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## Kashmir saffron in crisis

Saffron (*Crocus sativus*; Iridaceae), originating from the Arabic word ‘zafaran’ meaning yellow, is a fascinating spice steeped in rich history<sup>1</sup>. Its secrets stem from the dried red stigmas which accumulate large amounts of three glucosylated apocarotenoids<sup>2</sup>, namely crocin, picrocrocin and safranal, which, among the more than 150 volatile and aroma-yielding compounds, contribute to the colour, bitter flavour and aroma so typical of saffron. The spice is used as a flavouring and colouring agent in food and is a vital part of the dye, perfumery and flavouring industries. Saffron also has countless biological properties like anticancer, antimutagenic and antioxidant<sup>3</sup>. As a result, saffron fetches the highest price as a spice in the world, at approx. US\$ 1100–11,000/kg (<http://en.wikipedia.org/wiki/Saffron>), depending upon the country of its production<sup>4</sup>. Its production is typically favoured in countries where labour is cheap, such as Iran and Azerbaijan, but is also produced in countries like Greece, Spain, Argentina or the USA with global production exceeding 200 tonnes<sup>5</sup> and newer areas being brought under its cultivation, viz. China and Japan.

One of the key centres of saffron production that has painted the face of this ‘golden’ spice throughout history has been in the plateaus of Pampore in Indian Kashmir (India), where saffron has been cultivated since AD 750 (Figure 1). Kashmir, despite being one of the oldest historical saffron-producing areas, is now facing a rapid decline of saffron industry. The total area under saffron in Kashmir in 2009 was 2667 ha with a production of 5.61 tonnes while almost a decade earlier, in 1997, these were 5707 ha and 15.95 tonnes respectively. This shows a decrease of 114% in area and 184% in production in just a short span of 12 years<sup>6</sup> (Figure 2).

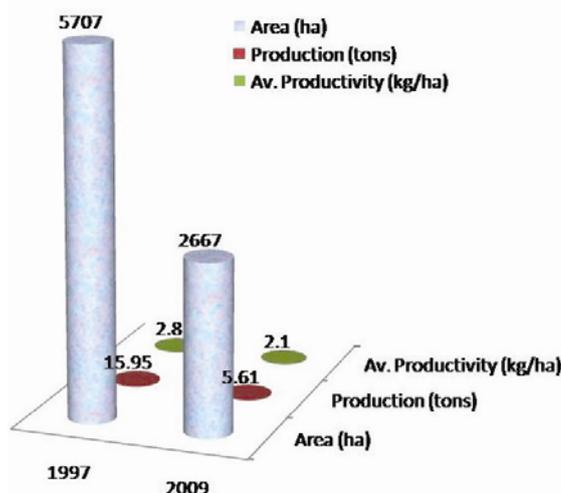
Major factors responsible for decline of saffron industry in Kashmir include the lack of availability of good-quality corms as seed material, poor soil fertility, lack of assured irrigation, infestation by rodents and diseases, poor post-harvest management, and improper marketing facilities, increased urbanization on saffron land, helplessness of the Government in checking adulteration and clandestine smuggling of cheap saffron (allegedly from Iran), which is then sold in the name of Kashmir saffron<sup>6</sup>. In view of the limited scope of laws like Prevention of Food Adulteration Act 1954 and Saffron Act 2007, coupled with poor implementation of Saffron Quality Standards like ISO 3632 and BIS 5453, the initiative of launching ‘Brand Kashmir’ saffron has remained a difficult dream. The most serious challenge is to check the adulteration of saffron by way of adding some nature-based adulterants like maize silk, saffron stamens, ray florets of marigold, dyed tender roots of *Salix* sp. (willow), fibrous roots of various grasses, fibres of shredded meat coloured with saffron water, or synthetic adulterants like liquid glycerine, codeine phosphate (cough syrup), dyed newspaper clips, nylon fibres, etc. (pers. commun.).

Here, we propose some steps to bring saffron back to its former levels of grandeur in Kashmir: (i) Prevent clandestine smuggling of cheaper (allegedly Iranian) saffron and its use as adulterant. (ii) Adopt modern, mechanized production and post-harvest management technologies, while minimizing the use of chemicals to only when indispensable<sup>7</sup>, as saffron has a preformed innate passive defence system<sup>8</sup>, and employ efficient biocontrol agents like antibiotic-producing *Pseudomonas* strains to reduce input of chemicals. (iii) Implement biotechno-

logical approaches for enhancement of its odour, taste, colour and aroma<sup>9</sup>, and set up tissue culture facilities for clonal mass propagation of disease-free, good quality corms of uniform size and genetic consistency for field planting<sup>10</sup>. In future, this could also lead to mass production of stigma-like structures under *in vitro* conditions<sup>11</sup>, and mass production of crocin, picrocrocin, crocetin and safranal for industrial use, which would be of uniform quality and not subject to fluctuations caused by environmental factors. (iv) Identify pockets for ‘organic farming’ of saffron and setting up of government machinery for its subsequent certification, as this would fetch higher price in the international market. (v) Promulgate and implement laws specific to Kashmir saffron, like declaring Kashmir saffron as geographic indication, preventing use of traditional saffron land for purposes other than saffron cultivation (i.e. construction or conversion to horticulture/agriculture), strict punishment for those indulging in saffron adulteration, and devising a mechanism of certification for saffron purity, analogous to seed certification mechanism followed for vegetables and cereals<sup>12</sup>. One such law which was promulgated in 2007, the Saffron Act 2007, has to be made more



**Figure 1.** Saffron in full bloom at Pampore, the Food and Agriculture Organization identified Saffron Heritage Site in India.



**Figure 2.** Decline in Kashmir saffron area, production and productivity from 1997–2009.

effective both in terms of implementation and re-examining some of its provisions, in light of the Expert Group recommendations<sup>13</sup>. (vi) Invent kits for easy detection of adulterated material and spread awareness among consumers to demand conducting such tests before buying saffron from local unorganized and uncertified agencies. Moreover, there is lesser chance in getting cheated while buying laccha-type (stigma with short style) saffron, because to fabricate artificial saffron (synthetic material) resembling the laccha-type is cumbersome compared to the higher priced mongra-type (only stigma) saffron.

The good news however is that recently, the Government of India initiated a National Saffron Mission with a financial outlay of Rs 3.74 billion for resolving the saffron crisis in Kashmir through different programmes, which include rejuvenating saffron farms by corm

re-planting, digging bore wells for irrigation, and setting up of a modern Saffron Park with quality control laboratory for providing adequate marketing cover to saffron growers, thus eliminating exploitation by middle-men. There are mixed reactions from saffron farmers about the approach followed in Saffron Mission, and therefore the net results of this massive initiative remain to be seen!

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## Is Ladakh a ‘cold desert’?

Delimited by the Eastern Karakorum Range in the north and the Western Himalaya Range in the south, Ladakh lies in the bio-geographic zone 1 (Trans Himalaya) among 10 such zones into which the whole of India is divided. The region is further divided into two bio-geographic provinces, namely Ladakh Mountains and Tibetan Plateau (1A and 1B)<sup>1</sup>. The Ladakh Mountains is spread

through Kargil, Zaskar, Leh and Nubra. These areas are mostly rugged mountains and valleys and have a large altitudinal range from 2650 m in Kargil region to over 7000 m in the Karakorum Range. The ‘Tibetan Plateau’ includes Changthang characterized by vast plains, rolling mountains and some large, high-altitude brackish water lakes. Most of this region lies above an elevation of 4200 m.

As the region is situated in the rain shadow of Western Himalaya, it does not receive moisture from the northwest monsoon. Climate of the region is characterized by extremely low temperatures (25°C below freezing point), meagre precipitation (<250 mm annual), diurnal pattern of temperature fluctuations and abridged growing season with insignificant growing season precipitation<sup>2</sup>. Most