



HAL
open science

The emerging saffron value chain in the M'Zab valley – southern Algeria: an analysis of ongoing dynamics and strategic development options

Ahmed Benmihoub, Samia Akli, Fatah Ameur, Amine Ooulmane, Nicolas Faysse, Mounia Mokani, Aïssa Belhadi

► To cite this version:

Ahmed Benmihoub, Samia Akli, Fatah Ameur, Amine Ooulmane, Nicolas Faysse, et al.. The emerging saffron value chain in the M'Zab valley – southern Algeria: an analysis of ongoing dynamics and strategic development options. *New Medit*, 2022, 21 (05), 10.30682/nm2205h . hal-04568771

HAL Id: hal-04568771

<https://hal.science/hal-04568771>

Submitted on 16 May 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

The emerging saffron value chain in the M'Zab valley – Southern Algeria: an analysis of ongoing dynamics and strategic development options

AHMED BENMIHOUB*, SAMIA AKLI**, FATAH AMEUR*, AMINE OULMANE*,
NICOLAS FAYSSE***, MOUNIA MOKRANI**, AÏSSA BELHADI*

DOI: 10.30682/nm2205h
JEL codes: Q01, Q13, Q18, Q56, R11

Abstract

The saffron growing has emerged over the last decade in Algeria and has diffused in different agroclimatic regions, especially in the M'Zab valley and its periphery in the Saharan region of the country. This study sets out to analyze the emerging saffron value chain in the M'Zab valley and suggests strategic options for strengthening its development. The analysis was based on a case study. The methodology applied the tools of value chain analysis in its positive and normative dimensions: a combination of qualitative and quantitative approaches based on the triangulation of data collection methods (interviews, secondary data collection, direct observations). A participatory approach was used to make a SWOT analysis and to propose strategies for developing the value chain. The results showed that the local saffron value chain has strengths (profitability and quality) and opportunities (growing demand of healthy and natural products), but its performance is limited by weaknesses (producers skills, marketing) and threats (fraud or counterfeiting related to imported saffron) mainly related to the deficiencies in the institutional environment. Recommendations are made for elaborating a national saffron export strategy and building a competitive value chain able to take advantage of the expected growth in world demand.

Keywords: Saffron, SWOT, Value Chain Development, Agriculture, Ghardaïa, M'Zab Valley, Algeria.

1. Introduction

Saffron, commonly known as “red gold” is the most expensive spice in the world and well known for its aroma and medicinal properties (Mikhailenko *et al.*, 2020; Winterhalter

and Straubinger, 2000). Despite its high price, global demand is growing as its multiple health benefits are increasingly attracting the pharmaceutical and cosmetics industries and consumers (Naeli and Orsi, 2020; Razavi and Hosseinza-

* Research Center in Applied Economics for Development (CREAD), Algiers, Algeria.

** Laboratory of Agricultural, Agri-food and Rural Economics and the Environment (LEAARE), National Higher School of Agronomy (ENSA), Algiers, Algeria.

*** G-Eau Research Unit, CIRAD, Montpellier, and INAT, Tunis, Tunisia.

Corresponding author: a.benmihoub@cread.dz

deh, 2017). The prospective analysis carried out by Grand View Research (2021) expects an annual growth rate of 7.3% for the global saffron market over the 2021-2028 period. Saffron is mainly produced in developing countries, such as Iran and Afghanistan, which are located in (semi)-arid regions facing a scarcity of natural resources. Saffron plays a major role in improving the livelihoods of rural inhabitants and can also bring sustainable development to these regions (Naeli and Orsi, 2020).

Saffron has long been considered a minor crop used merely for the needs of agricultural diversification. In recent years, saffron has acquired a more interesting role in low-input farming systems (no use of fertilizers and chemical treatments, low irrigation water requirement), becoming a viable alternative for sustainable agriculture (Mollafilabi *et al.*, 2021; Dar *et al.*, 2017; Sahabi *et al.*, 2016; Gresta *et al.*, 2008). Indeed, given its morphology and physiology, saffron is a rustic crop able to cope with severe weather conditions (Alizadeh *et al.*, 2009; Molina *et al.*, 2005). Its specific life cycle allows it to overcome the hostile season (summer), which coincides with its dormancy phase (Lopez-Corcoles *et al.*, 2015; Alvarez-Orti *et al.*, 2004). The interest in developing this crop is also explained by the possibilities it offers for using “marginal” or less fertile lands in fragile agro-ecosystems, such as those in rural and mountainous areas (Gresta *et al.*, 2008). Experience has shown that saffron is traditionally a family-farming crop grown on relatively small farms based on sustainable use of available local resources (Khajeh-Hosseini and Fallahpour, 2020).

In addition to its agronomic characteristics, its importance also lies in socio-economic aspects. Indeed, the crop employs a large workforce, usually women, and provides important sources of income for small-scale rural farmers (Mzabri *et al.*, 2019). Thus, saffron cultivation has been considered as having potential for reducing rural-urban migration and providing income to rural communities (Ghorbani, 2007). The traditional nature of most activities, such as flower collecting, trimming, processing and packaging explains the high labor requirements, based on endogenous knowledge. This makes the crop labor-intensive, and thus a naturally expensive spice (Aytekin and Acikgoz, 2008; Molina *et al.*, 2005; Koocheki, 2004). Indeed, it takes

150,000 to 200,000 flowers harvested by hand to obtain 1 kilogram of saffron, and each flower has three stigmas that must be separated manually and then dried (Pandita, 2021), calling for about 400 hours of labor (Mzabri *et al.*, 2019).

The high labor requirements, concentrated over a few days and a few hours per day, and growing costs have led to a reclassification of saffron-producing countries (Giupponi *et al.*, 2019; Dar *et al.*, 2017; Gresta *et al.*, 2008). In European countries, the traditional producers (Spain, Italy and Greece), have seen a decline in their production areas despite the increase in saffron prices (Dar *et al.*, 2017; Gresta *et al.*, 2008; Fernández, 2004). By contrast, a strong increase in saffron production has been recorded in Iran and other Asian countries, where labor is still cheap in comparison (Mzabri *et al.*, 2021; Yasmin *et al.*, 2018; Gresta *et al.*, 2008). Indeed, saffron is now mainly grown in Iran (108,000 ha), which accounts for 89% of the world's area and production, followed by Afghanistan (7,557 ha), India (3,674 ha), Greece (1,000 ha), Morocco (850 ha), Spain (150 ha), Italy (70 ha) and France (37 ha) (Cardone *et al.*, 2020). The growth in production in Middle Eastern and South Asian countries, with low prices and poor quality control, may accelerate the decline in production in European countries if changes are not made to production technologies and quality identification methods (Gresta *et al.*, 2008).

Saffron used to be grown in Algeria, but then disappeared from agricultural landscapes for several decades, combined with the loss of a culinary consumption culture (Tozanli, 2018). There were then failed attempts to reintroduce it during the colonial era (Chevalier, 1926). However, it is only recently that this traditional crop has started to regain in popularity (Zobeidi and Benkhalifa, 2014). Saffron was reintroduced as part of a research and development project, conducted in cooperation between the National Institute of Forest Research (INRF) and the International Development Research Centre (IDRC, Canada) as part of a project entitled “Participatory and adaptive experimentation of the management model of forest resources in the Atlas Mountains: Algeria, Morocco, Tunisia” (INRF, 2012). Saffron corms were distributed to about ten agropastoralists, so the first saffron plots were cultivated in 2009 in the South of the

Aures Mountains, in Khenchela Region (Khemici *et al.*, 2014; Gadiri, 2011). In that region of south-eastern Algeria, experimental trials were conducted in 2010 at three sites in the semi-arid and arid bioclimatic stages by a research team from the Scientific and Technical Research Center for Arid Regions (CRSTRA) (Lahmadi *et al.*, 2013). During a second research project in 2013/2014, saffron was given to rural women in mountain oases particularly characterized by a lack of water (Bengouga *et al.*, 2020). Besides, during the same period, some farmers individually initiated saffron production, especially in the Constantine region of eastern Algeria (Tozanli, 2018).

Over the ten years since its reintroduction, saffron production has grown quickly, from a few pilot saffron farms to more than 500 saffron farms spread over twenty-five wilayas (Departments), located in different agroecological regions (ranging from the Tell to the Sahara). The total area is estimated at 45 hectares under irrigation, with the average size of the saffron farms varying between 2,500 and 5,000 m² (Tozanli, 2018). Organizationally, two national associations of producers were created in 2018 and 2019, respectively, to promote saffron. In 2020, saffron was recognized and officially included in the new expanded list of agri-

cultural value chains (Order of May 11, 2020 establishing the list of agricultural sectors, JORADP N°31). This official recognition allows the value chain to benefit from technical, organizational and financial support provided by the State.

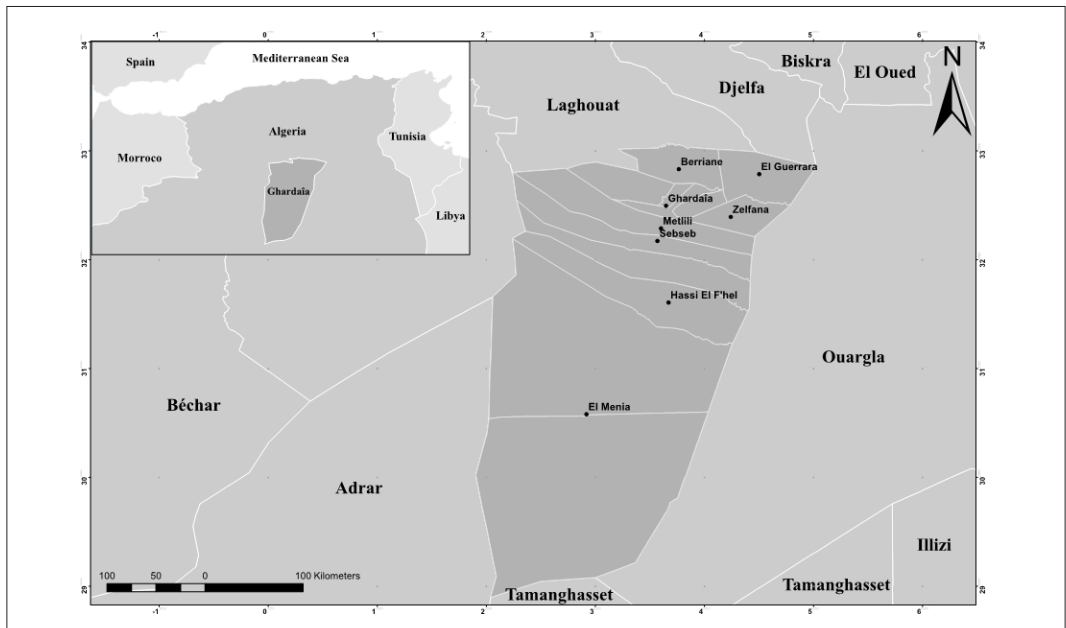
The ongoing dynamics in the emerging saffron value chain are very poorly documented in Algeria, especially in the arid regions of the country (Mokrani, 2020). Consequently, this article sets out to analyze and evaluate the development of the value chain, illustrated through a case study in a Saharan region, the region – or wilaya – of Ghardaïa, the aim being to characterize the value chain (structure, functions), identify the factors influencing its performance, suggest strategic options for its development and recommend policy measures to make the institutional environment more favorable to its promotion.

2. Methodology

2.1. Case study

The study area was the wilaya of Ghardaïa, which is located in the northern part of the Sahara. The territory is mainly part of a large geomorphological complex in the form of rocky

Figure 1 - Geographical location of the wilaya of Ghardaïa before the 2020 division.



plateaus, with an altitude varying between 300 and 800 m (Maachou, 2013). The study was conducted more specifically in the M'Zab valley, the area called the "Chebka du M'zab" ("The net of M'zab"), and its periphery in the North of the wilaya. This area includes the municipalities of Ghardaïa, Bounoura, El-Atteuf and Berriane in particular, see Figure 1. The area is a rocky plateau cut into irregular and tangled valleys. The climate is arid, resulting both from low rainfall (78 mm on average per year) and the intensity of evapotranspiration related to high temperatures (the average annual temperature is 23°C, according to climate data from the Ghardaïa station over the 2006-2015 period).

Ghardaïa is one of the Saharan wilayas that have recorded strong growth and diversification of agricultural production (mainly cereals, fodder crops, dairy cattle, fruit trees and date palm), over the last two decades. These agricultural dynamics outside the traditional oases are based on an expansion of new production areas under different land access arrangements (agricultural extensions accounted for 93% of 58,508 ha of farmed areas in 2018, according to the Agricultural Services Directorate of the wilaya), and on the use of groundwater, mainly drawn from the fossil and deep intercalary continental aquifer. Floods in the wadis (temporary rivers) crossing the region are caused by rainstorms on the southern flank of the Saharan Atlas. These floods account for the majority of the limited surface water resources and replenish the alluvial aquifers.

The new agricultural extensions are privileged places for introducing new crops and the farms amount to real "open air laboratories". Besides the main crops (cereals, milk, dates, etc.), other high added-value crops, such as aromatic and medicinal crops, have been introduced. Among the latter, saffron made its appearance for the first time in 2016 in a development area on the periphery of the ancient oasis of Berriane (northern Ghardaïa). Two young associated farmers bought bulbs (30 kg) from a pioneer farmer in the wilaya of Khenchela to install a first saffron plantation covering an area of 400 m². After five years, approximately 150 farmers from the wilaya of Ghardaïa, mainly in the M'Zab valley and its periphery (municipalities of Berriane and

Ghardaïa for the most part) have embraced saffron on a total area estimated at between 5 and 10 ha according to different sources, making the wilaya of Ghardaïa the second production area after the pioneer region of Khenchela.

2.2. Methodological approach and analysis tools

The methodological approach involved a value chain analysis tool in its two dimensions, positive and prescriptive (or normative). Defined by Kaplinsky and Morris (2001) as: "the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use", this value chain concept was traditionally used for development interventions that often aimed to achieve better accessibility and conditions for small-scale producers. Today, value chain development integrates economic development goals with equitable income distribution objectives (Hiller *et al.*, 2014).

The positive dimension of the value chain analysis seeks to characterize and understand the structure, functions and coordination modes of a value chain. For this positive dimension, the analysis includes both qualitative and quantitative approaches. There are no "hard and fast" rules as to how it should be conducted, although Hellin and Meijer (2006) strongly suggest the use of a qualitative approach first, followed by a quantitative survey. A triangulation of data collection methods, based on a combination of semi-structured interviews, collection of secondary data and direct observation, is more commonly used (Olsen, 2004; Beebe, 1995). The normative dimension of value chain analysis seeks to identify strengths, weaknesses, opportunities and threats, and to define strategic development options.

Indeed, in our case study we used: 1) a review of different documentary resources on the saffron sector in Algeria: scientific publications (gray literature, papers and articles), published interviews, press articles and testimonies issued

on social networks; this allowed us to draw up an initial inventory of saffron development; 2) interviews with 12 saffron producers which represents about 10% of the estimated population of saffron farms. They were chosen in order to represent the diversity of size, farming system (individual or collective) and location of the saffron farms (the four main production areas: Berriane, Ghardaïa, Bounoura and El Atteuf). The interviews addresses issues related to the technical conduct and segmentation of saffron-related activities, costs and incomes, the farming system, natural resources management, social networks and relationship with other actors involved in saffron value chain and the main supports or problems identified. Coupled with direct observations, this stage allowed us to appreciate and to situate development of the saffron sector in the study area; 3) semi-directive interviews with four grocers-herborists (about 25% of this type of store identified in the communes of Ghardaïa and Bounoura) and five institutional actors who are the main ones concerned by the saffron value chain development (association of saffron growers, Chamber of Agriculture, Directorate of Forests, Directorate of Agricultural Services, local municipalities) to support our understanding of the structure and functioning of the value chain, its organizational dynamics as well as its institutional environment.

For the normative dimension, we used the SWOT (Strengths, Weaknesses, Opportunities and Threats) approach to identify the major external (opportunities and threats) and internal (strengths and weaknesses) factors that could influence the performance of the value chain, either positively or negatively (Da Silva and de Souza Filho, 2007). SWOT analysis allows situational assessments and generally consists of a listing of factors that can be used to describe current (SW sections of the framework) and possibly future (OT) trends in the internal and external environments describing and/or influencing the system under study (Yavuz and Baycan, 2013). The SWOT analysis has often been used by organizations in strategic planning processes (Da Silva and de Souza Filho, 2007). This tool was mobilized as part of a participatory value chain analysis approach

(participatory diagnosis and planning) adopted by the “Massire” research project. The participatory process consists in organizing a series of workshops with the different actors involved (producers, institutions, support organizations...) in order to coelaborate a development plan for the local saffron value chain. Indeed, a first workshop with a group of saffron growers (6 producers were present from the 10 invited, under the sanitary constraints of Covid-19) was organized and moderate by the research team in March 2021, to make a rapid participatory diagnosis by identifying strengths, weaknesses, threats and opportunities for the value chain. Despite the small number, the panel of participants was representative of the diversity of saffron grower types observed by ourselves (leaders vs followers, old vs young, great vs small). All the producers interviewed belonged to the local Mozabite community, which is part of the religious community of Ibadites present in several countries of the Middle East and North Africa.

Subsequently, we constructed the TOWS matrix to develop strategic options and policy recommendations. The TOWS matrix involves cross-analyzing the different sections of the SWOT matrix. External variables (opportunities and threats) are linked to internal factors (strengths and weaknesses) with a view to maximizing strengths and opportunities and reducing weaknesses and threats. The study focuses on the interactions of four different variable combinations. Matrix interaction is a technique for identifying multiple interactions between variables that can be used to develop strategic and policy suggestions (Da Silva and de Souza Filho, 2007). Indeed, the four groups of strategic alternatives are identified: SO (Strengths-Opportunities) strategies aim to maximize both strengths and opportunities, while ST (Strengths-Threats) strategies are based on maximizing strengths that are able to minimize environmental threats. WT (Weaknesses-Threats) strategies are created by minimizing both weaknesses and threats, while WO (Weaknesses-Opportunities) strategies attempt to minimize weaknesses and maximize opportunities (Weihrich, 1982, cited by Escobar *et al.*, 2020).

3. Results

3.1. Main characteristics of the local saffron value chain

a) An inclusive and gender-sensitive value chain characterized by the predominance of small-scale producers and organized under multiple informal arrangements

According to the president of the local association for the promotion of saffron, there were at least 100 saffron farms in Ghardaïa in 2021, their sizes varying from 10 m² to 10,000 m² (1 ha), concentrated in the M'Zab Valley and its periphery (Berriane in particular). The very fast adoption of the saffron by the farmers is partly explained by the nature of the production process, where women and children from the family are employed as a family workforce, as well as the cooperative spirit of the producers, who frequently exchange know-how, experiences, successes as well as failures. Small-scale producers (farming less than 1000 m²) are often grouped into informal groups (varying from 2 to 30 individuals) to pool resources and reduce production costs.

This value chain first attracted young people from family farms with limited financial resources, before attracting other social categories. These young people were sometimes pluri-active (civil servants, employees, daily workers, craftsmen, etc.). Given the high initial investment required, a lack of technical knowledge and the limited development of marketing channels, the producers prefer to start their activity on small areas to first learn the production techniques and then later on extend the farmed area thanks to multiplication of the bulbs. Moreover, setting up and starting production is not an easy task. Different types of arrangements, especially informal ones, are negotiated to mobilize productive resources that are often fragmented. These arrangements concern, for example, the physical division of the plot into squares, the division of labor between partners, etc. Several groups, formed by young people, are financed by other partners through local customary arrangements (which is called *El Orf* in the Arabic language), based on an equitable sharing of benefits and

risks. Producers never use bank interest-based credit for cultural and religious considerations, and no-interest credit schemes are difficult to mobilize. One farmer had tried to benefit from a no-interest loan subsidized by the State for the installation of his first saffron plantation. He did not succeed because of the absence of a technical document certifying adaptation of the saffron crop to the local edaphic and climatic conditions. Apart from drip irrigation, all operations related to the production of saffron are manual: soil tilling, planting, weeding, flower harvesting, pruning, pulling up and triaging the bulbs. The value chain employs many salaried women in the flower pruning, stigma drying and packaging operations. The daily flower harvest is processed at the farmer's home, or distributed in the village to women in their own homes. However, as the women were not happy with the status of workers, a startup specialized in saffron processing (cosmetic products in particular) was set up by a young woman graduate, in Berriane municipality, to take more advantage of the growing market for saffron and its by-products. This startup can further stimulate the female demand for saffron, by using new communication technologies, and thus contribute to the promotion of the local saffron consumption culture.

b) Predominantly short and informal sales channels characterized by strong producer-consumer connectivity

Farmers sell their production mainly via family networks, relationships and social networks (Facebook in particular). In this emerging value chain, which is in the process of being structured, the producer is often a seller, and extension of the value chain also implies the extension of marketing networks. At the current stage of value chain development, direct sales allow farmers to keep most of the profit margin. Sales through the formal channel of retail stores (spice shops and herbalists) and wholesalers remain marginal. The weak involvement of the interviewed retail traders was explained by the high price of the local pure saffron, superior to the saffron imported in an informal way, particularly from Iran, Spain and Morocco. According to well-informed producers, "imported saffron is of lower quality and

perhaps has gone through an industrial process to extract its medicinal properties and keep only its capacity to color food.”

The high price of the pure local saffron is thus a marketing drawback, in a context of reduced purchasing power for Algerian consumers. Moreover, the spice produced does not fit in with the old culinary traditions of the latter and this plant still seems to be unknown. Local demand for pure saffron is restricted to social categories with rather high incomes, who buy the product mainly for its medicinal properties.

c) Upgrading strategies and development of new functions

Producers face difficulties related to saffron marketing. They have set up several adaptive or alternative strategies designed to strengthen marketing functions and create added value through processing, along with the prospection of foreign markets through informal exports of very small quantities:

- Marketing strategies rely on marketing under different trademarks, improved packaging (quality and design), packaging more adapted to demand (boxes of different sizes: 0.2, 0.5 and 1 gram), (while noting by the producers the deficiency in the availability of quality packaging on the local market) investment in advertising to create new needs via social networks by designing and broadcasting videos or by distributing leaflets to increase interest in saffron, several initiatives to set up incentives for retail grocers and/or wholesalers of herbal products to distribute saffron through their distribution network, reinforcement through training in marketing strategy skills, especially on social networks (e-trade strategies).
- Activities for adding value by using saffron to produce various food supplements, cosmetic products, *floral* water, essential oil, honey with saffron, dried flowers, etc.
- Informal exporting of small quantities is carried out via relationships and community networks to the Gulf (mainly) and European countries. In addition, some local producers have put ads on *espaceagro.com* (French website) or engaged the services of consult-

ants to inquire into the conditions and opportunities for gaining a foothold in foreign markets (especially European).

d) Saffron production is profitable in the long term

The interviewed saffron farmers affirmed that they were interested in growing saffron because of its high economic profitability. However, the initial investment (notably bulb purchases) is costly, especially for young people and small-scale farmers, and new producers begin by planting small quantities of bulbs of small or average calibers, at relatively reduced prices, on small plots. As the bulbs multiply from one year to the next, this allows them, in addition to autonomy compared to seeds, to extend the cultivated areas in the years following their installation. Consequently, saffron yields are relatively modest the first year after planting (under one kilogram per hectare). In the case of a multi-annual plantation, the dry saffron yield generally increases from 0.9 (the first year) to 5.6 kg/hectare (the third year). Consequently, the sale of dry saffron (spice) thus only provides a positive gross margin from the third year onwards.

An estimation of the financial margin of saffron plantations shows that the main profit in the early years results from the sale of saffron bulbs (seeds) (Table 1). This emerging value chain is still fragile, because it depends on growing demand for seeds, that is to say on an expanding value chain. However, the bulb market has significantly decreased because of the Covid-19 pandemic, leading to a drop in prices (the price of large corms dropped from 154 USD to 95 USD per kilogram between 2018 and 2020). To cope with this situation and avoid cash flow problems, many growers were forced to leave their bulbs in the ground and postpone harvesting for later years.

e) Informal coordination patterns

The aspects discussed regarding coordination problems mainly concerned the quality and the price of saffron, as well as the remuneration of labor. In terms of saffron quality, commercial relations are based on trust to decrease uncertainties about quality in the absence of formal certifica-

Table 1 - Estimation of the gross margin for saffron growing (case of the pilot saffron farm in the study area).

	<i>First Year (2016)</i>	<i>Second Year (2017)</i>	<i>Third Year (2018)</i>
Area (m ²)	400	1200	3600
Purchase of seeds 30 kg	1,543.87		
Seed preparation operations (USD)	128.66	385.97	771.94
Preparation of the plot, purchase & transport of alluvium (USD)	557.51	1,629.64	3,602.37
Expenses related to soil preparation (USD)	171.54	514.62	857.71
Expenses linked to irrigation (USD)	85.77	257.31	771.94
Expenses related to saffron harvesting (USD)	214.43	643.28	1,286.56
General expenses (USD)	128.66	385.97	771.94
Land rental (USD)	514.62	1,029.25	2,058.50
<i>Total (1) (USD)</i>	<i>3,345.06</i>	<i>4,846.04</i>	<i>10,120.94</i>
Ratio expenses to kg of seed (USD)	110.07	52.89	36.85
Total number of bulbs – units	4,500	3,150	9,450
Total number of flowers	4,500	12,600	47,250
Number of flowers for 1 g of saffron	180	180	180
Total saffron in grams	25.00	70.00	262.50
<i>Total number of harvested bulbs in value (USD)</i>	<i>7,719.36</i>	<i>23,158.08</i>	<i>69,474.23</i>
<i>Total saffron production in value (USD)</i>	<i>1,072.13</i>	<i>3,001.97</i>	<i>11,257.40</i>
<i>General total (2) (USD)</i>	<i>8,791.49</i>	<i>26,160.05</i>	<i>80,731.62</i>
<i>Gross financial margin (= 2-1) (USD)</i>	<i>5,802.27</i>	<i>22,393.44</i>	<i>70,610.69</i>
<i>Margin rate</i>	<i>82.44%</i>	<i>81.80%</i>	<i>87.68%</i>
<i>Exchange rate in 2018: 1 USD = 116.59 DZD</i>			

Source: Authors.

tion. Saffron quality is highly sought-after by the producers. Some of them have carried out analyses (saffron's main components including picrocrocin, safranal, and crocin) based on the ISO method (ISO3632-2:2010, saffron-test methods) in European countries. These analyses have led to a classification of local saffron quality as category 1 (the highest), which contributes to perpetuating relations based on trust with end-users. Indeed, consumers are mostly interested in the health benefits of saffron and select their suppliers on the basis of trusted relations. The demand for saffron for its therapeutic value determines the behavior of producers-suppliers: non-use of chemical products, innovative by-products (food supplements, cosmetic products, etc.).

When saffron growing in the region started to expand, the producers based the local process,

involving an informal understanding, on the international price for saffron (notably the price in Europe). As supply increased, and with the difficulties linked to marketing, farmgate prices for saffron decreased by half (dropping from 46 USD to 15 USD /gram between 2016 and 2021). However, an informal agreement has been established around a “floor price”, to allow economic profitability for new and small-scale producers in particular. Tension persists on the selling price between large and small producers.

As for the remuneration of labor, producers comply with a standard, or convention, on the daily farming salary. For example, the rate for planting, flower harvesting and bulb removal is set at 11 USD /day (i.e. the same daily rate for male workers in the region), while the rate for pruning stigmas – carried out by women – is set

at 1 USD/hour (a woman can prune up to 2 kilograms of flowers in 8 to 10 hours per day).

f) A professional organization faced with functional difficulties

An association of saffron producers in Ghardaïa was created in 2019 (based on an initiative of 9 people¹) to promote saffron production in the oasis and Saharan regions. The founders had already organized a training day on the cultivation of saffron in Berriane – July 2018 by inviting three engineers/researchers from the National Institute of Forestry Research and some saffron pioneers in other regions, members of the national association for promotion of the saffron. Then, in 2019, some of the local association members participated in the “First Day of Saffron” organized on the Zeralda educational farm – Algiers. The four main founders interviewed were quite satisfied with the logistical support provided mainly by the Chamber of Agriculture of the wilaya of Ghardaïa, with the assistance of the local Inter-professional Council of Aromatic and Medicinal Plants. However, the association experiences operating difficulties due to several factors: large differences in saffron farm sizes, composed mainly of small-scale producers, conflicts of leadership, lack of public support, lack of material means and weakness in human skills.

3.2. Factors influencing the performance of the local saffron value chain

The participatory SWOT analysis allowed us to identify the internal and external factors impacting, positively or negatively, the performance of the local saffron value chain. Producers ranked the different factors according to three levels of importance (first, second and third rank) (Table 2).

a) Internal factors providing the assets or strengths of the value chain

The producers considered two main factors that represented vectors of strength for local saffron

production. The first factor comprised the economic assets of saffron production. Indeed, this crop generates quite high economic profitability (FS1) explained by several factors: the average yield is worthwhile (3 kg per hectare) if farming practices are adequate; a rather satisfactory selling price; a long shelf-life for saffron spice (3 to 4 years); input costs are rather low (seed multiplication, non-use of chemical fertilizers and phytosanitary products, low consumption of irrigation water). Moreover, the quality of their saffron, whose analyses are carried by around 10 leaders, makes it possible for producers to negotiate attractive prices, especially on the international market. The second factor concerned the horizontal cooperation between producers through their associative and/or collective work (FS3), leading to several positive impacts (assisting of new producers, sharing of knowledge, easier access to the marketing network, access to good quality seeds, etc.), which constituted a vector of sustainability for local saffron production.

b) Internal factors representing the weaknesses of the value chain

The saffron producers mentioned three factors at the root of the local saffron sector weakness. The difficulty of marketing saffron on the local market constituted the first weakness, resulting from several reasons related, on the one hand, to the lack of a saffron consumption culture and, on the other hand, to competition from saffron imported in informal ways and whose price was more attractive for the consumer in the context of a general decline in purchasing power (FW1). During the workshop, tension was perceptible between two categories of producers concerning the definition of the selling price (FW2): the leading and biggest saffron producers (whose plantation areas were around 1 hectare on average) considered the current price fixed in a tacit way between producers (including a larger area of farmers) to be too high and thus claimed the need to decrease the saffron price in order to sideline the informal importers. The small-scale

¹ 6 from Berriane, 1 from Ghardaïa, 1 from Al-Atteuf and 1 from Guerrara.

Table 2 - Results of the SWOT analysis for the saffron value chain from the participative workshop organized with producers (March 16, 2021).

<i>Strengths</i>	<i>Weaknesses</i>
<p>FS1* High profitability per hectare compared to other crops.</p> <p>FS2* Several analyses of saffron quality certify its classification in category 1 according to standard ISO 3632.</p> <p>FS3* Associative and/or collective work.</p>	<p>FW1* Saffron marketing difficulties linked to a lack of local consumption and of less competition.</p> <p>FW2* Fragile consensus on a “floor” selling price between small- and large-scale saffron producers.</p> <p>FW3** Producers lack information on foreign markets and skills on market penetration mechanisms and export procedures.</p> <p>FW4*** Constraints related to the lack of development of production areas, difficulties in accessing productive resources and their fragmentation.</p>
<i>Opportunities</i>	<i>Threats</i>
<p>FO1* Growing trend in the consumption of healthy and natural products, and the international market is especially promising for “organic” products.</p> <p>FO2** Job creation in the region (seasonal jobs for young people and women in particular).</p> <p>FO3*** Increase in the number of saffron producers, especially because of the installation of young people.</p> <p>FO4*** Benefits of forming cooperatives.</p>	<p>FT1* Fraud or counterfeiting related to the marketing of imported saffron.</p> <p>FT2* Threats related to fungal diseases affecting saffron seeds.</p> <p>FT3* Entry of opportunists motivated by the fast gain (“short-termists”).</p>

Source: Authors. Meaning of grades: (*) First rank (the most important); (**) second rank; (***) third rank.

producers, followers or new ones, considered the current price as motivating and as a factor of economic profitability. Another weakness concerned the lack of access to information, especially as regards the foreign market, and the lack of skills in terms of market penetration mechanisms and export procedures (FW3). The saffron producers expressed the need to build their capacities on these issues. Lastly, the difficulty in land access and the dispersion of production factors (i.e., if land is available, water or electricity may be lacking and vice versa) (FW4) were found to constitute a not insignificant weakness for the development of the sector. The interviewees declared that the saffron producers are in majority young people without land and 95% of producers were tenants and were confronted with the problem of a dispersion of resources; for instance when land was available and cheap, water was not there or of poor quality, or the electricity grid was far away. In addition, the saffron farmers pointed out the delays and

gaps related to the development of agricultural development areas (roads, electricity grids, deep wells) and the regularization of access to land.

c) External factors constituting opportunities for the value chain

The growing trend of demand for healthy and natural agricultural products, especially those labeled “organic”, both on the local and especially on the international market (FO1), is the main opportunity for saffron producers in the study area. The value chain also offers an opportunity for young people and women in rural areas (FO2). In addition, the easy installation of new and young producers allows seed market expansion and production growth (FO3). Another opportunity is offered to farmers wishing to group together in cooperatives to benefit from the advantages granted by the State (FO4) (such as incentives to invest, support for product promotion). With regard to this last factor, the appreciation of the producers was not clear-cut

because of a divergent evaluation in terms of costs-benefits and a lack of trust in formal organizations. In general, there was a preference for individualistic logics accompanied by informal organizational arrangements, in order to avoid possible fiscal control by the State.

d) External factors constituting threats

The saffron producers highlighted two factors representing threats for the development of the local value chain, classed in decreasing order of importance. Frauds concerning saffron quality, notably imported saffron (FT1), were unanimously considered as being the main threat. For instance, safflower or “false saffron” is imported under the denomination of pure saffron. In addition, the risks linked to diseases (FT2) were also considered to be a not insubstantial threat in the region, especially since chemical treatments are to be avoided to obtain good quality saffron. These diseases lead to a decline in quality and cause seed rot (notably fungal diseases).

Nevertheless, differences were found between the categories of producers in the expression of certain factors. The young and the new producers were the ones who highlighted more the risks linked to fungal diseases affecting seeds. Several saffron growers said that in 2017/2018, large quantities of poor quality imported seeds were distributed in the region causing major losses to several saffron growers. In addition, the entry of speculators or opportunists motivated by short-term profit in saffron production (FT3) led to a drop in sale prices. This induced strong tension and was perceived, notably by young people and small-scale producers, as a cause of demotivation and a threat to the profitability and sustainability of saffron production. These producers integrated this new saffron economy because they were seduced by the prices that aspired to euphoric futures. Some even gave up other activities to work fulltime on saffron production. The selling price of saffron initially applied by the pioneers, which was in line with the price paid by European consumers (between 20 and 30 euros/gram), had created strong interest among farmers. However, as production grew, farmers realized that this price was too high in relation to the local and national market. Consequently, the almost 50% drop in

prices now threatens the future of this sector. This is why different strategies are being deployed to perpetuate this activity. Large-scale producers bet more on quality to broaden access to markets, whereas young people, who produce less and are rather skillful in social networks, try to tap “niche markets” and advertise to create new needs, for saffron and its by-products.

3.3. Strategic options for development of the local saffron value chain

Application of the interactional matrix between external factors (threats or opportunities) and internal factors (weaknesses or strengths) led to the identification of combinations of relations between factors, thereby identifying four groups of recommendations for strategies and policy measures to develop the saffron value chain (see the TOWS matrix in Table 3). In practice, these strategies can overlap or be carried out together. These strategic recommendations, formulated by the authors, can be grouped into two major strategic options of sector development: one directed towards exports, the other towards the promotion and the protection of saffron on the national market. The main tendency is for the first option, a preference confirmed by several individual interviews, because the saffron producers perceived the international market as more attractive and more remunerative.

i) The saffron export strategy, designed to maximize the opportunity arising from the increase in world demand, breaks down as follows: modernization of saffron farms, certification and integrated management of saffron quality, reinforcement of coordination methods, strengthening of capacities, creation of a research-development system, incentive policies for investment, innovation and promotion of saffron.

ii) The promotion and protection strategy for local saffron on the national market mainly breaks down as follows: strengthening of promotion and marketing, differentiation of local saffron through alternative ways of guaranteeing quality that are more accessible to small-scale producers (compared to organic certification), reinforcement of the quality control system and fraud repression.

Table 3 - TOWS matrix of strategic options and public policy recommendations for developing the saffron value chain.

	<i>Threats</i>	<i>Opportunities</i>
<i>Weaknesses</i>	<p><i>“WT-min-min” strategies:</i></p> <p>Strategy WT-1: Strengthening ways of controlling and repressing saffron quality fraud (imported in particular).</p> <p>Strategy WT-2: Strengthening of coordination and dialogue between the various actors in relation to selling prices and sharing value, and preserving the inclusive nature of the value chain</p> <p>Strategy WT-3: Strengthening of technical advice to support saffron production</p>	<p><i>“WO-min-max” strategies:</i></p> <p>Strategy WO-1: Strengthening of actors’ knowledge and skills for saffron exports and integration in the global saffron value chain.</p> <p>Strategy WO-2: Modernization of saffron farms to increase production, productivity and competitiveness of local saffron on the international market.</p> <p>Strategy WO-3: Facilitation of the installation and access of young people/new producers of saffron to land and other productive resources in the agricultural development zones to support the creation of rural employment.</p> <p>Strategy WO-4. Promote the creation of cooperatives to benefit from public support and to favor the pooling of resources.</p>
<i>Strengths</i>	<p><i>“ST-max-min” strategies:</i></p> <p>Strategy ST-1: Implementation of a strategy for promoting and marketing local saffron on the national market</p> <p>Strategy ST-2: Modernization of saffron plantations to further increase efficiency, productivity and the competitiveness of local saffron on the national market</p> <p>Strategy ST- 3: Differentiation of the local product through an alternative system of quality guarantee (less expensive) compared to imported saffron</p> <p>Strategy ST-4: Strengthening of the ways of coordinating between saffron producers (horizontal) and between all the stakeholders (vertical) in relation to the price, seed quality and the end-product</p> <p>Strategy ST-5: Create a Research-Development system with a view to reducing phytosanitary risks, improving saffron yield and quality, and promoting a sustainable production system</p> <p>Strategy ST-6: Networking of farmers for better sharing of knowledge and experiences on saffron</p>	<p><i>“SO-max-max” strategies:</i></p> <p>Strategy SO-1: Implementation of a strategy and policy of promoting and adding value to local saffron on the international markets</p> <p>Strategy SO-2: Certification of local saffron quality to reach and take advantage of the growth of the international market (promotion of the ecological and social aspects) and establishment of integrated quality management throughout the chain (good agricultural practices, pruning, drying, conservation, packaging, etc.)</p> <p>Strategy SO-3: Organization in cooperatives to pool resources, maximize economic benefits and benefit from the support granted by the State</p>

Source: Authors.

4. Discussion

Given the results presented, local saffron production has several favorable assets for its promotion as an opportunity for rural development sustainability in the M'Zab Valley. The selection of the saffron sector is thus relevant and consistent with the goals of the rural renewal policy, aimed at diversifying economic activities, preserving and developing natural resources and improving income and employment conditions for rural populations (MADRP, 2017).

In a climate considered to be particularly hostile to agricultural production, where access to water and land is challenging, farmers' initiatives have made saffron a viable crop on which an expectation of wealth is placed. Farmers have successfully adopted this crop in their low-input production strategies, which was initially seen as an efficient business due to the positive feedback received.

Investment in saffron crops in this area also entails challenges for access to resources. In many cases farmers must overcome obstacles to gain that access. For example, the Algerian government has introduced policies for access to land ownership for development purposes. However, these lands are often without good soil, (the saffron producers bring the alluvium from wadi to spread it on the rocky lands to transform them into fertile soils), and access to water or electricity is often lacking. A saffron investment project assembled from scratch thus required many investments before being able to make profits. Saffron pioneers were able to do so and succeeded in multiplying returns (by five or six) after only 5 years of activity. This hostile environment thus stopped being a constraint for saffron.

The other strategy that these producers follow is that of saffron quality. According to studies of the global saffron market, demand is expected to grow significantly in the coming years, despite the high price of this spice. The benefits of saffron on health are likely to attract more consumers and companies, particularly in the pharmaceutical sector (GVR, 2021). However, a thorough assessment of export potential and local production competitiveness on the worldwide market is required. Development of a national export

strategy is more than necessary. This strategy should focus on the following goals: 1) Modernization of saffron farms to increase production, productivity, and allow economies of scale, as well as local saffron competitiveness (for example: adapt land policy and rural development to encourage investment; policy of financial incentives for initial investment and mechanization, etc.); 2) Stimulation of foreign market penetration based on quality certification and integrated management of saffron quality throughout the value chain, and financial incentives to promote exports; 3) Strengthening of coordination between stakeholders, along with improvement of the institutional environment and support services to develop the value chain.

However, the focus on the international market should not sideline an assessment of potential demand on the national market and the promotion of saffron on that market. The strategy for promoting saffron on the local market could be based on a number of factors, including: 1) Strengthening of anti-fraud systems to protect local saffron production and, for example, the setting-up of non-tariff quotas on imported saffron to limit competition; 2) Implementation of a less expensive alternative quality guarantee system based on lessons learned from experiences in other countries, such as the participatory quality guarantee system (Lemeilleur and Allaire, 2018) and territorial labeling to avoid a competitive field and/or an organic conduct; 3) Strengthening of communication and marketing strategies, particularly on social media (e-commerce), to boost demand and promote a saffron consumption culture; 4) Use of public order for the promotion of local saffron suggested by some leaders in production.

Although the pioneers' initial investment was substantial, this constraint in terms of mobilizing capital does not appear to exist anymore. Indeed, locally multiplied seeds are now accessible at more or less inexpensive prices, often with deferred payment arrangements. More than avoiding unemployment, this sector has allowed investment opportunities, especially for younger people. Furthermore, because of its labor intensity, the inclusion of small-scale producers and its gender sensitivity, development of the

saffron sector offers an opportunity to alleviate rural unemployment, a situation that disproportionately impacts young people and women in those areas. By employing young people and “housewives”, the saffron sector could contribute, on the one hand, to increasing agricultural employment and rejuvenating farmers and, on the other hand, to improving the empowerment conditions and incomes of rural women. In the saffron value chain, women are equal to men in terms of the work provided. This sector offers a home-based employment market for women in the region, focusing on pruning and drying operations. Women therefore have an indirect role in the development of this sector. Although these socio-economic benefits were not studied in depth, our work provides elements to guide research perspectives based on rigorous analyses of the socio-economic impacts of the saffron sector in the Algerian context.

Although the production environment is based on the values of sharing experiences, increased marketing difficulties are creating tensions between large- and small-scale producers regarding the “floor” selling price. The Covid-19 effect has revealed the opposition of interests within the pioneer association, whose rivalries are still latent today, and young people, who are still lacking in technical skills, have been found to be better able to manage the market problem, targeting niche markets by using social networks. What are the opportunities for cooperation between young people, who master access to marketing niches, and the pioneers who are well versed in farming techniques? The pooling and sharing of technical and marketing know-how may constitute an alternative for reinforcing the organization of producers and allowing the fair sharing of profit margins between the actors of the saffron value chain. For the time being, the dynamism of young people in marketing on social networks favors their positioning as producers-retailers of saffron by obtaining their supplies from the pioneers, in order to meet market demand, and benefiting from a discount on the selling price tacitly fixed at production level.

At the current stage of its development, the local value chain displays several vulnerabilities linked, on the one hand, to the very weak

involvement of other potential operators (spice retail stores, herbalist wholesalers, final industries, export traders), because of insufficient supplies and high production costs, and more especially, on the other hand, to the deficiencies of the institutional environment: competition from informally imported saffron, the import of fake saffron and quality frauds, lack of export knowledge and skills, deficit or absence of technical and financial support for producers, difficulties in accessing productive resources – land and water in particular – difficulties in the functioning of the association of saffron producers and coordination between the various stakeholders, lack of partnerships between industries or traders and saffron producers, etc. Consequently, the performance and development of the value chain hold an important role for the State to improve the institutional environment, as well as the public facilitation and regulation services. Among the support services, the promotion of quality analysis laboratories and certification bodies meeting international standards, as well as the establishment of an efficient research and development system to produce knowledge on the determining factors of saffron yield and quality in the different physical contexts, particularly in arid environments, are needed. More generally, the analytical results support the thesis that social and technological innovations are needed to co-design and co-implement public policies that are more adapted to the specific contexts of the Mediterranean hinterland territories and more inclusive of the multi-stakeholder involved for the development of high quality food value chains (Sanz-Cañada *et al.*, 2015; Fetoui *et al.*, 2020).

5. Conclusion

Official recognition of the saffron value chain by the Algerian government since May 2020, as well as the creation the same year of a new central directorate in charge of organic agriculture, labeling and promotion of agricultural products, are opportunities for improving the institutional environment and allowing a transition to a more structured and sustainable value chain. This mainly consists in defining a shared vision,

drawing up a development strategy and implementing an action plan with the involvement of all stakeholders, on several scales (local, regional and national). In this perspective, the results of the analysis based on the matrix of interaction between external factors (opportunities, threats) and internal factors (strengths, weaknesses) applied to the emerging saffron value chain in the wilaya of Ghardaïa, can serve as a basis for recommendations on strategic directions and public policies. Indeed, two strategic options are identified: the promotion and commercial development of saffron on the international market, along with the promotion and the protection of saffron on the national market. The first option is considered as a priority to build an efficient value chain able to take advantage of the growth of world demand for saffron. In perspective, these first results will be discussed and validated within the framework of the elaboration of a development plan of the saffron value chain following a multi-stakeholder participatory process.

Acknowledgements

The authors are grateful to IFAD for funding the field surveys under the Massire research project “Integrating multiple sources of water and local institutions to support improved food security in the North African hinterland through strengthening agricultural and rural innovation systems” coordinated by CIRAD (Montpellier) in partnership with CREAD and Tipaza University. They also thank the local institutions (the Direction of the agricultural services, the Chamber of agriculture, the local association for the promotion of the saffron, the APEB) and the producers of saffron for their support and their availability to carry out the participative workshops, the surveys and the individual interviews.

References

- Alizadeh A., Sayari N., Ahmadian J., Mohamadian A., 2009. Study for zoning the most appropriate time of irrigation of saffron (*Crocus Sativus*) in Khorasan Razavi, North and Southern Provinces. *Journal of Water and Soil (Agricultural Sciences and Technology)*, 23(1): 109-118.
- Alvarez-Orti M., Gomez-Gomez L., Rubio A., Escribano J., Pardo J., Jiménez F., Fernandez J.-A., 2004. Development and Gene Expression in saffron corms. *Acta Horticulturae*, 650(650): 141-153. DOI:10.17660/ActaHortic.2004.650.14.
- Aytekin A., Acikgoz A.O., 2008. Hormone and microorganism treatments in the cultivation of saffron (*Crocus sativus* L.) plants. *Molecules*, 13(5): 1135-1147. <https://doi.org/10.3390/molecules13051135>.
- Beebe J., 1995. Basic Concepts and Techniques of Rapid Appraisal. *Human Organization*, 54(1): 42-51. <https://www.jstor.org/stable/44126571>.
- Bengouga K., Lahmadi S., Zeguerrou R., Maaoui M., Halis Y., 2020. The saffron (*Crocus sativus* L.) cultivation introduction in mountainous oases in Algeria. *Acta Horticulturae and Regiotecturae*, 23(1): 8-11. <https://doi.org/10.2478/ahr-2020-0003>.
- Cardone L., Castronuovo D., Perniola M., Cicco N., Candido V., 2020. Saffron (*Crocus sativus* L.), the king of spices: an overview. *Scientia Horticulturae*, 272: 109560. <https://doi.org/10.1016/j.scienta.2020.109560>.
- Chevalier A., 1926. La culture du Safran (suite et fin). *Revue de Botanique Appliquée et d'agriculture coloniale*, 6(60): 490-501.
- Dar M.H., Groach R., Razvi S.M., Singh N., 2017. Saffron crop (golden crop) in modern sustainable agricultural systems. *International Journal for Research in Applied Science & Engineering Technology (IJRASET)*, 5(11): 247-259. <https://www.researchgate.net/publication/322488066>.
- Da Silva C.A., de Souza Filho H.M., 2007. *Guidelines for rapid appraisals of agrifood chain performance in developing countries*. Agricultural management, Marketing and finance, Occasional Paper 20. Rome: FAO. <https://pacificfarmers.com/wp-content/uploads/2014/05/Guidelines-Rapid-Appraisals.pdf>.
- Escobar A.L., López R.R., Guerrero J.E.G., Cuadrado E.S., 2020. Design of Strategies for the Implementation and Management of a Complementary Monetary System Using the SWOT-AHP Methodology. *Sustainability*, 12(17): 6849. <https://doi.org/10.3390/su12176849>.
- Fernández J.A., 2004. Biology, biotechnology and biomedicine of saffron. *Recent research developments in plant science*, 2: 127-159.
- Fetoui M., Dhehibi B., Fria A., Sghaier A., Kassam S., Aw-Hassan A., Arbi Abdeladhim M., Sghaier M., 2020. Towards an Innovative Olive Oil Value Chain: Options for Inclusive Development in South-Eastern Tunisia. *New Medit*, 19(3): 3-20. <https://doi.org/10.30682/nm2003a>.

- Gadiri N., 2011. *Introduction de la culture du safran (Crocus Sativus L.) dans les petites exploitations rurales de M'Sara (Khenchela)*. Communication, Atelier sur la recherche - développement rural : Cas du bassin versant de Isser-Sekak (Tlemcen) et des Monts des Aurès (M'Sara), INRF, Bainem, Alger, 21 décembre.
- Ghorbani M., 2007. The economics of saffron in Iran. *Acta Horticulturae*, 739: 321-331. DOI:10.17660/ActaHortic.2007.739.42.
- Giupponi L., Ceciliani G., Leoni V., Panseri S., Pavlovic R., Lingua G., Di Filippo A., Giorgi A., 2019. Quality traits of saffron produced in Italy: geographical area effect and good practices. *Journal of Applied Botany and Food Quality*, 92: 336-342. DOI: 10.5073/JABFQ.2019.092.045.
- Gresta F., Lombardo G.M., Siracusa L., Ruberto G., 2008. Saffron, an alternative crop for sustainable agricultural systems. A review. *Agronomy for Sustainable Development*, 28(1): 95-112. DOI: 10.1051/agro:2007030.
- GVR - Grand View Research, 2021. *Saffron, market analysis 2017-2028, Opportunities Beyond COVID-19 Crisis*. Dublin: Research and Markets.
- Hellin J., Meijer M., 2006. *Guidelines for Value Chain Analysis*. Rome: Food and Agriculture Organization of the United Nations (FAO).
- Hiller S., Hilhorst D., Weijis B., 2014. *Value chain development in Fragile Settings*. IS Academy, Occasional Paper no. 14. Wageningen University, 90 pp. https://www.researchgate.net/publication/283069670_Value_chain_development_in_Fragile_Settings.
- INRF - Institut National de Recherche Forestière, 2012. *Rapport final du projet "Expérimentation Participative et Adaptative de Modèles de Gestion des Ressources Forestières dans la chaîne montagnaise de l'Atlas (Algérie, Maroc, Tunisie)"*, projet CRDI N°105568 composante 002, Alger, 20 pp. <https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/52373/IDL-52373.pdf>.
- Kaplinsky R., Morris M., 2001. *A handbook for value chain research*. Brighton: University of Sussex, Institute of Development Studies.
- Khajeh-Hosseini M., Fallahpoor F., 2020. Emerging innovation in saffron production. In: Koocheki A., Khajeh-Hosseini M.B.T.-S. (eds.), *Saffron: Science, Technology and Health*. Sawston: Woodhead Publishing, pp. 205-216. <https://doi.org/10.1016/B978-0-12-818638-1.00012-5>.
- Khemici M., Gadiri N., Hamani M., Rouibi A., 2014. Introduction de la culture du safran (*Crocus sativus L.*) dans la region des Aurès – Premiers résultats et perspectives. *La Forêt Algérienne*, 9, INRF.
- Koocheki A.A., 2004. Indigenous knowledge in agriculture with particular reference to saffron production in Iran. *Acta Horticulturae*, 650(17): 175-182. <https://doi.org/10.17660/ActaHortic.2004.650.17>.
- Lahmadi S., Guesmia H., Zeguerrou R., Maaoui M., Belhamra M., 2013. La culture du safran (*Crocus sativus L.*) en regions arides et semi-arides cas du sud-est algérien. *Journal Algérien des Régions Arides*, n° spécial, 18-27.
- Lemeilleur S., Allaire G., 2018. Système participatif de garantie dans les labels du mouvement de l'agriculture biologique. Une réappropriation des communs intellectuels. *Économie rurale*, 365: 7-27.
- Lopez-Corcoles H., Brasa-Ramos A., Montero-García F.J., Romero-Valverde M., Montero-Riquelme F., 2015. Phenological growth stages of saffron plant (*Crocus sativus L.*) according to the BBCH scale. *Spanish Journal of Agriculture Research*, 13(3): e09SC01. <https://doi.org/10.5424/sjar/20151333-7340>.
- Maachou H.M., 2013. Le M'Zab : de la Pentapole à la Métropole. *Bulletin des Sciences Géographiques*, 28: 63-70.
- MADRP - Ministère de l'Agriculture, du Développement Rural et de la Pêche, 2017. *Stratégie de développement du secteur de l'Agriculture, du Développement Rural et de la Pêche 2035. Contribution à l'élaboration d'un nouveau modèle de croissance économique à 2035*.
- Mikhailenko A.O., Volodymyr D., Ivanauskas L., Georgiyants V., 2020. Standard operating procedure of Ukrainian saffron cultivation according with good agricultural and collection practices to assure quality and traceability. *Industrial Crops and Products*, 151(3):112376. DOI: 10.1016/j.indcrop.2020.112376.
- Mokrani M., 2020. *Analyse d'une filière émergente : cas de la wilaya de Ghardaïa*. Mémoire de Master, Département d'Économie rurale, École Nationale Supérieure Agronomique (ENSA), Alger, 167 pp.
- Molina R.V., Valero M., Navarro Y., Guardiola J.L., Garcia-Luis A., 2005. Temperature effects on flower formation in saffron (*Crocus sativus L.*). *Scientia horticulturae*, 103(3): 361-379. DOI: 10.1016/j.scientia.2004.06.005.
- Mollafilabi A., Davari K., Dehaghi M.A., 2021. Saffron yield and quality as influenced by different irrigation methods. *Scientia Agricola*, 78(1): e20190084. <http://dx.doi.org/10.1590/1678-992X-2019-0084>.
- Mzabri I., Addi M., Berrichi A., 2019. Traditional and modern uses of saffron (*Crocus sativus*). *Cosmetics*, 6(4): 63. DOI: 10.3390/cosmetics6040063.
- Mzabri I., Charif K., Rimani M., Kouddane N., Boukroute A., Berrichi A., 2021. History, biology,

- and culture of *Crocus sativus*: Overview and perspectives. *Arabian Journal of Chemical and Environmental Research*, 8(1): 1-28. <http://www.mocedes.org/ajcer/volume8/AJCER-01-Mzabri-2021.pdf>.
- Naeli S., Orsi L., 2020. *Saffron value chains, insights from Iran*. Roma: Aracne Editrice, 132 pp. <http://aracneeditrice.com/pdf/9788825534153.pdf>.
- Olsen W., 2004. Triangulation in Social research: Qualitative and Quantitative Method can really be mixed. In: Hollborn M. (ed.), *Developments in sociology*. Ormskirk: Causeway Press.
- Pandita D., 2021. Saffron (*Crocus sativus* L.): Phytochemistry, therapeutic significance and omics-based biology. In: Aftab T., Rehman Hakeem K. (eds.), *Medicinal and Aromatic Plants*. Cambridge: Academic Press-Elsevier, pp. 325-396. <https://doi.org/10.1016/B978-0-12-819590-1.00014-8>.
- Razavi B.M., Hosseinzadeh H., 2017. Saffron: a promising natural medicine in the treatment of metabolic syndrome. *Journal of the Science of Food and Agriculture*, 97(6): 1679-1685. <https://doi.org/10.1002/jsfa.8134>.
- Sahabi H., Feizi H., Karbasi A., 2016. Is saffron more energy and economic efficient than wheat in crop rotation systems in northeast Iran? *Sustainable Production and Consumption*, 5: 29-35. <https://doi.org/10.1016/j.spc.2015.11.001>.
- Sanz-Cañada J., García-Brenes M.D., Barneo-Alcántara M., 2015. Value Chain and Typicity Analysis in Jaén Mountain Olive Oil, Spain. *New Medit*, 14(3): 50-60.
- Tozanli S., 2018. *Etude du marché algérien intérieur et import/export de la pistache, de la câpre, de l'amande et du safran*. Programme d'Action Pilote pour le Développement Rural et l'Agriculture, PAP-ENPARD Algérie, 74 pp.
- Weihrich H., 1982. The TOWS matrix—A tool for situational analysis. *Long Range Plan*, 15(2): 54-66. [https://doi.org/10.1016/0024-6301\(82\)90120-0](https://doi.org/10.1016/0024-6301(82)90120-0).
- Winterhalter P., Straubinger M., 2000. Saffron—renewed interest in an ancient spice. *Food Reviews International*, 16(1): 39-59. <https://doi.org/10.1081/FRI-100100281>.
- Yasmin S., Nehvi F., Sethi J., Wani A., 2018. Horizontal expansion of saffron in new areas of Jammu and Kashmir - A case study. *Acta Horticulturae*, 1200: 55-58. [10.17660/ActaHortic.2018.1200.9](https://doi.org/10.17660/ActaHortic.2018.1200.9).
- Yavuz F., Baycan T., 2013. Use of swot and analytic hierarchy process integration as a participatory decision making tool in watershed management. *Procedia Technology*, 8: 134-143.
- Zobeidi Z., Benkhalifa A., 2014. La culture du safranier (*Crocus Sativus* L.) en Algérie. In: *1^{ère} Exposition Ethnobotanique et 2^{ème} Atelier d'Initiation à la phytotechnie*, Jardin du Hamma, Alger, 7 juin.