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Some expected climatic changes impacts on the pasture and forage species in Morocco

C. Al Faiz, I. Thami Alami, R. Moussadek and M. El Oumri

Institut National de la Recherche Agronomique, BP 6570, Rabat Instituts, Morocco
e-mail: faiz@inra.org.ma

Abstract. In Morocco, many grazed areas, such as rangelands, forage cultivated areas and fallows, constitute the most important feed resources for livestock. However, in last year's, climatic factors such as drought, have affected the availability of forage production in quantity and quality. Drought is the major climatic change factor affecting the growth of cultivated forages and the survival and regeneration of many pasture species growing in rangeland areas. Thus, in rainfed areas, forage cropping system will change progressively according to each crop water requirements. In the irrigated area, alfalfa, a water consumer crop will be probably replaced by some less water consumer crop, and the summer production crop will be banished due the high temperatures and water scarcity. The spontaneous forage species will be much more affected by biodiversity reduction. Perennial grasses and legumes which are the forage species most appreciated by animals are also the most threatened. According to their agro-physiological needs, these species will suffer differently from the climatic changes. However, until now, there is no study on how the climatic changes will affect these two major groups of species or predicting their evolution. We will present some hypothesis to predict the expected effects of climatic changes on some forage and pasture species. Some issues for research to improve plant resilience will be discussed.

Keywords. Forages – Pastures – Climate change impact – Drought.

Impacts probables des changements climatiques sur les espèces pastorales et fourragères au Maroc

Résumé. *Au Maroc les ressources fourragères proviennent des parcours, de la sole fourragère et des jachères. Cependant, des facteurs climatiques, telle que la sécheresse, ont largement influencé la disponibilité fourragère tant en quantité qu'en qualité. La sécheresse étant le principal facteur de changement climatique affectant la croissance des fourrages cultivés et la survie et la régénération des plusieurs espèces pastorales au niveau des parcours. Ainsi, dans les zones pluviales, il faudrait s'attendre à un changement des systèmes de culture fourragers selon les besoins de chaque espèce. Dans les zones irriguées, la luzerne, culture consommatrice d'eau, serait probablement remplacée par d'autres cultures moins exigeantes en eau et la production fourragère estivale risque d'être bannie à cause des hautes températures. Les espèces spontanées seraient plus affectées par l'appauvrissement en biodiversité, parmi lesquelles les graminées et les légumineuses seraient les plus affectées. Cependant, à l'heure actuelle, il n'y a pas eu d'études spécifiques et précises sur les impacts possibles et probables des changements climatiques sur la production des espèces fourragères et pastorales au Maroc. C'est pourquoi, nous nous sommes limités dans cet article à la formulation d'hypothèses sur la base des rares données disponibles.*

Mots-clés. *Cultures fourragères – Espèces pastorales – Changements climatiques – Sécheresse.*

I – Introduction

According to intergovernmental group of experts on the climatic changes, the average of earth temperature will increase by 1.4° to 5.8℃ by t he end of this century. In general, we expect a rainfall augmentation in the high latitude and the equatorial zones, and a diminution in the subtropics but with high intensity rainfall. Climatic changes would have incidence on individual organisms, populations and species repartition and ecosystem function.

In Morocco, according the "Météo Nationale" as reported by the forestry administration, an augmentation of 2 to 5°C will occur, accompanied by a reduction of rainfall which could reach up to 45%, especially in the Middle Atlas Mountains. These climatic changes will have negative effects on the ecosystem balances and their dynamics, causing the species migration as well as from latitude (nearly 200 km by each 3°C) than from altitude. These transformation will result in a new reconfiguration most of the ecosystems.

Studies on the impacts of climatic changes on some crops production (mainly wheat) have been published by Göbel *et al.* (2006) in the "Atlas bioclimatique"' showing that the temperature increase from 1971 to 2000 and the modification of vegetation period cycles will have important impacts on the agriculture in Morocco. Other predictions expect waypoints toward a more arid climate, due to the decrease of rainfall and the augmentation of temperature, particularly during summer periods (Fig. 1). This situation will have negative repercussions on the yields of the most cultivated crops by 2030. Morocco will be unfortunately vulnerable to such transformation due to the modest technology progresses registered in the agriculture, the role of the agriculture as a source of income (15% PIB) and labor (40%), and the weak uses of tools to well manage drought risks (Balaghi and Dahan, 2009).

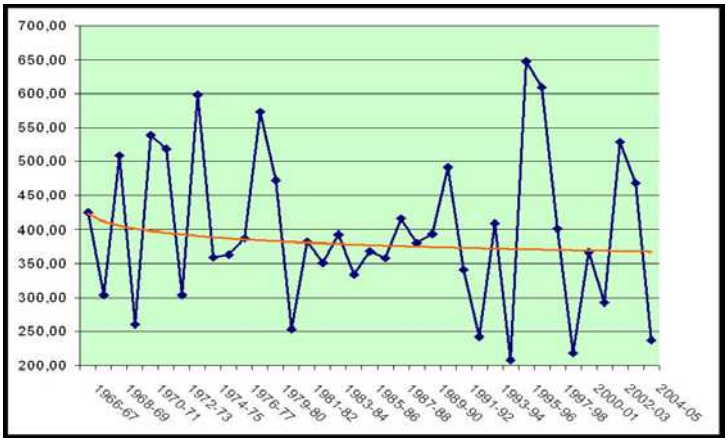

Fig. 1. Rainfall variation at national level during 20 years in Marocco (1966-2005).

II – Impacts on forage production

In the recent years, many studies have been devoted to the eventual effects of climatic changes on forage production. According to Soussana *et al.* (2002) simulations, the CO_2 duplication concentration in the atmosphere will increase the forage production in the temperate zones by approximately 15 to 20%. But if it is combined with a 3°C global warming, no production improvement could be registered, even if length of vegetative cycle increases, considering the summer water deficit. In, Morocco, however, there is no specific studies on the possible impacts of climatic changes on the forage production. Only hypothesis can be made on that issue, basing on current knowledge on forage sector and the available data.

1. Forage production in rainfed areas

Figure 2 shows the adaptation of several forage and pasture cultivated or tested successfully in Morocco. With the tendency of rainfall diminution, particularly during active vegetation growth and the augmentation of temperatures, many species and crop will have very shorted

adaptation geographic area. For instance, oats, which is normally cultivated in the plains of the center in Morocco Saïs and Zaer (450-500mm/year), Moutains regions of Ifrane-El Hajeb-Khénifra (500-600mm) and the West-northern region: Tangerois (800), will probably disappear from the plains. Triticale and barley, more rustic and drought tolerant cereals, will be less affected and will replace oats where it can't be grown any more. Some high water demanding forages grown in favorable rain fed area, such as *Trifolium alexandrinum* and *Sorghum* spp.*,* Will meet much difficulty to grow in the same area, without any supplementary or full irrigation.

Concerning pasture species, even if their cultivation is still no significant in Morocco, some of them should developed and encouraged to be grown giving the adaptation to low rainfall, such as medics or other perennial species with high confirmed summer survival, such as tall fescues and orchard grass. These latter, with their original summer dormancy trait, which is correlated to drought tolerance (Shaimi *et al*. 2009) present a promising crop for the future. Some high water demanding species such as *Trifolium fragiferum*, *Lolium rigidum* will have a minimum chance to be grown.

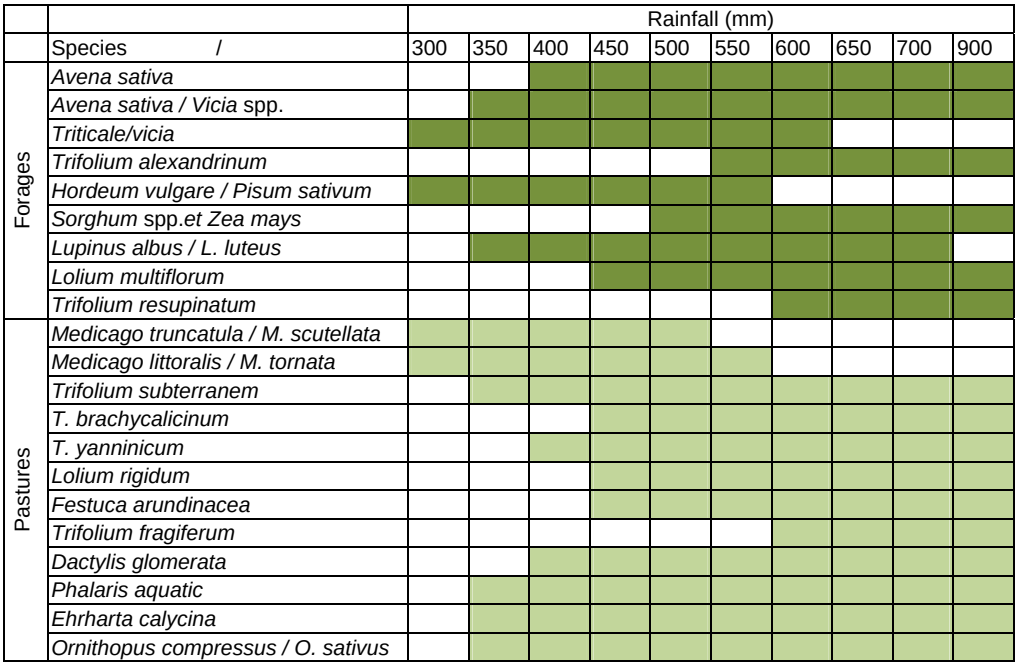

Fig. 2. Climatic adaptation (rainfall) of fodder and pasture species in rain fed area of Morocco (Jaritz, 1997 modified).

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2. Forage production in irrigated areas

In most irrigated zone in Morocco, water became very scarce with the extended of cultivated area and waters no availability due to drought. With the climatic changes, the water reduction will be more accentuate by reduction of dam's water reserves and intensive summer evaporation. This situation has lead to think about a new farming system in these areas, such as the banishment of the high water consuming crops and summer active grown species like alfalfa. In other terms, that means that the growing vegetation cycle will be modified towards autumn and winter season. Indeed, this period water use efficiency reported to the biomass production will be more profitable.

Replacing summer forage production, mainly represented by alfalfa by winter production, supposed that forage crop production will be concentrated during winter season, where a proportion should be stocked under hay or silage. Potential crop to be introduced in such system could be forage mixture, oats, annual ray grass, forage beet, etc.

Some forage calendar could be adopted according to the regions. In this context, we have proposed and tested some possibilities in a case study for the Haouz region. This region situated in the south of Morocco, around Marrakech, suffer from a chronic water shortage, especially during the hot summers of the region. (Al Faïz *et al.*, 2001). The current forage calendar consisted of Berseem (*Trifolium alexandrinum*) and forage barley during autumn and winter, and alfalfa during spring and summer. Five options were proposed:

Option I: This option consisted of replacing alfalfa by a less water consumer summer crop, and another annual winter crop to be exploited respectively as silage and hay. The proposed crop could be maize for silage and oats, oat/vetch or *Pisum*/triticale mixtures. Berseem and forage barley will be maintained to ensure forage production during autumn. This forage calendar could be complemented by adding minerals (Ca, P and oligo-elements), vitamins (A).

Option II: This option was based on the green forage exploitation crop during summer such as forage sorghum or Sudan grass or maize. Oaten hay or annual ray grass hey could be used during the gap period (late spring-early summer) where summer crop in not yet productive. Mineral insufficiency of summer crop could be corrected by adding P, Ca, Cu and Zn.

Option III: This option was based on the retry of summer crop and concentrates all the forage production during winter period. It means that the current forage system will be maintained by removing alfalfa and extending forage superficies to grow forage crops for hay (oat, triticale, cereal/vetch mixture, annual ray grass). The hay produced will be use during summer season.

Option IV: This option is similar to option III, but characterized by the introduction of forage beet, to be exploited from May up to summer, since its conservation in the soil is possible. Some technical rules should be respected: Protein and phosphate supplementary should be added. Fiber feed should be distributed to animal before to avoid rapid fermentation in the rumen.

Option V: This option requires preliminary research to study some new forage crop such as *Chloris gayana* et lupin. These crops have some interesting potential for the region. *Chloris gayana* is a rustic and perennial productive grass, while lupine is a high protein crop. For the first, adapted technical practices should be well known while for lupine, calco-alkaline tolerant varieties should be obtained.

3. Spontaneous pastures

Forage production of the spontaneous pasture species in the Moroccan's rangeland is submitted to implacable degradation due to overgrazing and drought. High stocking rate causes the impoverishment of the pasture value of rangeland starting by a net decrease of the best pastures. The process lead by the end to the quasi elimination of most palatable species and their replacement by animal undesirable species, like Apiaceae, Brassicaceae, Euphorbiaceae, Liliaceae, etc.

As drought is becoming frequent in Morocco, each year with a significant rainfall deficit resulted of negative effects on both animal production (feeding deficit and high mortality) and vegetal production (overgazing, deforestation, and biodiversity losses). This situation is much more complicated by the absence of real agro-ecological and socio-economical strategies.

It became quasi certain that the climatic changes effects will accelerate the biodiversity losses. Bounejmate (1992; 1994) has already reported substantial genetic erosion of *Lotus* spp., *Lupinus* spp., *Medicago* spp., *Vicia* spp., *Festuca arundinacea* and *Phalaris aquatica*. Furthermore, four Medicago species described (1959) – *M. rigidula*, *M. rotata*, *M. secundiflora* and *M. sauvagei* – have not been found during recent collection trips. Other recent perennial grasses germoplasm collection (Shaimi *et al.*, 2009) revealed significant genetic erosion for *Festuca arundinacea* and *Dactylis glomerata.*

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