

Potential cultivation areas of Saffron and its economic effects on forest dwellers welfare

Armin Mashayekhan ^{*1}, Hamid Jalilvand ², Mohamd Reza Pourmajidian ², Mohamad Reza Gholami ³, Mojgan Sabet Teimouri ⁴

^{1*} Ph.D Candidate of forestry Sari Agriculture and Natural Resources Sari, Iran

² Associated Professor Sari Agriculture and Natural Resources Sari, Iran

³ Shirvan Higher Education Complex Shirvan, Iran

⁴ Academic Center for Education, Culture and Research, Mashahd, Iran

* Corresponding author e-mail: mashayekhan@yahoo.com

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Abstract: The maintenance of natural forest and forest dwellers welfare are vital to biodiversity conservation. For this purpose, introducing of Saffron cultivation as innovation in agricultural activities outside of the forest could be a key factor. To achieve this goal, it is necessary to determine the agronomic suitability and the appropriate spatial pattern for the Saffron cultivation. Geographic Information System (GIS) was used to identify suitable areas for Saffron cultivation in the North of Khorasan Province, Iran. Relevant environment components such as climate factors (temperature and rainfall), topography (Digital Elevation Model and slope) and land-use were considered. The results of this study were specially looking for potential cultivation areas for expanding Saffron and to develop suitable map for Saffron cultivation. We found that 69% (1887 ha) of agricultural land have currently suitable for Saffron cultivation in North of Khorasan, Iran. The map of land suitability for cultivation of Saffron can be practiced for improving livelihood and forest conservation.

Keywords: Geographic Information System, suitability map, Saffron cultivation, potential areas, livelihoods, forest, Iran

Potansiyel safran yetiştirme bölgeleri ve orman sakinlerinin refahı üzerindeki ekonomik etkileri

Özet: Doğal ormanın ve orman sakinlerinin refahının sürdürülmesi, biyoçeşitliliğin korunması açısından son derece önemlidir. Bu amaç doğrultusunda, orman dışındaki tarımsal faaliyetlerde bir yenilik olarak safran yetiştiriciliğine başlanması önemli bir faktör olabilir. Bu hedefin gerçekleştirilebilmesi için, safran yetiştiriciliğinin tarımsal uygunluğunu ve uygun mekansal modelin belirlenmesi gerekmektedir. İran'ın Kuzey Horasan Eyaleti'nde safran yetiştirmeye uygun alanların belirlenmesi için Coğrafi Bilgi Sistemi (GIS) kullanılmıştır. İklim faktörleri (sıcaklık ve yağış miktarı), topografya (Sayısal Yükseklik Modeli ve eğim) ve arazi kullanımı gibi çevre bileşenleri dikkate alınmıştır. Bu çalışmanın sonuçları, özellikle safranın yaygınlaşması için potansiyel yetiştirme bölgelerine ve safran yetiştiriciliği için uygun bir haritanın geliştirilmesine yöneliktir. İran'ın Kuzey Horasan Eyaleti'nde tarımsal arazinin %69'unun (1.887 ha) halihazırda safrana uygun olduğunu gördük. Geçim kaynaklarının iyileştirilmesi ve ormanların korunmasını sağlamak için safranın yetiştirilmesine uygun olan arazinin haritası üzerinde bir çalışma yapılabilir.

Anahtar Kelimeler: Coğrafi Bilgi Sistemi, uygunluk haritası, safran yetiştiriciliği, potansiyel bölgeler, geçim kaynakları, orman, İran

1. INTRODUCTION

In the course of the last 8,000 years, the earth's forest cover has been reduced by almost half from 62 million km² to 33 million km², and much of this loss has occurred in the last three decades (Bryant et al. 1997). During 1980-2014, 6 million ha of Iran forest were lost and 2.8 million ha of forests were degraded. According to the Forest Survey of Iran, forest comprises almost 7.4% of Iran's geographical area and of these 100% is owned by the state.

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In developing countries, 80% of people use forest products for food and personal care (Anonymous, 2000). Rijsoort (2000) suggests that farmers cultivate Non-timber Forest Product (NTFPs) on their homesteads as a strategy for reducing the pressure on natural forest resources. There are around 5 million forest dwellers in Iran. Rural population (31.9% of total population) in Iran was 23 million as of 2013. FAO (1999) estimated that 40% of rural families in Iran live in poverty, relying on subsistence agriculture and livestock rearing for their livelihood.

The lack of investments on off-farm job and revenue opportunities compels more people to be dependent on additional agricultural production on marginal lands gained on forests and rangelands. Saffron is one of the most important export products around the world and plays a significant role in the development of Iranian income especially in forest dwellers. Saffron has the potential to contribute to the improvement of rural livelihood, due to the capacity to small holders to enhance from production and income. More than 60% producers of Saffron in Iran have less than 0.5 ha, and cost-benefit ratio and inner rate is 1.85 and 47.3 % respectively (Griliches, 1958; Akino and Hayami, 1975; Hertford and Schmitz, 1977; Araj, 1989; Horton, 1990; LakerOjok, 1994). Iran is the largest producer of Saffron with 93.7% of the world's total production. However, Saffron cultivation requires identifying conditions that are suitable for Saffron, but such a system is currently lacking in Iran. At present, the regions where Saffron can be cultivated are restricted in the eastern part of the country and the scientific basis for this restriction is weak. The suitability of land for Saffron cultivation should therefore be evaluated.

The aim of this study is to determine potential cultivation areas for expanding Saffron production using GIS method and to develop a suitability map for Saffron cultivation based on Physical and Climatic factors in North Khorasan, Iran. This effort included the introduction of Saffron to increase productivity on existing agricultural lands at the forest margins.

2. MATERIAL AND METHODS

2.1 Study Area

The study area is placed in the North of Khorasan Province, Iran. Its elevation ranges from 900 to more than 2030 m a.s.l., and covers an area of 22,500 hectares (Figure / Şekil 1). The land-use consists of forest (45%), rangelands (35%), arable lands (12%), settlement areas (5%) and other (3%). The inhabitants are approximately 1,200 people having a demographic decline in the last decades. The farms in the area are about 0.5 ha and the main crops grown are wheat and barley.

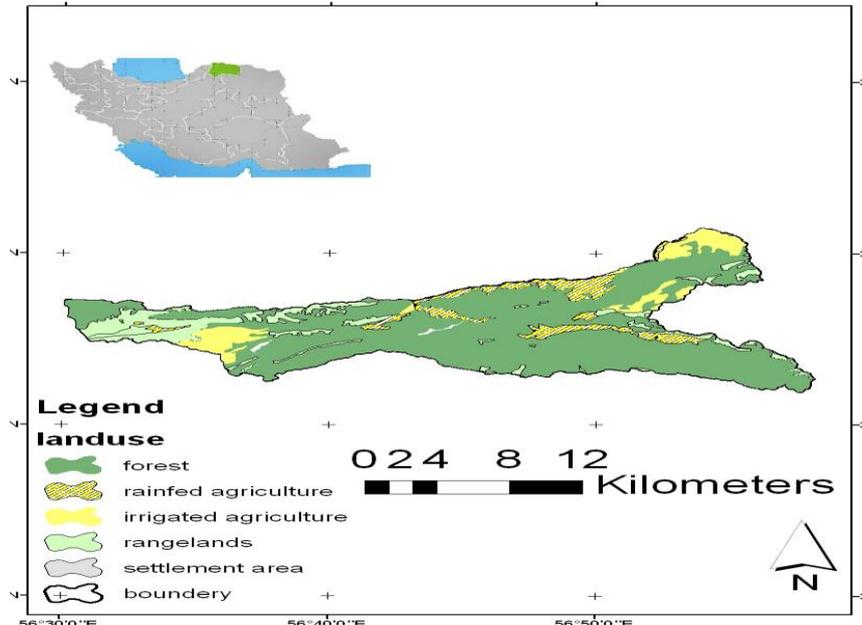


Figure 1. Location of the study area in Iran
Şekil 1. Çalışma alanının İran'daki konumu

2.2 Terms for growth of Saffron

To be able to produce an optimal amount of Saffron, the following requirements which are derived from agricultural experiments and literature review are needed: 0 to 1300 meters, over 300 mm rainfall per year, 0-15% slope, average temperature in March and April $>6^{\circ}\text{C}$, minimum temperature threshold of 10°C at night and maximum threshold of 20°C in day time in March and April. The main characteristics of the Saffron requirements are summarized in Table / Tablo 1.

Table 1. Land suitability for Saffron cultivation
Tablo 1. Safran yetiştirme için alan uygunluğu

No	Map Name	Classification	Suitability
1	Elevation map	0-1300 m	Suitable
		1300-2300 m	Less Suitable
		>2300 m	Unsuitable
2	Land-use map	Open and farming area	Suitable
		Rural settlement	Less Suitable
		Rangeland and forest	Unsuitable
3	Slope map	0-8%	Suitable
		8-15%	Less Suitable
		$>15\%$	Unsuitable
4	Rainfall map	>300 mm/year	Suitable
		250-300 mm/year	Less suitable
		Less than 250 mm/year	Unsuitable
5	Temperature map	Winter mean temperature $>3^{\circ}\text{C}$	Suitable
		Spring mean temperature $>6^{\circ}\text{C}$	
		Winter mean temperature $<3^{\circ}\text{C}$	Less Suitable
		Spring mean temperature $>6^{\circ}\text{C}$	
6	Land-cover map	0-25%	Suitable
		$>40\%$	Unsuitable

2.3 Method

The suitable areas for Saffron cultivation are produced from Geographical Information System (GIS). All the base and thematic maps was in the scale of 1:250,000 with a standardized map format then carried out the analysis with overlapping technique. All analysis was conducted using ARCGIS 9.3.1. Software using the key has been prepared, so it can produce 2 classes of suitability: suitable and less suitable.

All maps characteristics are explained as follows:

Topographic data: In this study, Digital Elevation Model (DEM) and Slope maps were prepared and analyzed. These maps were prepared based on general topographic maps in the scale of 1:250,000 produced by the National Geographic Organization of Iran.

Climatic data: Daily meteorological data of Darkesh and Rabat weather station within the period of 2000-2013 were collected. The preparation of rainfall and temperature maps was performed based on the calculation of linear regression between rainfall/ temperature data and elevation of the study area.

Land-use data: Land-use and Land-cover maps were acquired from the Agricultural Research Institute of Iran.

Potential cultivation area map generated by overlaying six maps using the classification key land suitability of Saffron mentioned above (Figure / Şekil 2).

3. RESULTS AND DISCUSSION

Saffron cultivation is a significant contribution to the income and welfare of study household. Table / Tablo 2 shows that Saffron makes a significant contribution to Iranian household income. Over 70% of household income is made by Saffron. Saffron is the main source of annual family income and about 50% of the annual income of villagers in Iran comes from the sale of Saffron (Table / Tablo 3).

Table 2. Share of Saffron in household income
Tablo 2. Hane halkı gelirinde safran yetiştiriminin payı

Share %	Producers%
Less 25	30.1
25 to 50	31.8
50 to 75	26.2
More 75	11.9

Table 3. The situation of Iran in producing of Saffron (2013) and Saffron income
Tablo 3. İran'da Safran üretimi (2013) ve Safran geliri

Producing of Saffron in the world(tons)	Producing of Saffron in Iran (tons)	Efficiency in kg/ha	Price of kg in dollars	Gross income per hectare in dollars	Expenditure per hectare in dollars	Net income per hectare in dollars
170	150	5	40,000	200,000	13,640	186,360

(Government of Iran. Ministry of Jihad Agriculture, Agronomy statistics of Khorasan Province, 2013)

We defined the forest, rangeland and settlement area as completely unsuitable for Saffron cultivation based on the current land-use policy in Iran. Therefore, we eliminated them from our evaluation procedures. In general, land suitability by overlay maps (climate and topography characteristics) indicated that 69% (1887 ha) and 31% (836 ha) of agricultural land have currently suitable and less suitable respectively for Saffron cultivation in North of Khorasan, Iran (Figure / Şekil 2).

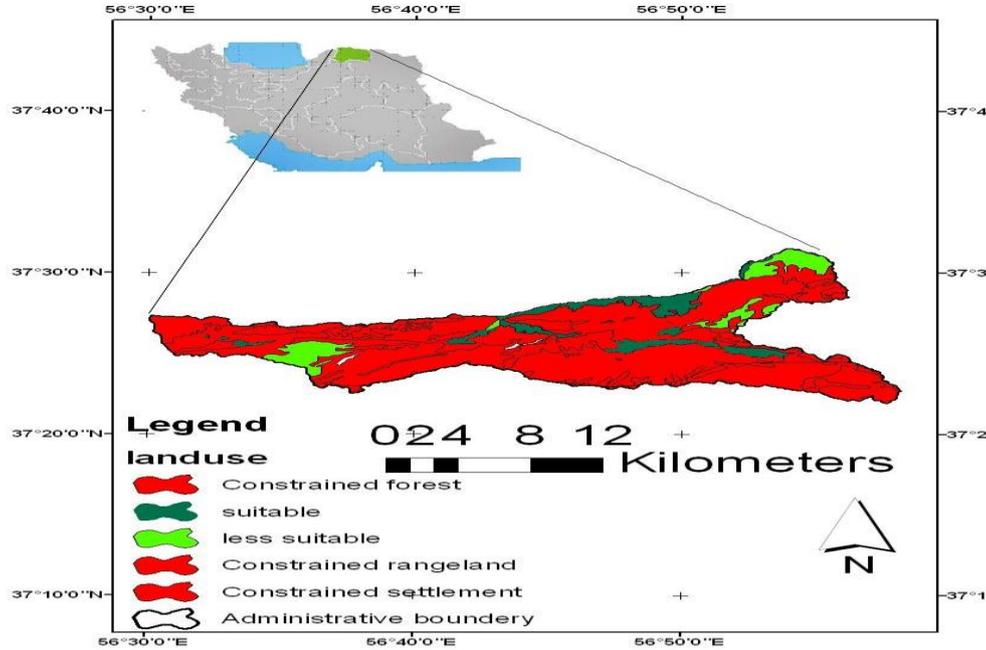


Figure 2. Map of Saffron cultivation suitability in North of Khorasan, Iran
Şekil 2. İran'ın Kuzey Horasan Eyaleti'nde safran yetiştirmeye uygun alanları gösteren harita

About 5 million people living near the forest 1-10 km, depend on the forest for subsistence. In Iran, managers of the forest did not consider the local communities and their dependence on subsistence products, thus the local communities often conflict with the managers of the forest. The selection of medicinal plant

species by the communities is dominated by the short cycle factor of the cropping period. An early harvesting period was found to be an important consideration for farmers of medicinal plants in choosing the species to be cultivated (Shahidullah, 2007; Shahidullah and Haque, 2010; FAO, 2004; Burkhart et al. 2009). One of the reasons Saffron was among the most favorite species was that harvesting began after a short period of time, 1 to 2 months, from the beginning of cultivation. Through this study, the adaptation of Saffron cultivation for livelihood-supportive and forest conservation are introduced. Saffron cultivation by the poor people in Iran, around 6% of rural households are landless and 62% have less than 0.5 ha of land. Saffron can be easily grown on poor soil, small pieces of land, which ensure quick cash generation in short cycles. Now in Iran, 80,000 ha of land is being exploited through the production of Saffron. Saffron is an exceptional product with little water and low care requires that can improve income of farmers. It is therefore an important plant for the innovation in agricultural activities outside of the forest. The settlement of a species in an area relies on the availability of desired conditions, thus there may be a need to include additional factors for the selection of suitable cultivation sites such as soil to arise the accuracy of the research using GIS. Our study area is the largest area in north eastern Iran. Due to unsuitable agricultural practices the production capacity of this area seems to be declining. On the one hand, the demands for agriculture commodities are increasing due to ongoing improvement of standards of living in Iran and this is driving the farmer move on to fresh forest land to convert forests to farm fields. Therefore, it will be necessary to develop Saffron cultivation in regions to solve this problem. Saffron is one of the world's highest priced plants and it thus seems to be an excellent choice. Saffron is a major product of Iran and can improve forest dweller welfare. It is therefore an important plant to support livelihoods. Saffron has a comparative advantage over wheat (relative resistance to disease and require fewer irrigation than wheat) can be cultivated in Iran so the government needs to encourage farmers to cultivate this new crop (Gohar, 2006; Soltani et al. 2009).

4. CONCLUSION

The greatest threat to the remaining forests in Iran is agricultural encroachment. There is consequently an urgent need to encourage local people to cultivate Saffron. We found that the cultivation of Saffron could play an important role in improving the livelihood of poor people which offered them a fresh benefit. Saffron as short-cycled plant has been gaining more popularity among the forest dwellers because of fast-growing and fully productive in a small area. Different alternatives such as Saffron cultivation to improve agricultural output, community shares in the economic benefits of forest tourist and employment in the forest, which would enable the communities to respect the forest boundaries. This study showed that climate and topography are useful in the identification of potential areas for Saffron cultivation, within a GIS environment. This research provides information at a regional level that could be used by farmers to choose their crop pattern. 'Map of Saffron cultivation suitability outside of forest boundaries' is recommended with respect to forest conservation, management programmers in the forest region and to enhance forest dweller welfare. Actually, we can illustrate that the Saffron cultivation suitability map can be very useful, not only for the forest management and conservation, but also for the economic development of a domain, especially in complex landscape outside of the forest areas.

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