in annual precipitation (GTZ, 2007). There will be a 28% decline in the country's water resources and the loss of arable cropland is expected to be about 20% by 2030. Dairy farms in Tunisia are experiencing warmer temperatures, above the thermo-neutral zone of cows, for more than 5 months each year, which has reduced production efficiency and resulted in significant economic losses (Bouraoui et al., 2002). Drought years are frequent and sometimes occur over 2 consecutive years after no more than 3 consecutive years of normal rainfall. This has led to a reduction in the quality and quantity of fodder, which constitutes a key constraint in livestock farming in the country (Kayouli, 2006). The genetic expression of high-yielding breeds has been hampered and the ability of high-potential cows to cope with these harsh conditions and disturbances is questionable (Hammami et al., 2008). The expected climate change scenarios will accentuate these difficult conditions and affect the natural resource base, animal productivity and health, and the sustainability of livestock-based production systems (Salem, 2011).

Understanding farmers' perceptions and how they are likely to respond to short- and long-term initiatives aimed at helping all stakeholders withstand climate disturbances is a key factor in planning robust strategies for climate change mitigation and adaptation. Depending on their farming system, farmers have specific approaches, targets and solutions for combatting the effects of climate change. Classifying them into clusters and gaining a better understanding of their perceptions of climate change should help in the development of cost-effective policies on climate change resilience. The main objective of this study was to investigate Tunisian farmers' perceptions of the impact of climate change and explore possible adaptation strategies for the various cattle dairy farming systems in the country. A large farm survey was conducted in 19 governorates to establish a typology of Tunisian dairy farms and investigate the climate change-related perceptions of farmers within each type.

2. Materials and methods

2.1. Survey

A questionnaire was conducted among a sample of 566 dairy farmers in the 19 governorates of Tunisia (Fig. 1) over 8 months (May to December 2015). The farmers were selected randomly based on cattle herds enrolled in the national milk recording schemes. Access to registered data on past farming practices, herd management and performance is lacking for most dairy farmers in Tunisia, particularly the smallholders, who represent about 80% of the total number of dairy farmers in the country. We therefore used a bottom-up approach based on a survey of local stakeholders, with the national milk recording operator as an important player in its implementation. The survey was initially validated by a Tunisian consortium of research and development organizations and then tested for 1 month by technicians. It consisted of 70 questions relating to information on: (i) farmer characteristics (e.g., land use, labour capacity, herd size, cattle breeds and species); (ii) dairy housing structure; (iii) animal feed management and organization; (iv) herd health care and disease occurrence; (v) milking management; (vi) milk marketing and processing; (vii) productive and reproductive performance; (viii) farm facilities and machinery; (ix) farm management, and replacement; (x) technical and economic support; (xi) past and future evolution of milk production; (xii) milk production constraints; (xiii) perception of climate change impact; and (xiv) climate change adaptation strategies.

The Livestock and Pasture Office was commissioned to administer and manage the survey. Awareness days were created in order to explain the questionnaire to the technicians and ensure its proper functioning and implementation. The questionnaire was applied during face-to-face interviews, in local languages, and was reinforced by direct observation of the herds and the farm environments. Each farm visit lasted an average of 60 min.

2.2. Statistical analysis

Multiple correspondence analysis was performed to establish a typology of Tunisian dairy farmers. A multiple correspondence analysis reduces the dimensions of contingency tables, gives a graphical representation and allows detecting the factors that best characterised the farms and enabling their uses in the subsequent analyses (Milán et al., 2011).

The most appropriate variables for the typology were selected according to relevance and to data availability and quality. First, variables that lacked variability and made little contribution to distance measurements used to form the clusters were discarded (Escobar and Berdegué, 1990). Second, any variables that were highly correlated to other variables were eliminated, because their contribution to distance measurements was reflected by changes in those other variables (i.e., location, cattle genetic resources, milking process, legal status). In this study, the classification of dairy systems was based finally on criteria relating to the structure of production units (farm size and herd size), as well as on technical criteria related to regional and climate specificities proxies, such as animal feeding (number of months fresh forage was distributed) and diversification of agricultural activities (forage area). The