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Electronic version

URL: <https://journals.openedition.org/rga/2902>

DOI: 10.4000/rga.2902

ISSN: 1760-7426

This article is a translation of:

Stratégies d'adaptation des producteurs du Safran de Taliouine (Maroc) face au changement climatique - URL : <https://journals.openedition.org/rga/2820> [fr]

Publisher:

Association pour la diffusion de la recherche alpine, UGA Éditions/Université Grenoble Alpes

Electronic reference

Larbi Aziz and Widad Sadok, "Strategies used by the saffron producers of Taliouine (Morocco) to adapt to climate change", *Journal of Alpine Research | Revue de géographie alpine* [Online], 103-2 | 2015, Online since 01 September 2015, connection on 08 December 2022. URL: <http://journals.openedition.org/rga/2902> ; DOI: <https://doi.org/10.4000/rga.2902>

This text was automatically generated on 8 December 2022.

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Strategies used by the saffron producers of Taliouine (Morocco) to adapt to climate change

Larbi Aziz and Widad Sadok

Introduction

- 1 In Morocco, the mountainous regions extend over 187,741 km², which is about 26% of the national territory. Approximately 7,548,000 inhabitants live in these areas, which is about 30% of the country's total population, with a density¹ of 40 inhab/km² (IFAD, 2014). They contain opportunities for agriculture, forestry, pastureland and mining, which play essential roles in the life of the rural populations and in the economy of the country.
- 2 The production systems in these zones are characterised by crop diversification and the integration (at the farm level) of annual crops, fruit trees and livestock. However, these zones are currently threatened by erosion and desertification and, during the last 20 years, they have become vulnerable to the effects of climate change² (IFAD, 2014). In fact, at the national level, the climatic projections listed by various institutions (FAO, World Bank, INRA, etc.) indicate a greater frequency of extreme events and progressive growth of aridity because of the decrease in precipitation (from -10 to -20%) and the increase in temperature (from +2 to +3°C) (Schilling *et al.*, 2012). Extreme climatic phenomena (floods, hail, etc.) cause much damage to crops and often affect the productive capital of small farmers and herders and accelerate the degradation of natural resources (IFAD, 2014). In fact, the negative effects on yields, in particular from 2030, are estimated by ICARDA to be in the range of a 15 to 20% reduction (Dahanet *et al.*, 2012).
- 3 To cope with these situations, local populations, particularly those in the mountainous regions, have developed adaptation strategies involving a change in procedures, practices and structures to limit or eradicate the potential damage or to benefit from

opportunities provided by the variability and climate change (Brodhag *et al.*, 2009). To analyse these strategies, a study was carried out in the zone of Taliouine in the Anti-Atlas, south of Morocco.

Figure 1: Taliouine location map

- 4 We chose to work in the agricultural sector because it constitutes the main pillar of the local economy. To illustrate the vulnerability of small farmers to climate change, the saffron crop was the main focus of the study. It constitutes one of the major supports of the economy of this region (Garcin and Carral, 2007) and is recognised as a special feature of Taliouine at a national level. Although it requires much water, it constitutes the most profitable crop in this area because it is the most expensive spice in the world (Gresta *et al.*, 2008; Aït Oubahou and El Otmani, 2002). Besides, the saffron cropping system is used as a tourist attraction to draw visitors to the region (Landel *et al.*, 2014). It represents the local cultural identity based essentially on a local knowledge of technical crop production practices and their adaptation to the prevailing changing climatic conditions. Therefore, how do the saffron producers adapt to the climate change that is affecting the area in order to maintain the current local dynamics? This study aims to identify the knowledge used by the farmers of Taliouine to build resilience mechanisms. Our initial hypothesis is that new knowledge is built through the integration of imported “technical” knowledge with traditional knowledge inherited from previous generations.

Methodology

Presentation of the study zone

- 5 In terms of administration, Taliouine falls within the province of Taroudant, in the region of Souss-Massa. As reported by the agricultural division office in the region, the

study area is under the authority of the Regional Agricultural Development Office of Ouarzazate (ORMVAO). It is bordered to the north by the province of El Haouz, to the west by Aoulouz (Province of Taroudant), to the east by Taznakht (Province of Ouarzazate) and to the south by the province of Tata. Its total population is 63,784 inhabitants distributed in 9100 homes and 297 *douars* (ORMVAO, undated). The zone is mainly mountainous with agriculture covering hardly 9,645 ha, 5,985 ha of which are rain-fed and 3,030 ha are irrigated.

Figure 2: Extract of the Google Earth image of the zone of Taliouine

- 6 The prevailing climate in Taliouine is known as a local steppe climate. There is little rainfall throughout the year; about 317 mm of precipitation falls annually. The climate is classified as BSk by the Köppen-Geiger system. The average annual temperature in Taliouine is 17.4°C. The driest month is July with 1 mm of precipitation while in November, the precipitation reaches its peak, with an average of 47 mm (source: CLIMATE-DATA.ORG, <http://fr.climate-data.org/location/37264/>).

Figure 3: Climate graph of Taliouine

- 7 The local population practices subsistence farming based on the cultivation of cereals (barley, durum wheat and soft wheat), saffron, vegetables (potato, onion, carrot, turnip, tomato, and garlic), forage crops, mainly lucerne, and fruit trees, in particular almond and olive trees. Fifty-two percent of the farms do not exceed 1 ha in size and are divided into small plots of land from 500 to 1,300 m² (ORMVAO, undated). Irrigation is limited to those plots surrounding springs, rivers and private wells. This crop production system is associated with extensive livestock farming, mainly sheep and goats.

Investigation tools

- 8 In the zone of Taliouine, the saffron crop is distributed in eight rural districts (RD) situated at elevations from 1,200 m to more than 2,000 m. The work was carried out in two rural districts: Sidi Hssain and Agadir Melloul. The first RD is situated in the low-elevation agro-ecological zone (1,500-1,600 m) while the second is in the agro-ecological zone at medium altitude (1,700-1,800 m).
- 9 Saffron was introduced into these two districts a long time ago, which explains the population's strong historic and cultural attachment to this crop. Sixty farmers chosen randomly were surveyed using a questionnaire and a number of value-chain stakeholders were interviewed using a semi-structured interview guide.

Figure 4: The various stakeholders interviewed

Organisation	Contacted actors
Subdivision of the Agricultural Development Office of Taliouine – ORMVAO)	The head of the service “Extension and Professional Organisations”
The Group of Economic Interest (GEI) “House of Saffron”	The person in charge of the sales department
The Souktana cooperative	The person in charge of marketing
The Migration and Development Association	The head of the social economy sector
The 123 Saffron company	The technical manager

The socio-economic characteristics of the farmers surveyed

- 10 The characterisation of our surveyed group contributes to understanding and connecting the various elements that may explain the local dynamics. Our sample has an average age of 55 years: the oldest farmer is 83 years old whereas the youngest is 32 years old. The majority are between 50 and 70 years old. Concerning their educational level, 53% of those surveyed went to primary school, 27% went to a traditional Koranic school, 13% are illiterate and only 7% of the farmers reached secondary level.
- 11 In both rural communes where this study was carried out, the economic activity of the interviewees is dominated by agriculture and livestock (84%) and the main income-generating activity is marketing saffron. The agricultural activities are carried out collectively, by men and women, but there is a division of the type of labour within the community according to gender. Particularly for the saffron crop, harvesting the bulbs, preparing the soil and/or ploughing, sowing, fertilisation and irrigation are essentially male tasks. As for the women, they take care of the lifting of bulbs, weeding, harvesting the saffron flowers, pruning (separating the strands of the flower), drying and cutting the dry saffron flowers collected. In fact, harvesting and pruning are painful tasks for the women and take up most of their time.
- 12 The associative movement is very dynamic in the target area, which has a rich social capital characterised by solidarity between the local community members and strong neighbourly relationships, typical of the farming system in the Moroccan mountains. This is due to the fact that these farmers still largely share the same cultural heritage, the same customs, the use and the management of natural resources. This leads to strong ties and confidence between the farmers based on interpersonal relationships developed over the long term.
- 13 In this zone, the agricultural subdivision³ of Taliouine lists 44 Agricultural Water Users Associations (AUEA), 2 federations of the AUEA, 3 agricultural associations, 3 women’s cooperatives for argan oil extraction and 10 saffron cooperatives, recently created and organised into a Group of Economic Interest (GEI) of saffron. These agricultural professional organisations (APO) are also supported by governmental structures within

the framework of a strategy aimed particularly at involving the AUEA in the rational management of irrigation water and the organisation of small farmers into saffron producers' cooperatives. The development of the cooperatives is an interesting alternative to reach the high-value markets and reduce the gap between the price paid to the producer (who does not benefit enough) and the market price (which mostly benefits the middle men and the processing firms). In parallel, and to re-locate the added-value to the regional level and protect the producer and the production (ensuring good quality), the saffron was awarded the Protected Label of Origin certificate (PLO), "Saffron of Taliouine", in 2010. In addition, the "House of Saffron" (consisting of a quality laboratory, a packing unit and a marketing hall) has been created in Taliouine, which will serve as a centre for marketing the certified saffron production. Thus, saffron is a territorial resource that creates employment and improves the income of the local population. This trend toward organisation was also found within the sample targeted by this study. In fact, 84% of those surveyed are involved in an APO, of which 56% are members of a cooperative, 12% of an association and 32% of both an association and a cooperative.

Figure 5: A cooperative from Taliouine at the International Agriculture Fair of Meknes (Morocco)

Photograph: L. Aziz, 2014

Characteristics of the farms in the studied area

- 14 At both low and medium elevation, the farms are small in size; 40% of farmers have small plots of less than 5 ha, while those with between 5 and 10 ha and more than 10 ha represent 23% and 37%, respectively, of the surveyed group. This domination of small farms affects the area assigned to saffron, which remains relatively limited but still

provides significant income to the producers. For example, 83% of those surveyed allocate areas of 1 ha or less to this crop, while 17% of them reserve an area between 1 and 2 ha. The plots are situated on terraces built according to the slope contour lines to prevent soil and water loss. This reflects the wealth of local knowledge that concerns not only the production but also the preservation of its key input factors (soil and water). This practice of terracing ensures the sustainability of the production systems of this region (Aboudrare, 2009). The yields vary between 5 and 6 kg/ha according to the growing season. The land tenure is dominated by private ownership (*melk*), which represents approximately 83% of the total area, while the remaining 17% concerns collective lands. Three-quarters of those surveyed still use traditional tools and equipment to carry out their agricultural activities, while the remaining quarter use modern equipment (tractors and ploughs, combine harvesters, saffron dryers, etc.). As the saffron crop requires much water, most of our surveyed group have a well on their farms.

Technical production practices of saffron

- 15 Although Morocco is a small producer (3 tons, 1.5 % of the world production), its saffron has a great reputation at national and international levels (Lage and Cantrell, 2009). Proud of the quality of their saffron, the surveyed producers grow this crop according to a technical scheme that they inherit from one generation to another. The main practices are described below:

Soil preparation

- 16 For the farmers, working the soil means preparing it to receive the saffron bulbs. This involves deep or medium ploughing with a hoe then making furrows of 8 to 10 cm in depth at the time of planting. This local knowledge corresponds well with the technical knowledge. According to Aboudrar *et al.* (2011), crossed and in-depth ploughing of 30-35 cm is necessary to facilitate the preparation of the soil before planting. A first ploughing is necessary to mix in the organic material. The same authors state that the manure should be applied before working the soil. It is recommended that all soil preparation steps be done in early summer after the harvest of the previous crop (May to July) and several weeks before planting. A second soil ploughing is done just before the planting, enabling a good preparation of the seed bed and the elimination of self-propagating plants. After ploughing, farmers add cattle manure "*amazir*"⁴. They do not use sheep manure because, according to them, it increases the temperature of the bulbs and burns them. The farmers have found out that adding manure is enough for the crop and there is no need for chemical fertilisers. Aboudrar *et al.* (2011) have the same opinion, noting that the use of chemical fertilisers is not recommended if the organic fertilisation (by adding manure) is well managed and the fertility of the soil is not threatened. Besides, for the organic production of saffron, the GEI requires its members not to use either chemical fertilisers or pesticides.

Planting

- 17 The surveyed farmers plant the saffron bulbs in the middle of September even though early planting in late summer showed improvement in the quantity and quality of the crop (Aboudrare *et al.*, 2011).

Figure 6: The saffron bulbs distributed by the ORMVAO to the producers

Photograph: W. Sadok, 2013

Irrigation

- 18 According to our surveys, irrigation depends on precipitation. The critical stages of the crop are flowering (in October) and the reproductive period (in March-April) requiring one or two irrigations per month. Thus, in the absence of precipitation, the farmers irrigate two weeks before flowering and twice at the beginning of flowering (in the middle of October). Surface irrigation is widely used by the surveyed farmers.

Harvest

- 19 The flowers are picked at dawn before being exposed to sunlight. The duration of the harvest depends on the quantity of flowers to be collected and the availability of women labour.

Perceptions of farmers about climate change

- 20 Like other Moroccan territories, the region of Taliouine experiences climatic disturbances that are felt by the local population; 96% of the surveyed farmers noted variations in the climate in the region. These concern an increase in temperatures, and a decrease in precipitation and the quantity of snow in the mountains. In fact, these farmers assert that they have noticed a marked decrease in precipitation in recent years, even though there have always been periods of more or less dry years in this region. In particular, they observed (especially the oldest farmers) an irregularity in the precipitation reflected by the late arrival or early end of the rains with a poor distribution over the year. They also noted an increase in temperatures. For them, the temperature regime was rather regular from one year to the next, with 45°C recorded locally in July and the highest temperatures from June to August. These variations were confirmed by members of the GEI, for whom the tendencies and climatic impacts observed over the years show that climate change has become a reality at the regional scale. This is also confirmed by the other local stakeholders, particularly the Migration and Development Association.

Effects of the changes induced by the regional climate on the saffron value chain and the local population

- 21 The recorded climate change is worrying for farmers regarding their agricultural production. 77% of those surveyed have already noted a reduction in the annual production of saffron. For them, the recorded increase in temperature in recent years has induced an increase in evapotranspiration causing the drying of saffron bulbs and thereby affecting their reproduction. This has an indirect effect on the productivity and quality of the saffron strands. Moreover, the high temperatures in September, recorded in recent years, affect the flowering of the crop.
- 22 In winter, the frost and cold often cause damage to crops and to saffron in particular. According to the farmers surveyed, saffron tolerates low temperatures. Gresta *et al.* (2008) also noted that the crop tolerates severe temperatures, which could reach 40°C in summer and -18°C in winter. However, these temperature effects have become more marked in recent years and negatively affect the crop during the flowering phase. Aït Oubahou and El Otmani (2002) found that snow can cause significant damage to saffron flowers and leaves. Besides, the farmers noted that, although the temperatures had become lower, the cold period had become shorter with a reduction in the quantity of snow in the region.
- 23 Concretely, the lack of precipitation causes a decrease in agricultural yields, a loss of livestock, a drying up of streams, and consequently a reduction in the farmers' income. This illustrates the vulnerability of these mountainous populations and their agriculture to the climatic variations recorded in the region. Especially for saffron, the drying out of water sources and the reduction in the groundwater table have reduced the doses of irrigation given to the crop. This deficit in water coupled with an increase in temperature during flowering delay this phase and thus negatively affect the biological cycle of the crop.

- 24 These different effects in the agricultural sector have had negative consequences for the local socio-economic fabric. In fact, because of the fall in household incomes, young people are leaving in search of other revenue sources in the closest cities (Agadir, Taroudant, Tata and Ouarzazate). This rural migration impacts negatively the saffron crop because it results in a deficit in the labour that is essential for the production of this crop. Moreover, the local population is worried that the recent dynamics engendered by the development of saffron as a territorial resource will collapse. That is why they have tried to implement practices in order to adapt to these new situations.

The strategies adopted by the farmers to deal with climate change

- 25 Considering the uncertainty of the water resource and the increasing difficulty of marketing saffron, the search for viable options in agriculture, as in other sectors, is a daily concern for the local farmers. In both targeted rural communities, they have adopted various strategies to adapt to these new situations. Sixty percent of the interviewees declared that they have implemented some actions to protect the water resource, generally by converting the surface irrigation system to drip irrigation, which saves water, labour and time. In doing so, they benefited from government subsidies. For the same reason, they had restored the traditional irrigation systems, “*khetaras*”, while 30% of farmers had opted to dig new wells or restore existing wells to capture more water. These farmers think that the drip irrigation system is not suitable for growing saffron, and so some of them preferred to decrease the irrigated area on the farm and rely on springs and “*khetaras*”.

Figure 7: A saffron plot irrigated by a drip irrigation system

Photograph: W. Sadok, 2013

- 26 A more precise analysis shows that the problem lies not only in the lack of water, but also in the mismanagement of this water. In fact, in these old traditional areas, the infrastructure for moving water is mostly in poor shape. The water distribution networks are often made of earth, which is subject to water loss by infiltration. Even the lined channels are often cracked or damaged, requiring repair.
- 27 Nevertheless, 10% of the farmers, particularly the younger members of the professional organisations, have made changes to the agricultural production practices of the crop:
- changing the planting date (September instead of July) to avoid the bulbs drying out;
 - changing the irrigation periods (to avoid frost) and increasing the frequency of irrigation in the absence of precipitation;
 - spreading the harvest over time to avoid problems related to the unavailability of labour during the harvest periods;
 - extracting bulbs from the ground in the 5th year (because of the increase in temperatures) and planting them in other areas instead of leaving them for more than 7 years, on the same plot, in normal climatic conditions.
- 28 These new practices are also the fruit of the interventions of the managers of organisations working in the area (ORMVAO, FAO, INRA, Migration and Development, etc.) and of local professional organisations. They have managed to incorporate new “technical” knowledge into the local inherited know-how, thus giving evidence of the acceptance of “outside” knowledge by the local people.
- 29 In addition, during the saffron harvest periods, some farmers are decreasing their expenses by replacing external workers by the family workforce. They also turn to the mutual help between families, because the production of saffron requires a great deal of manual work, particularly for harvesting the flowers and pruning (Gresta *et al.*, 2008, Wyeth and Malik, 2008).
- 30 Nevertheless, these activities are undertaken by relatively young farmers, while 2/3 of the farmers surveyed (especially the oldest) prefer not to change their technical production practices, which they inherited from their parents.
- 31 Livestock farming and mixed cropping are also strategies adopted by the farmers of the region to improve their income and sometimes to provide food. According to the manager of the agricultural subdivision of Taliouine, farmers also cultivate cereals (dominated by barley, then wheat and some irrigated maize) and have introduced new plantations. He explained that “olive trees and almond trees are appearing in the low valleys while walnut trees are grown in the high valleys. Besides, we have helped plant some modern orchards: olive trees (20 ha), almond trees (35 ha) and apple trees (35 ha) in Agadir Melloul, and almond trees (15 ha) in Sidi Hssain”. Livestock constitutes a family asset. The Siroua breed of sheep is mostly farmed, which is renowned in the saffron zones due to the quality of both its meat and its wool.

Conclusion

- 32 The results of this study show that the small farmers of the mountainous regions of the Anti-Atlas, working on small plots, marginalised and degraded, are particularly vulnerable to the current climate changes. Nevertheless, like their ancestors, they continue to observe the variations in their environment and adapt to them. Faced with these climatic changes, they have adopted adaptation strategies resulting in the

construction of a “new” collective intelligence based on the integration of imported “technical” knowledge with inherited local knowledge. These strategies concern the revision of certain practices in growing saffron, the adoption of mixed farming, the marketing of their production, the use of external agricultural labour and the introduction of new technologies. The diversification of local economies and the pool of immigrant labour, in particular, have also provided new opportunities for farmers to diversify their sources of income.

- 33 However, these adaptations are only *ad hoc* responses to these variations in the local climate. In fact, it is a question of moving from a spontaneous to a planned adaptation using Brodhag *et al.*'s (2009) terms. Indeed, it is essential to be able to anticipate events and act in a preventive way instead of waiting to experience the effects of these changes then acting in a curative way. Local agriculture, especially saffron which is the most profitable crop and the most capable of creating wealth at the local level, must be supported so that it is more productive and more resistant to the various risks, including those inherent in climate change. Without this support, the forging of an identity and the development of the territory of Taliouine based on saffron, the resource on which many territorial activities depend (tourism, cultural heritage, etc.), may fall apart. That is why numerous actions must be taken to reach the anticipated development, mainly: (i) application of the best saffron production practices developed by research, which are resilient to climate change, and by exploiting the success of certain local producers; (ii) improvement of harvest, post-harvest and packaging techniques; (iii) support for producers and their organisation in the implementation of PLO certification and for the “House of Saffron” to fulfil its role; (iv) implementation of mechanisms to regulate the saffron market so it is more profitable for local households, who can increase their income and avoid the emigration of young people, for which climate change is partly responsible.

NOTES

1. The national average density is estimated at 37 inhab/km².
2. Climate change is considered here as all the variations in the climatic characteristics in a given place, in time, due to intrinsic processes on Earth or which result from human activities (UNDP, 2012).
3. Local administrative entity under the Regional Office of Agricultural Development of Ouarzazate (regional agricultural entity of the Ministry of Agriculture) responsible for mentoring and technical support for farmers and management of irrigation water.
4. In the local Amazigh language.

ABSTRACTS

In Morocco, the mountainous regions extend over about 26% of the national territory where 30% of the total population live. They contain opportunities for agriculture, forestry, pastureland and mining. The production systems in these zones are characterised by crop diversification. However, these areas have become vulnerable to the effects of climate change. To understand these effects in relation to the population living in these areas, a study was carried out in the zone of Taliouine, in the Anti-Atlas. The vulnerability of crop productions to climate change was analysed and the different ways of adaptation adopted by farmers were identified. The work was done on saffron, the most profitable crop in the target area even though it requires much water. Our results show that the majority of the farmers surveyed had noticed variations in the climate of the region: irregularity of precipitation leading to a decrease in quantity and an uneven distribution throughout the year; rise in temperature; reduction in the cold period and less snow. These variations had impacts on the cropping system of saffron and its productivity. To cope with these effects, the farmers adopted various strategies: better management and use of water; diversification of agricultural activities; increase in the contribution of non-agricultural activities to their gross income; and seasonal migration.

INDEX

Keywords: climate change, Taliouine, saffron, perceptions, adaptation strategies

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