Climatic changes: scenarios and strategies for the livestock sector in Portugal

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The scenarios of climatic evolution for Portugal point to unfavorable conditions for agricultural and forestry activities by the end of the 21st century, resulting from the reduction of precipitation and temperature increase towards an increased susceptibility to desertification, which already affects large areas of the country.

To support the development of the adaptation strategy to climate changes, the Portuguese Institute for Sea and Atmosphere (IPMA) (www.ipma.pt) performed the analysis of the information collected on climate variables and found that from the 1970s the climate in Portugal has been registering an increase of 0,5º C per decade in average temperature, with a decrease in temperature range, an increase in minimum temperature, a reduction in cold days and increases in hot days in most of the country, as well as an increased frequency of "heat waves."

Regarding rainfall, it was observed a decrease in about 80% of the weather stations, with a decrease in rainfall in the spring and an increase in the fall and, more worrying for our climatic characteristics, semi-arid and dry sub-humid, predicting an increased frequency and intensity of vulnerability to drought, that will accentuate the areas susceptible to desertification. Farms production conditions throughout the interior of the country are conditioned by the nature of the soil, mainly by the low levels of organic matter, tending to a rapid decline due to the continuous high temperatures during the summer. Erosion and leaching of soil nutrients are a problem in some regions.

Extensive animal production systems

The expected climate changes will have an effect on animal production systems based on rainfed pastures and crops, effect that seems more significant in the ability to dramatically enhance the agricultural abandonment that has been occurring since 1989 (data from Agriculture General Census (RGA), 1989, 1999 and 2009). The RGA 2009 shows that the utilized agricultural area (UAA) in continental Portugal amounts to 3.668 million hectares, in which permanent pastures occupy 49%, arable land reaches only 32% and permanent crops 19 % of the total UAA.

Permanent pastures are areas of low feeding value in that, as indicated in the RGA, 2009, 3/4 are not subject to any technical intervention (seeding or fertilization). In the south of Portugal, most of the permanent pasture area develops under cork and holm oak trees whose conditions are impaired with the foreseeable increase of the dry seasons (spring/summer).

In the interior center and north of the country, where permanent pasture are also the main utilization of the land, the situation may worsen with the forecast for climate changes referred above. Indeed, despite the increase in area of permanent spontaneous pastures, the numbers of sheep and goats between 1999 and 2009 RGA decreased 24% and 41% respectively, and the same happened to the number of farms that are dedicated to this activity (a decrease of 27% and 22% respectively). These indicators, together with the decline of family farming population and their aging (agricultural producer type is a 63 years' old man), lead to the abandonment of large areas of territory, promoting the growth of shrub vegetation, reducing the environmental services provided by pastures and accentuating the large fire growth potential.

Soil is a strategic natural resource for the development of agriculture and forest, especially in the south, interior center and northern Portugal, and has great vulnerability to desertification, that could worsen with the expected reduction in precipitation that predictably will be more pronounced in areas already susceptible.

Trees and well conducted agricultural practices have an important role in protecting the soil against erosion, due to the coverage provided during the rainy season and promotion of increased organic matter content. This can be changed by the rise in air temperature, which associated with drier conditions can cause a reduction in the levels of organic matter, both by lower production of biomass and increased mineralization rate, that will promote erosion and, with an increase in the risk of fire, potentiate the processes of desertification in all vulnerable regions.

The major potential impacts due to the expected climate trends - the increase in temperature and changes in the distribution of rainfall, could be dramatic to extensive livestock production, especially conditioned by the pastures production. The prediction of higher temperature in winter can enable an increased dry matter (DM) production and stocking rate, with a consequent reduction in the conserved feed needs. However, it will be the lower rainfall after March, the period when temperature is more favorable for plant growth, which will imply lower production of total DM in pastures, resulting in harshest conditions for grazing ruminants.

The production system of grazing ruminants requires that, during warm weather, animals utilize the excess of grass produced in early spring, whose nutritive value and voluntary ingestion will decrease over the period. This requires the need of conserved feeds, causing a decrease in the profitability of this type of production. Climatic conditions, particularly the extent of the rainless season, will be harmful especially to the ecosystem of the southern oaks, the "montado", under which the permanent pasture develops, by increasing the trees' susceptibility to pests and diseases.

As a strategy for the plant resources, it seems that the main adaptation measures should consider: the expansion of the area of annual legumes due to their importance on the recovery of natural pastures and fixation of nitrogen in the agrarian system; the grass and legumes mixture to be used should be diverse to ensure greater DM yield, adaptability and persistence of pasture, including species with good performance at lower temperatures and grasses with higher summer dormancy; also the possibility of using pasture irrigation during late spring, resuming in late summer, would expand the grazing time providing some intensification of these extensive systems. Irrigated pastures, if used, should consider grasses from subtropical climates for better withstanding high temperatures and greater efficiency in water use.

Strategies related to the animals should promote autochthonous breeds, take advantage of the ability of females to body fat deposition during the availability of grass, for subsequent mobilization over the periods of greater needs, and anticipate the breeding season (final pregnancy and early lactation). It will be important to select females for their hardiness - disease resistance, maternal ability, longevity, ease of mobilization of fat reserves and good hooves to support grazing on large areas. The understanding of the metabolic mechanisms of animals in adverse weather conditions will also be essential, as well as improving the knowledge on the efficiency of utilization of fiber rich diets and type and amounts of protein and energy sources to help support the animals during hot weather.

Intensive animal production systems

In intensive production systems animals are fed directly to grains, of which a high proportion is excreted in the environment. This fact results in an overall loss of nutrients at several levels: competition with the use of cereals for human consumption, low digestive efficiency by the animal, excess excreta (manure) that must be addressed before any application and negative environmental impact in regions with high concentration of holdings. Moreover, farmers are faced with the need to comply with the impositions of EU legislation (e.g. Nitrate, Water, and Emissions Ceiling Directives).

Those negative environmental impacts are extremely serious and would contribute to the pollution of the aquifer reserves as the management is inadequate or when there is an improper or accidental discharge of waste. When there are high concentrations of holdings in certain regions problems arise with the limitations of areas available for disposal of waste at farm level (the volume of excreta of animal origin may exceed soil absorption capacity). There may be pollution of aquifers by leaching mechanisms of excess elements, conducting to Vulnerable Regions (nine identified in the Continental region), as well as high levels of gaseous emissions to the atmosphere.

With global warming these concerns will be even more serious, being important to identify issues such as the concentration of intensive production farms, the overall production system (from feeding to manure management and the flow of nutrients at farm level), the quality (chemical /microbiological) of manure produced and situations of over-fertilization of soils. Next, it is important to find solutions aimed at environmental protection and sustainable management of resources and waste.

In addition to the required adaptation of livestock buildings (ventilation, temperature regulation, watering and disposal/treatment of waste) and to the adequacy of transports, as strategies, in such systems, are suggested:

- Introducing more heat-tolerant livestock breeds by the development of breeding programs that should consider species less susceptible to heat stress.

- In a comprehensive approach to environmental safety it will be needed to optimize the productive efficiency and particularly the digestive efficiency of feed (by adjusting the production requirements or by the inclusion of exogenous factors in the diet), with consequent decrease in competition for food and reduction of environmental pollution load. The assessment of the metabolic mechanisms in adverse climatic conditions is also essential.

- Evaluation of manure management strategies to reduce the risk of environmental pollution: water pollution in flood situation and rains and gas emissions (NH_3 and GHG) in drought and heat waves scenarios. According to soil requirements, the treatment will often be avoidable, in some cases be essential or optional, and the processing option in co-product or energy should always be considered. Optimizing the use of manure as organic fertilizer will contribute to the maintenance of appropriate levels of organic matter, resulting in the increase of the vegetation cover and consequent prevention of soil erosion

Animal breeding and conservation

The conservation, sustainable use and promotion of animal genetic resources for food and agriculture have been a priority of successive Portuguese national policies and community for several years. The particularities of the country, with an enormous variability of conditions associated with a strategic geographical location, make Portugal hold an enormous diversity of Animal Genetic Resources (AnGR) being actually considered one of the "Hot Spot" regions on the planet, represented by 50 autochthonous breeds of livestock species.

AnGR represent an example of multifunctionality in agriculture activity and are the basis of innovation of the modern livestock sector, on which the farmers depend, for improved breeds, varieties and populations to provide quality and safe products to the society. Additionally undoubtedly contribute to increasing competitiveness, diversification of economic activities, improvement of the environment and rural landscape, as well as to promote the quality of life in rural areas.

Climate change will affect the animals, products and services provided by animal biodiversity. However, this biodiversity has not yet been properly integrated into strategies for adaptation to and mitigation of climate change. Its role in the resilience of food systems still needs to be addressed.

Most of the Portuguese autochthonous breeds present, generally, a low productivity as compared to other genotypes with an intensive breeding program. However, over the years, these breeds were produced mainly in marginal areas and under unfavorable production systems of low-input, low-output, where they are now fully integrated. The need to redefine the breeding programs has been widely recognized in most species, especially where sustainable development is a priority and considers a long-term perspective (Gama, 2006; Carolino, 2011).

The design and implementation of sustainable breeding programs directed to the production of animals that best adapt and produce under certain environmental restrictions or conditions may be one of the ways to follow, by the national livestock sector, to face possible climate changes. These programs should consider different factors, such as, genetic diversity, the use of natural resources, welfare and animal health, food quality and safety, the disadvantages of the technologies to be used (Liinamo and van Nieuwenhoven 2002, Gama 2006).

Animal Genetic Resources in Portugal represent a unique heritage, which despite all the efforts and advancement is still mostly at risk of extinction. However, inter and intra breed genetic variability existing in most of livestock species, the ability to adapt and produce at a wide variability of adverse environmental conditions and the possibilities for yielding products of quality, allow facing with optimism the need of adaptation to future climate changes.

Conclusion

This group participated in the elaboration of the document on the Agriculture and Forestry Adaptation Strategies to Climate Change (GPP, 2013), a report of ENAAC 2010, resulting in a set of guidelines for adaptation measures to climate changes, defined from identified sector vulnerabilities. Our approach to the potential impacts to the expected climate trends on livestock production systems will continue with ENAAC 2020, currently ongoing on public consultation and focused on three objectives:

- Improving the level of knowledge on climate change;
- Implement adaptation measures;
- Promote the integration of adaptation into sectoral policies.

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