



Research Article

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# SAFFRON AS A MAIN CASH, MEDICAL AND RESISTIVE PLANT FOR SUSTAINABLE ECONOMY AND LIVELIHOOD OF RURAL PEOPLE IN DRIED REGIONS OF IRAN

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## Abstract

One of the most valuable and irreplaceable cash, medical and resistive plants in dried conditions all over the world is Saffron. It can be seen in arid areas of Iran with cold winter and hot summer. Major areas for cultivating Saffron are in South and Razavi Khorasan provinces in east of Iran that producing more than 70 percent globally production of this valuable plant. Because of Saffron's numerous unique qualities and utilizations plus its important role that plays in the economy of Iranian farmers it calls for a particular attention for eradicating its problems in production, export and merchandising. In Iran it is specially an exceptional product, because it requires little water and low care. It can provide jobs for villagers and prevent their emigration from rural areas to cities and urban regions. Compared to the other kinds of agricultural products, it can bring about a remarkable income both for the farmers and for the country. Saffron is important from aspects of economy, medicine, producing employment opportunities and as food stuff. Author in this article on the basis of his experiences, observations and studies about this plant during more than two decades, tries to introduce and describe a brief history of Saffron, its qualities and ecosystem, its role in sustainable economy and livelihood of rural people in dried regions, its problems and difficulties in production and export in Iran and South Khorasan province especially.

**Keywords:** Saffron, Farming, Economy, Medical, Cash, Plant, South Khorasan, Iran

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## 1. Introduction

Saffron (*Crocus sativus* L.) is widely cultivated in Iran and is one of the natural edible dyes with high economical and biological value which is used to increase acceptability of foods in society. Iran has long been a significant, but often overlooked, source of high - quality Saffron production and export.

Saffron is a Native plant of Iran including various medical and food properties. Saffron has an important place and great background in terms of economic issues in Iran (Golmohammadi et al., 2014). Saffron, an exotic and elaborately extracted spice, has for centuries been in global demand. Highly coveted for its beauty, aroma, healing powers, and overall appeal, "Red Gold" is known to be the most expensive spice in the world.

Today, with more than 85 percent of the universal production, Iran is considered the main producer of Saffron in the world (Agronomy Statistics, 2019).

Saffron or *Crocus sativus*, accentuates myth, magic, medicine, and meals all over, with legendary “roots” that can be traced back through history and into story.

Traditional agriculture in Iran is based on development of cropping systems with low water requiring crops such as Saffron. In west of Asia with low annual rainfall, cold winters and hot summers. At present, Saffron is cultivated in Iran and a few countries with old civilization such as Spain, India, Greece, Morocco etc. Saffron is a cash plant that most of researchers believe it is indigenous plant of Iran (Golmohammadi, 2012a; Golmohammadi et al., 2014; Amin, 1991; Aynehchi, 1986; Chiej, 1984).

Saffron in Iran is planted as a perennial crop and its yield varies in successive and consecutive years as do fruit trees (Sepaskhah et al., 2008; Sepaskhah and Kamgar-Haghighi, 2009).

Iran is leading country in Saffron production with 110000 ha cultivated area and 405 ton annual production (3.7 kg – 4.2 kg/ha yield). In recent years 5000 ha add to cultivated areas of Saffron in Iran continuously (Agronomy Statistics, 2019).

The main Saffron production areas in Iran are located in South and Razavi Khorasan, Fars and Kerman provinces. Its cultivation area increased by an annual rate of about 22% in last decade, however, its annual production increased by about 14%. This indicates that the saffron yield (kg/ha) decreased about 50% that may be due to occurrence of drought and newly cultivated fields with low yield (Alipour Eskandani, 2013; Agronomy Statistics, 2019; Behdani, 2013).

In the South Khorasan province, 35830 farmer households in 15000 ha cultivation area, are working on Saffron production and main sources of their family income obtain from this plant. These statistics in Razavi Khorasan province, are 85000 ha cultivation area, and 730000 population of this province are engaged in various stages of farming and cultivating of Saffron production (Agronomy Statistics, 2019; Golmohammadi, 2018; Golmohammadi, 2019).

Iran in 2017 export 250 tons of Saffron to abroad and earned about 352 million dollars (USD). This amount added to 350 tons of Saffron and earned about 443 million dollars (USD) value of export in 2018 (Agronomy Statistics, 2019) Table 1 and Table 2.

**Table 1.** Saffron production in Iran and the world (2017and 2018)

Country / Region	Average annual production (Ton)	Percentage share from global production (in 2017 & 2018)
Razavi Khorasan province	288 (in 2018)	61 (in 2018)
	256 (in 2017)	60 (in 2017)
South Khorasan province	54 (in 2018)	11 (in 2018)
	46 (in 2017)	10.77 (in 2017)
Iran (all of the provinces – plus two above main provinces)	376 (in 2017)	88 (in 2017)
	405 (in 2018)	85 (in 2018)
Greece (Kozani)	7 (in 2018)	1.5 (in 2018)
India (Kashmir)	22 (in 2018)	4.6 (in 2018)
Spain (La Mancha)	21 (in 2018)	4.4 (in 2018)
Other countries (Afghanistan, Morocco etc.)	20 (in 2018)	4.2 (in 2018)
Total production of the world	427 (in 2017)	100
	475 (in 2018)	

**Table 2.** Value and amount of Saffron export in Iran to the world (2016 and 2018)

Year	Amount of Saffron export (Tons)	Value of Saffron export – million dollars \$ (USD)
2016	203	286
2017	250	352
2018	350	443

There is a growing concern and demand for healthy food on behalf of both policy makers and the public. Traditional Saffron production systems which, in both technical and social terms are forms of ecological

production are still operated in many parts of Iran. The most quality of Saffron production in Iran and the world is belonging to Qayen city - Recognized as the “City of Saffron” in Iran - in the South Khorasan province, east of

Iran, because of favorable environmental conditions and Traditional Knowledge (TK) and experiences of its farmers and local rural people (Figure 1 and Figure 2).



Figure 1. Saffron (*Crocus sativus* L.).



Figure 2. Saffron field.

### 1.1. History of Saffron

From the cradle of civilization to Cleopatra's courts, from Sumerian and Persian kingdoms to Greek and Biblical divinity, from the Near and Far East to the European and American West, Saffron appears everywhere, both in trade and in tale.

The domesticated Saffron crocus, *Crocus sativus*, is an autumn-flowering perennial plant unknown in the wild. Its progenitors are possibly the eastern Mediterranean autumn-flowering *Crocus cartwrightianus*, which is also known as "wild Saffron" and originated in Greece.

Iran has more than 3000 years of history for farming of Saffron. In the South Khorasan province there are documents that this plant has been cultivated from 700 years ago (Agronomy Statistics, 2019; Gruenwald et al., 2000).

### 1.2. Farming conditions and Botany of Saffron

Saffron is originated from iridaceous. According to some European sources, it is produced locally in Mediterranean and west Asian climate. Saffron is grown in arid and semi-arid regions in Iran in late autumn, winter and late spring with rainy season. It should be irrigated by supplemental basin irrigation. Since rainfall is usually delayed in autumn, therefore, a pre - flowering irrigation of about 100 mm is needed. In areas with a seasonal rainfall of 600

mm a post - flowering irrigation of about 50 mm is adequate for economical yield. In areas with seasonal rainfall of 400 and 200 mm continuous supplemental irrigation is needed with intervals of 24 and 15 days or irrigation regimes of 50% ETp and 75% ETp, respectively. In these areas, irrigation regimes can be planned based on Crop Water Stress Index (CWSI) of 0.60 and 0.27, respectively. Resistant of Saffron shrubs to hot and dried plus snow and very cold air temperature (-15' C) during winter mentioned in various studies in Iran (Figure 3).



Figure 3. Resistant of Saffron shrubs to snow and very cold air temperature (-15' C) during winter in the Ghandab (Khoonik Olia) village in Nehbandan city in South Khorasan province - east of Iran.

The Saffron crocus probably resulted when *C. cartwrightianus* was subjected to extensive artificial selection by growers seeking longer stigmas. *C. thomasi* and *C. pallasii* are other possible sources. It is a sterile triploid form, which means that three homologous sets of chromosomes compose each specimen's genetic complement; *C. sativus* bears eight chromosomal bodies per set, making for 24 in total. Being sterile, the purple flowers of *C. sativus* fail to produce viable seeds; reproduction hinges on human assistance: clusters of corms, underground, bulb - like, starch-storing organs, must be dug up, divided, and replanted. A corm survives for one season, producing via this vegetative division up to ten "cormlets" that can grow into new plants in the next season. The compact corms are small, brown globules that can measure as large as 5 cm (2.0 in) in diameter, have a flat base, and are shrouded in a dense mat of parallel fibers; this coat is referred to as the "corm tunic". Corms also bear vertical fibers, thin and net-like, that grow up to 5 cm above the plant's neck (Golmohammadi, 2012b).

The plant grows to a height of 20 - 30 cm (8 - 12 inch), and sprouts 5 - 11 white and non-photosynthetic leaves known as cataphylls. These membrane-like structures cover and protect the crocus's 5 to 11 true leaves as they bud and develop. The latter are thin, straight, and blade-like green foliage leaves, which are 1-3 mm in diameter, either expand after the flowers have opened

("hysteranthous") or do so simultaneously with their blooming ("synanthous"). *C. sativus* cataphylls are suspected by some to manifest prior to blooming when the plant is irrigated relatively early in the growing season.

The crop production function for water (water application/yield response function) is dependent on the year of production. This is due to the fact that the amount of corm per unit area (corm intensity) varies in consecutive years. Therefore, the crop production function of Saffron for water is dependent not only on the amount of applied water but also on the amount of corm in unit area.

For perennial crops such as Saffron, the economic analysis of deficit irrigation is dependent on the amount of corm in unit area (Sepaskhah, et al. 2008).

There are distinct differences between eco - physiological behavior of Saffron and other crops. Flowers appear before development of other plant organs. Occurrence of flowers coincides with cold temperature in fall. In contradiction of the economic yield of most conventional crops, Saffron yield is style/stigma that is a small part of its flower. Harvest index of Saffron is less than 0.5% compared with 30 to 60% for other crops (Golmohammadi, 2012c; Golmohammadi et al., 2014).

Traditionally, Saffron is irrigated four times during October to May, however, to achieve high yield, appropriate irrigation scheduling should be used (Alipour Eskandani, 2013).

As Saffron is "worth its weight in gold," for years, scandalous merchants have either "cut" the product with various additives, added water weight, or simply tried to pass off cheap imitations as the real Saffron. Powder and thread form are both found and are equal in potency and quality, however, the powder is often cheaper, because of it is easier to imitate (Alipour Eskandani, 2013).

Its floral axes, or flower - bearing structures, bear bracteoles, or specialized leaves that sprout from the flower stems; the latter are known as pedicels.

After aestivating in spring, the plant sends up its true leaves, each up to 40 cm (16 inch) in length. In autumn, purple buds appear. Only in October, after most other flowering plants have released their seeds, do its brilliantly hued flowers develop; they range from a light pastel shade of lilac to a darker and more striated mauve. The flowers possess a sweet, honey-like fragrance. Upon flowering, plants average less than 30 cm (12 in) in height. A three - pronged style emerges from each flower. Each prong terminates with a vivid crimson stigma 25 - 30 mm (0.98 - 1.18 in) in length (Golmohammadi, 2012d; Golmohammadi et al., 2014).

### 1.3. Medicinal elements in Saffron

Saffron (*Crocus sativus* L.) is a valuable medicinal plant which has many therapeutic applications since long time ago as anti-spasmodic, carminative, and diaphoretic. Some of the most important elements in Saffron are Crocin Glucosid, Crocetin, Beta & Gama Saffronol,

carotene, Lycopene and Picrocin. Saffron is anodyne and it is useful for stomach. It is used to cure menses irregularities and it is useful for women's bleeding resulted from delivery. It is exhilarating and good for strengthening human's senses and mental abilities. It is also good for Liver, spleen, headache, sleeplessness, etc. Renal stone can also be cured if used by honey (Golmohammadi, 2012b; Golmohammadi et al., 2014; Rahaiee et al., 2013).

### 1.4. Saffron in arid areas of Iran

Saffron can be seen in arid areas of Iran with cold winter and hot summer that available in Southern and Razavi Khorasan provinces in east of Iran. While other wild types of Saffron are also used because of their beautiful decorative flowers, the common agricultural type has a particular economic value. In Southern Khorasan the ecological condition is that of a desert. Low precipitation, high evaporation causes very low humidity. Large Temperature fluctuations occur during days and nights. In some higher areas conditions are ecologically more favorable for plant growth, but they are not so distinct from those of the deserts (Golmohammadi, 2012b; Golmohammadi et al., 2014; Mahboubi et al., 2013; Mashayekhi et al., 2013). Figure 4 shows preparing land, getting organic and animal fertilizers and sowing bulbs of Saffron.



**Figure 4.** Preparing land, getting organic and animal fertilizers and sowing bulbs of Saffron.

## 2. Method

Type of this research is qualitative and Location area in rural regions of South Khorasan province, east of Iran. The present study has been done by author during 2013 - 2019 years (Figure 5). South Khorasan province consists of 11 counties namely Birjand, Ferdows, Tabas, Qaen, Nehbandan, Darmian, Sarbisheh, Boshruyeh, Sarayan, Zirkouh and Khusf. Four main regions that in their villages Saffron has been cultivated, are Qaen, Saravan, Darmian

and Birjand counties, thus majority of author field research has been done in these locations. Main instruments for gathering information in this article were qualitative and participatory research methods and place - based approaches, using in - depth semistructured interviews and participatory observation, discussions, experiments, documents, pictures, and nonformal interviewing with villagers, related officers, specialists and experts in domain of Saffron during 2013 – 2019.

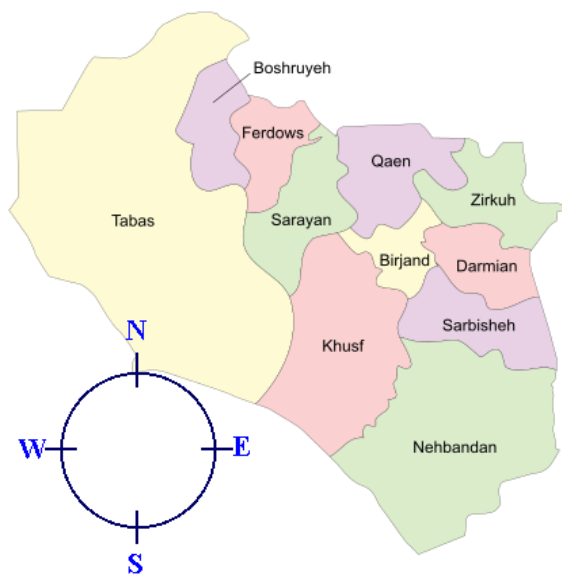


Figure 5. Map of the South Khorasan province in east of Iran.

### 3. Environmental Requirements, Conditions and Irrigation of Saffron

Saffron growth in temperate and dry climate is favored. However, vegetative growth of saffron coincides with cold air temperature with freezing conditions in winter. The mean monthly maximum and minimum air temperatures in October to December in southern parts of South and Razavi Khorasan are 20 and 0.0°C, and for Fars province are 15.0 and -8.9°C, respectively (Vafabakhsh et al., 2010). According to this reference, absolute minimum

temperature of -22°C occurred in Torbate-Hydarieh (Saffron production area) in northern part of Khorasan province while this value is -20.0 °C for Fars province.

Although Saffron is planted in arid and semi-arid regions in Iran and is adapted to these conditions, however, according to the research findings in Greece, saffron should not be under water stress in some of the growth stages. In Greece, saffron corms grow in March and April, and September it is the time of flower initiation, therefore, saffron should not be under water stress in these periods. In Morocco, saffron is irrigated by basin irrigation. In these fields, 30-50 mm of irrigation water is used weekly in September to November and the amount of applied irrigation water is 35-50 mm during December to March that is applied with two weeks interval. Furthermore, Saffron is not irrigated during April to August. By this irrigation regime, Saffron yield of these fields reported to be 2-2.5 kg/ha, and it is much lower than those reported in Italy (10 -16 kg/ha) and Spain (10 -12 kg/ha). Almost similar irrigation schedule is practiced in Saffron plantation in Iran that results in low Saffron yield (3.4 kg/ha) as reported by Vafabakhsh et al. (2010). Therefore, it hypothesized that other irrigation methods, i.e., furrow and appropriate irrigation interval may improve Saffron yield (Golmohammadi, 2012a; Golmohammadi et al., 2014; Hagianhosseinabadi and Amooaghaei, 2013).

Water quality is an important factor in plant growth and yield specially yield of Saffron. Saffron growing season coincides with late autumn, winter and early spring with cold to moderate temperatures. However, during the summer where water shortage is a limiting factor for growth of many crops, Saffron is in its dormant stage with no water requirement. High yield of Saffron depends on a strong vegetative growth that requires enough water after flowering in late autumn to early spring. Therefore, for irrigated Saffron or supplementary irrigated Saffron for rain-fed conditions, proper planning for irrigation regimes is necessary (Sepaskhah et al., 2008; Janpoor and Soltanian, 2013; Mirbakhsh and Hosseinzadeh, 2013).

### 4. Harvesting of Saffron

As indicated in legend, Saffron itself is derived from the long reddish - orange stigma of the low ornamental saffron crocus plant's large lily - shaped purple flower. Handpicked and harvested on early autumn morning of warm nights, anywhere from 70,000 to 250,000 of them are actually needed in order to collect just one pound of pure saffron. It took 45 - 55 minutes to pick 1000 flowers and 100 - 130 minutes to remove stigmas for drying. This means it takes around 370 - 470 hours of work to produce 1 kg of dried Saffron (Figure 6). Thus, this labor-intensive but highly cherished yellow -hued wonder has established itself worldwide as “a spice to be reckoned with.” Luckily, a little bit of Saffron goes a long way, as only one pinch is needed in order to flavor and color a culinary creation (Rostami and Golfam, 2013).

In fact, more than a pinch could be not only bitter, but also ultimately toxic:

“The use of it ought to be moderate and reasonable, for when the dose is too large, it produces a heaviness of the head and sleepiness. Some have fallen into an immoderate convulsive laughter which ended in death.”

Culpeper's The Complete Herbal. As quoted: (Alipour Eskandani, 2013).



**Figure 6.** Harvesting of Saffron

The harvest of saffron crop begins with picking of the blossoms and separating the stigmas from them. The harvest period is traditionally from late September to the late December. The process begins early in the morning before sunrise. The stigmas collected are placed in shade in a warm and dried room for five to seven days to dry. In some cases the drying is done in a ritual of roasting. And finally, after the stigmas are dry, they are variously packed and stored away from light and humidity. A survey of the regions where saffron is grown will provide testimony to the fact that the knowledge of cultivation was transferred from Iran to other regions (Alipour Eskandani, 2013).

After harvesting, the stigmas are taken to dry - a process whose execution is especially crucial due to the stigmas' natural moisture, essential in maintaining active chemicals' properties. Traditionally placed in a warm, dry, shady room for just under a week, saffron stigmas have even sometimes been known to be roasted. Once dried, they are "packed away far from light and humidity," often employing the latest and most sophisticated technological methods to ensure preservation of this highly coveted, low-return treasure of labor. Standards are then calculated from lab analyses, conducted based on the ISO 3632 standard (Golmohammadi, 2012d).

### 5. Discussion and Conclusion

Traditional agriculture in Iran is based on development of cropping systems with low water requiring plans such as Saffron. In Iran, the most significant quantity and quality of Saffron comes from Southern Khorason, Due to the long experience with its cultivation, and the transfer of methods of growing and harvesting from person to person, or generation to generation, Iranian Saffron has managed to keep its distinctive qualities in comparison with those produced in other regions of the world. That might also explain why Iranian Saffron enjoys such an exceptional recognition for its fragrance, flavor and color at international markets. Iran uses 10 - 15 tons in its domestic market and the rest is exported to Spain and

Emirates. Spain and Emirates re-export this product together with its own. Trade statistics, therefore, give an inflated impression of the size of the Spanish and Emirates industry. Overall, Spanish production is in decline, due mainly to increasing labor costs and the unwillingness of young people to enter the industry.

A return to more sustainable production systems in a country like Iran with a long history of ecological agriculture could be one effective method to protect the fragile local environments. Agronomic practices such as application of organic fertilizers, non - chemical methods for pests and weed control, complete family labour work for production and processing, share - cropping and socio - cultural environment surrounding the whole process of Saffron is in compliance with organic farming principles.

Alternative treatments in which application of chemical pesticides is at its lowest level have been under increasing consideration.

Nowadays, the world business is based on the competition. In this regard, the use of more efficient methods and tools has been the center of attraction.

Packing is one of the effective measures in the process of selling products to count. Iran enjoys favorable climate conditions; therefore, it can produce many crops such as Saffron and it also is the biggest producer of it in the world. But due to lack of proper facilities for packaging, the license of direct exports of the product is lost.

Despite of first rank of Iran in Saffron production among all of the countries of the world with more than 95 percent of Saffron global production that belonging to Iran, but share of Iran from its export in global market is very small and worthless and Iran has the seventeenth (17th) rank among countries that export this valuable and irreplaceable cash, medical and resistive plant.

This unfavorable phenomenon occurred while that Spain with total Saffron production about 20 tons in year, is the greatest exporter of Saffron in the world that volume of its export is more than 200 tons annually.

Spain and emirates are two main countries that play role of middlemen for Saffron of Iran. They buy raw, in bulk and unpacked Saffron from Iran and then packaging Iranian Saffron in luxury and beautiful packages and marketing them in the global market with their brand and name of their production and obtaining main and huge profits of Saffron in this unequivalent and unfair trade. With considering above issues, author present following recommendations for improving Saffron farming, economy, trade and export in this region and Iran;

- Moving from traditional sowing and planting, nursing the plants to maturity and harvesting toward modern and mechanized methods in various stages of Saffron cultivating, farming, etc.
- Instability and fluctuations of Saffron prices in Iranian and global markets that caused destroying livelihood security of farmers. For confronting this problem establishing and strengthening the stock exchanges of Saffron is recommended.

- Preparing appropriate workshops and extension education programmes for farmers toward improving their technical and modern knowledge about Saffron cultivating.
- Extending utilization of organic, animal and non-chemical fertilizers among Saffron farmers.
- Encouraging and educating farmers toward utilizing hygienic methods and containers for Saffron especially during harvesting, drying and packaging phases.
- Establishing a national and unique brand for Iranian Saffron and protecting from its spiritual and material rights of Iranian Saffron in the international societies and assemblies such as Food and Agricultural Organization of the United Nations (FAO) and other related organizations, societies and assemblies.
- Increasing productivity of Saffron among Iranian farmers by providing infrastructures in their farms (Modern technologies such as new irrigation methods, Integrated Pest Management - IPM, etc.) and applying appropriate extension education programmes for them.

As a general conclusion, Iran has drifted away from multilateral trading, and instead, toward establishing bilateral trade agreements with several key nations that caused huge losses and harms for economy of the country.

### Conflict of interest

The author declare that there is no conflict of interest.

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