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RESEARCH ARTICLE

SAFFRON: A LEGENDARY HIGH VALUE CROP OF JAMMU AND KASHMIR STATE AND A SOURCE OF LIVELIHOOD FOR MANY FARM FAMILIES

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ABSTRACT

Saffron is a legendary crop of Jammu and Kashmir. Saffron is the most expensive and most valuable spice in the world. It is mostly known by its good quality. It is derived from the red stigma of the plant famously known as *crocus Sativas*. It has numerous colors which are known to the customers, the red one is the most famous among all, so it is rightly known as RED GOLD. The saffron cultivation can be put forth in any part of the world and its production is accessible to everyone. Saffron price mechanism is depending on the intensive labor during the harvest. The saffron plant is attractive in its appearance and is perennial and globular corms. And its height may be from fifteen to twenty centimeter the plant has its native origin to Europe and is also grown in Mediterranean countries like Spain, Austria, Iran, Turkey etc. The species has been also grown in Indian subcontinent especially in J &K and Himachal Pradesh. The saffron belongs to the family of iridaceous and commercial part of the saffron is known as stigma. The saffron has been known by many names in different states in India, in Kashmiri its known as (Kong). And in Urdu its known as Zaffron. There are many factors which influence the growth of saffron. Saffron cultivation is a traditional art in India. About 5707 hectares of land in under saffron cultivation. The annual production of saffron in India is around sixteen thousand kilograms. Jammu and Kashmir is the leading producer of saffron in India. Out of total 5707 hectares of land, 4496 hectares of land under its cultivation lies in Jammu and Kashmir. The famous worldwide for high-grade saffron is Pampore which is situated at a distance of fifteen kilometers from Srinagar in Kashmir.Crocus sativus L. is one of the most important plants. It is having various medicinal potential, and is widely being used in food industries. In Jammu and Kashmir State (recently an union territory), its cultivation is restricted to two districts only (Pulwama and Kishtwar). The extension agency must flash the light more on problems of saffron cultivation in recent days and considering a high value crop must promote its cultivation among farmers especially those areas where saffron cultivation is possible bypassing its existing limitations and it is possible then, the earning from saffron cultivation will be the real sense of livelihood of many farm families in India.

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INTRODUCTION

Crocus sativus L. (saffron) or Golden spice or Red gold or 'Kesar' belongs to the family 'Iridaceae'and is one of the most expensive spices in the world.Saffron has several medicinal properties.Saffron cultivation is labour intensive requiring hand labour in the various stages of its cultivation. Its stigma needs to be carefully picked from its flower manually. Thus harvesting followed by processing requires trained work hands. Therefore, saffron is costly due to its high labour requirement, low yield, careful handling and limited worldwide distribution. The environmental and topographic conditions for its growth and development vary between countries. Temperate, semi-arid and arid areas are some of the ideal climatic conditions favouring saffron in the world. In India, it is mainly grown in temperate climate condition, where the soils are loose and well-drained. The clay calcareous soil to silty-clay soil and sandy to sandy-loam soil are generally considered good for its growth. For flower development optimum temperature range is 23–27 °C in summer and winter temperatures should not be less than − 15 to − 20 °C. Therefore, it was observed that environmental conditions play a prime role in saffron growth and development. However, these conditions serve as a basis for finding the suitable regions for their cultivation but that needs to be further explored to understand specific requirements for a targeted region favouring their optimum growth. The supportive factors such as quality planting materials, cultivation techniques and methodology for corm

production, rate of survival after sowing, etc., also play an important role in its proper growth and development.To increase the saffron production in India with the appropriate quality, many efforts have been made, and it has been cultivated in new areas from time to time but has failed to result in an optimum yield and quality. The reason may be that those areas might have been targeted by visual judgements. Here through an analysis of environmental conditions, it was possible to evaluate that those areas that appeared similar to areas where saffron is already cultivated were not suitable for the growth of saffron. The quality of saffron produced in such regions was also monitored in the laboratory by their chemical evaluation. Our main intention is to introduce saffron in a large area to meet at least our domestic household and industrial demand. Our idea is that with our effort there will not only be an increase in the area under saffron cultivation but it will also generate employment and provide additional income to the farmers involved in its cultivation.*Crocus sativus* L. is small perennial plant, considered as king of the spice world. The genus Crocus consists of about 90 species and some are being cultivated for flower. The flowers (three stigmas-distal end of the carpel) of the C. sativus contain three key components, known as crocin, picrocrocin and safaranal. These three components are reported to be responsible for the colour, taste and aroma of the saffron. The flowering time in case of C. sativus during autumn. The tradition methods of saffron cultivation and flower harvesting are very tedious and labour extensive and leads to increase the cost of the saffron. Due to its high demand and low production, it is the most expensive spice and is called as red gold in the present scenario. It was reported that total saffron production (50 million tons) annually around the globe and estimated its costs worth about $50 million.

History: -Saffron in Kashmir was introduced by the Central Asian Immigrants around 1st century B.C. Rajtarangini authored by Kalhana includes Kashmiri saffron among those special attributes of Kashmir that "could not be available even in paradise." The Kashmiri vaids namely Veghbhata and Sushtra used saffron as an important ingredient in Aurervedic medicines. It also finds its name in Kashmiri records which dates back to 5th century.The word "safron" has multiple linguistic origins, and it's a testament to the historical trade routes and interactions between various cultures. The Arabic word 'asfar' does mean yellow and it's the root from whch the term 'saffron' was derived. Saffron's vibrant reddish-orange color is a significant characteristic, and this connection to the color yellow likely contributed to the naming of the spice. In Sanskrit this aromatic spice is known as "kunkin" and "Kesarnard" and "kung" in Kashmiri. Saffron has deep roots in various cultures and languages, and its names in different languages reflect its cultural and historical significance.

Taxonomy: -Kingdom: Plantae, Division: Spermatophyta, Sub-division: Angiospermae, Class: Monocotyledonae, Sub-class: Liliidae, Order: Liliales, Family: Iridaceae, Genus: Crocus, Species: sativus, Botanical name: *Crocus sativus.*

Distribution: -Saffron is mainly cultivated in Iran, India, Greece, Morocco, Spain, Italy, Turkey, France, Switzerland, Pakistan, China, Japan and Australia. Iran ranks first in its production and almost 80% of the world demand for saffron is met by Iran. India contributed only 5% of the world's total production. About 90% of the country's saffron is produced in Jammu and Kashmir (J&K) and here it is mainly confined to Pulwama and Budgam districts. Saffron production in J&K has been reported to decrease year by year. From 1997 to 2015 the decrease in area and productivity of saffron was observed by 83% and 72%, respectively. The origins of C. sativus is not clearly known, some suggest eastern Mediterranean as its endemic place and some consider its Iranian origin. As per the archaeological and historical data, the domestication of C. sativus is very old (2,000 to 1,500 years BC). The C. sativus is reported to be cultivated in Afghanistan, Azerbaijan, China, Egypt, France, Greece, India, Iran, Iraq, Israel, Italy, Japan, Pakistan, Morocco, Spain, Switzerland, Turkey, United Arab Emirates since ancient times and recently Australia also have started its cultivation.

Area under saffron in J&K (2010)

District	Area under saffron (ha)	% of total area
Pulwama	3200	84.54
Budgam	300	7.92
Srinagar	165	4.35
Kistiwar	120	3.17
Total	3785	100

Source: Directorate of Agriculture J&K

No. of farm families engaged in saffron cultivation in J&K

District	No. of farm families
Pulwama	9000
Budgam	1227
Srinagar	732
Doda	5310
Total	16269

Source: Deputy Director, Planning Department J&K

Importance of saffron cultivation: It has been associated with traditional Kashmiri cuisine and represents the rich cultural heritage of the region. It is a very precious and costly product. In ancient Sanskrit literature, saffron is referred to as 'bahukam'. It is cultivated and harvested in the Karewa (highlands) of Jammu and Kashmir.It rejuvenates health and is used in cosmetics and for medicinal purposes.Saffron has several medicinal properties such as aphrodisiac, antispasmodic, antimicrobial, antibacterial, antifungal, antiseptic, and antiinflammatory. It has anticancer medicinal properties also, which has elevated its cost. Its stigma is used in food, pharmaceutical, cosmetic, perfumery and textile dyes industries in various ways (mostly in dry form). As per reports, since the pre-historic times, the medicinal potential of the C. sativus are well documented . In the present scenario, saffron water extract (carotenoid) have proven with medicinal potential to treat cancer, cerebrovascular and cardiovascular complications. It is also reported to have various other activities in different parts of the world e.g. in Middle East, it is reported to be used as antispasmodic, aphrodisiac, carminative, cognition enhancer, emmenagogue and thymoleptic in traditional Chinese system of medicine, saffron was used to treat amenorrhea, high-risk deliveries, menorrhagia and postpartum lochiostasis. In Indian system of medicines, saffron was used to treat the disease of bronchitis, fever, headache, sore throat and vomiting. Various pharmacological activities are also reported in saffron viz. antihypertensive activity, anticonvulsant activity antitussive activity, anti-inflammatory action of saffron, antioxidant activity of saffron. Besides the medicinal importance, saffron is being used as a spice regarded as all-time king of spice world, as a dye, as perfume, in food industry .One of the reasons for saffron's economic importance is that it is a very

low-yield crop, which makes it an expensive food ingredient. The most important use for saffron is in food, where it is valued for its colouring, flavouring and aromatizing in the production of some traditional dishes. In addition to its use as a spice, saffron has long been considered a medicinal plant for its therapeutic properties. In milk and milk desserts, saffron is used as a flavour and coluring component. It's used as season cheese, mayonnaise, and meat, among other things. In Mughlai cuisine, they are utilized as a flavoring and seasoning agent. It is used to treat arthritis, infertility, liver enlargement, and fever in Ayurveda it's a common ingredient in perfumes and cosmetics.

Saffron Benefits: -The extension of saffron production will help in meeting the annual demand in India.It will help in reducing imports.It will also diversify agriculture and provide new opportunities to the farmers in the North-East. Some of benefits of saffron are the followings: (a)Fights free radicals (b)Rich in Vitamins and folic acid (c)Relieves depressive symptoms (d)It may help fight cancer (e)Improves memory and concentration (f)Can improve hair-growth (g)Relieves PMS ailments (h) Protects your body against cold (i)Aids Arthritis (j)Can improve eye vision (k) It may cure sleeplessness or chronic insomnia (l)Aids in digestion (m)Heals wounds from minor injuries

Cultivation procedures of saffron

Climate: Optimum temperature for flowering as well as corm development is in the range of 23-27°C. Corms require a temperature of 17°C for flower emergence. Saffron grows well at an altitude of 2000 meters above sea level. It needs a photoperiod (sunlight) of 12 hours.

Soil: It grows in many different soil types but thrives best in calcareous (soil that has calcium carbonate in abundance), humus-rich and well-drained soil with a pH between 6 and 8. One of the most important aspects of saffron growing is the soil. It thrives on loamy, sandy, and calcareous soils. A gravelly soil is also excellent for saffron farming, however a heavy, clayey soil is not. Saffron grows best on acidic soil. It thrives well when pH of soil is around 5.5 to 8.5.

Land preparation: Farm yard manure and organic content are also mixed with the soil before cultivation. Saffron can be cultivated in both beds as well as in pits. Pits are dug that maybe 12-15 cm deep with an inter-plant distance of 10 cm. The field is ploughed 3 to 4 times with the depth of 25-30 cm to make the soil fine and porous. Make the soil brittle before ploughing or planting saffron seeds by ploughing the land thoroughly. Put 20 tonnes of cow dung, 90 kg of nitrogen, 60 kg of phosphorus, and 60 kg of potassium per hectare on your field before final ploughing, and plough it thoroughly. Your soil will remain fertile and rugged as a result, and your saffron crop will be excellent.

Propagation: Propagation Saffron propagates only vegetatively through corms. During each season, new corms are formed above the old ones, which wither, and eventually rot away. Each corm produces 4-10 daughter corms and cormels.

Plantation time: The plantation time for saffron is from middle of September to October.

Seedrate/Corm Rate: The seed rate/corm rate/ha depends upon corm size/corm weight, crop duration and spacing. About 40-50 q of saffron corms or about 5 lakh number of corms of average diameter of 2.5 cm (average weight 10 g) are required for plantation in 1 ha area.

Corm size: Corms around 20-30 mm are ideal as they're more likely to flower prolifically. While smaller corms may not flower in their first year they'll grow bigger and are more likely to produce flowers later on. Selecting larger corms at purchase can enhance your chances of enjoying saffron blooms in the first season.

Planting time: Any crop must be planted at a specific time. We don't receive the expected yield since we don't plant seeds at the proper time. As a result, make sure to plant the seeds on the fields at the appointed time. The greatest months to harvest saffron are July and August, with mid-July being the best. When applying the saffron croms, make a 6 - 7 centimetre pit for the croms to go into, and leave about 10 cm between the two corms. The croms will flourish as a result, and plenty of pollen will be produced. For the best results, plant your corms in late Summer to early Autumn. The depth at which saffron corms are planted can significantly impact their yield.

Spacing and depth: Saffron corms are planted in rows at a spacing of 20 x 10 cm and at a depth of 15 cm with 1corm/hill or with a planting geometry of 25 x 15 cm with 2 corms/hill maintaining a planting density of 5 lakh corms/ha with a seed rate of 50 quintals/ha.

Irrigation for saffron crop: There is no need to water the land if there is light rain a few days after planting the crop. If there isn't any rain, we'll have to irrigate twice or three times during the course of 15 days. It is important to remember that there should be no water deposits in the field during irrigation, and that if water deposits do form, drainage should be arranged as quickly as possible. Crops will be harmed if they are not properly organized.

Nutrient management: A fertilizer dose of 45:60:60 kg NPK/ha is best for higher yield of flowers as well as corms. Full dose of P and K along with 1/3 N should be applied at the time of plantation. Remaining N should be applied in 2 split doses i.e. half dose at 1 month after planting and remaining half dose in the month of January.

Weed management: Manual weeding was found to be the best method for controlling the weeds with regard to morphological, corm related traits and saffron yield without any residues in the saffron product However, in terms of expenditure, it is a costly, time and labour consuming which could negatively affect returns to growers.

Disease pest management: A Saffron farmer has to deal with saffron flower enemies to help the natural, healthy flourish of the saffron flower. Safran's natural enemies, insects, and mite pests destroy crops, against which farmers use chemical pesticides. The use of pesticides against saffron enemies is a common practice in many regions, but it is not accepted by many European saffron standard requirements. First, we would like to start with rodents that endanger the life of saffron flowers. Porcupines, mice, moles, rabbits, and voles are the common rodents that tend to feed from saffron leaves and corms. Mites are other examples of saffron pests. Saffron bulb

mites attack saffron corms through wounds and produce tunnels and cavities, in which they start the reproduction activity. Insects also threaten the health of saffron flowers. Saffron corms may get involved with various diseases such as: corm rot, root rot, bulb rot, bacterial rot, Corm neck rot, saffron smut etc. Laying a piece of chicken wire, or hardware cloth, over the planted area to prevent them from digging. Offering alternative food sources for rodents: you can set up a place to provide the required grain, nuts, or corn to deter rodents from your saffron bulbs.

There are some folklore solutions claiming to deter rodents, such as hanging Irish spring soap bars in mesh bags, sprinkling cayenne pepper, chili pepper, or crushed red pepper around the soil, and even spreading rodent hair around the planting area.Avoid using sheep and poultry manure (only use weed-free composted cow manure). Avoid summer-time irrigation. Plant corms in a depth of 15-20 cm depending on soil texture. Do not plant corm that comes from infected areas

Harvesting: The saffron harvesting process typically takes place during the flowering period of Crocus sativus, which usually lasts a few weeks in the fall (October to November) The optimal timing for harvesting is crucial to ensure the best quality of saffron.

Crop productivity: Saffron is the only spice in the whole world that is sold in grams. A hectare of saffron farmland produces around 1.2 to 1.7 kg of saffron depending on corms quality under best farming practices. It takes about 150 flowers to give one gram of dry saffron.

Post-Harvest Management: Following innovative post-harvest technologies will result in minimum losses with superior quality saffron.

- Saffron flowers should be picked in the morning hours probably before the sunrise, using hand gloves.
- Saffron flowers need to be picked on 2nd day of emergence in baskets with proper aeration, as age of flowers and collection material has a direct impact on saffron yield and quality. It is worth mentioning that craft paper bags, plastic baskets or willow baskets should be used for picking.
- Separation of stigma should be done within 10-12 hours of flower picking. This results in achieving maximum pistil recovery. (If the separation is delayed by 2-3 days (36-72 hours), it will result in loss of recovery).
- After the separation of stigma, farmers need to dry saffron as it is the most important part of the whole procedure of post-harvest processing. In Kashmir Saffron growers usually dry stigmas by spreading out on large shady surfaces that takes about 27-53 hours. However this type of drying adversely affects the quality of saffron, especially Crocin degradation. Artificial drying involves high temperature of about 40±5ºC that has to be applied on the stigmas through hot air streams.
- Saffron growers should adopt modern methods of drying viz. Solar saffron dryer, hot air dryer, solar tunnel saffron dryer, in which a temperature range of 40-50 ºC is achieved and drying of saffron takes only 4-7 hours. Due to fast drying, pigment concentration is not affected; hence quality of saffron is maintained.
- Saffron samples with low initial moisture content (8%) can be stored in airtight containers safely up to months.

Quality: Its quality is graded by the proportion of red stigma to yellow style, varying by region and affecting both potency and value. The Food Safety and Standards Authority of India (FSSAI) has taken the initiative under the #detecting food adulteration on Twitter to increase awareness about adulterated food items among the common man. According to this initiative, there are specific quick tests that you can perform at home to identify whether the food is adulterated or not.

Hot Water Test: To conduct a hot water test, take a few threads of Saffron and soak them in hot water. Remember, it should not be boiling water. Keep it standing for 5 to 20 minutes, and you will notice that the color will remain intact for real Saffron even in warm water. Further, the water might turn uniformly yellowish. However, to prepare fake Saffron, an artificial red dye is usually used, and when soaked in hot water, it comes off. You will find the water to be red in color, and the colors might not mix uniformly with the water.

Cold Water Test: Simply take a few strands of Saffron and place them in cold water. You will notice that the color is being released in the water, which will happen for both pure and impure saffron strands. After 15 - 20 minutes, you will find that the entire glass has turned yellowish, maintaining uniformity. However, if you find a deep red color in the water, then it is a definite sign of adulteration. You might also find that the water is turning bright yellow or prominent red color stains in the water. Moreover, a pure saffron thread will never lose the red color. However, if you keep fake Saffron for an hour in this cold water, it may turn white.

Taste test: The most common hack to identify real and fake Saffron is to understand the taste profile. Fake Saffron is coloured red using foreign substances, and it lacks the true flavor of Saffron which is sweet. You might get a bitter or metallic taste. Thus, you are not only losing the Kesar benefits but also its wonderful taste. On the other hand, real Saffron has a very strong scent, along with an earthy and floral taste. Even if the water test fails, your taste buds won't make a mistake.

Finger/Palm Rubbing Test: Dip the saffron threads for a few seconds in cold water, and then place them on your finger or palm. Now, rub the threads with two fingers back and forth for a few seconds. If it is a pure saffron thread, then it won't break. However, if the Saffron threads are adulterated, then upon rubbing, they will turn into dust or might even turn into liquid. Thus, the health benefits imparted by this Indian spice, along with Saffron benefits for skin, are also lost due to fake saffron usage.

Smell Test: The most competent quality of pure Saffron is its taste and smell. Saffron usually has a very sweet and floral smell. If you take the aroma of your Saffron, it will be similar to the honey and hay mixture. Other than this, if you have bought adulterated Saffron, you will get a pungent smell from the spice. This is due to the high level of chemical usage in the form of Safranal and Picocrocin.

Baking Soda Test : Take a cup of water and mix at least two tablespoons of baking soda in the water until the mixture looks uniform. Now, add a few saffron threads to it and stir for 2-3 seconds. If the mixture looks yellowish, it denotes that you have bought pure quality saffron. However, if the mixture turns maroon or reddish, you have fallen prey to cheaters. This also deprives you of the Kesar powder benefits.

Storage of croms: After the first few frosts, but before the ground has frozen solid, carefully dig out the corms, place them in a wooden crate or plastic tub, and completely cover with dry peat moss or sand. Store in a cool (40-50°F), dry place, such as a basement.Place the dried corms in a breathable container, such as a mesh bag, paper bag, or wooden crate. Avoid using plastic bags or containers, as they can trap moisture and lead to rot.

Best Saffron Storage Tips to Preserve Flavour: Saffron is one of the most luxurious spices that can transform the look and taste of a dish. Used in various savoury and sweet dishes, this delicate thread-like spice is obtained from the stigma of the Crocus sativus flower. To ensure you get maximum flavour from your saffron, only buy saffron online from premium sources. Procuring high-quality saffron is easy these days as top brands such as Dry Fruit Basket make it possible to order saffron online. However, as this is a delicate yet expensive spice, proper storage is essential to retain its flavour, aroma, and visual appeal. Here, we bring you the top tips to correctly store saffron.

Temperature and Environment: -Saffron's delicate flavour and aroma can be quickly compromised when exposed to elements such as heat, moisture, sunlight etc. This premium spice survives best when stored in a cool, dark pantry cupboard, away from direct heat and light. Opt for a cupboard which maintains a consistent temperature throughout the year. Avoid placing saffron in areas near the stove, oven, fridge or other sources of heat as such fluctuations in temperature can compromise the flavour and freshness of saffron.

Keep Away from Moisture: -Moisture is one of the biggest enemies of saffron. When you buy saffron online, be sure to check for a sealed container. Moisture in transit can cause the saffron strands to stick together and lose their aroma. Store the saffron in a dry place and avoid storing it in the fridge or freezer for this very reason.

Pick the Right Container: -Selecting the right storage container is an important step in properly storing saffron. Store saffron in airtight containers to keep these delicate threads away from exposure to air and moisture. Glass and ceramic containers are ideal as they are neutral and do not affect the flavour in any way. Be sure to check that the container is completely dry before placing the saffron.

Regular Maintenance: -One of the biggest mistakes people make is in their daily usage of saffron. Most people leave the storage container lid loose or leave the container for prolonged periods of time while cooking. This causes heat from the surrounding environment to degrade the flavour and aroma of the saffron. Always seal the container properly and immediately to retain freshness.

Avoid Plastic Jars: -Plastic containers or bags can lead to unwanted odours and compromise the flavour of the saffron over time, compromising its quality. Avoid plastic bags especially if they are not suitable for food storage or made using non-food grade materials. Use glass or metal containers instead. Also, when you order saffron online from premium brands such as Dry Fruit Basket, it can last for a couple of years when stored properly giving you the best value for your money.

When it comes to this fragrant spice, proper storage is critical to maintain potency and freshness. By following these guidelines and storing saffron in the right storage containers, you can ensure that your saffron remains fresh for an extended period. To ensure you get the best flavour and aroma in your dishes, order saffron online from Dry Fruit Basket, known for its premium quality and hygienic packaging.

Indoor cultivation process of saffron: Saffron, one of the world's most precious spices, is typically grown in regions with specific climate conditions, such as Iran, Kashmir, and parts of Europe. However, with modern agricultural technology, it is now possible to cultivate saffron anywhere, even in non-traditional climates, by creating a controlled environment like a cold room. Cold rooms, CO2 regulation, and optimal growing conditions are required to cultivate saffron in a controlled indoor environment.

Why Grow Saffron Indoors?: Saffron (Crocus sativus) is a delicate plant requiring very specific conditions, including cold winters, well-drained soil, and moderate water. Traditional saffron cultivation is restricted to areas with these natural conditions. However, cultivating saffron in a controlled environment allows farmers to replicate these conditions and grow the plant year-round in any location. Here's how you can set up and manage an indoor facility for saffron cultivation:

Cold Room Setup: -Temperature Control: Saffron corms (bulbs) require cold temperatures to flower. Ideally, the room should be maintained at around 5-15°C (41-59°F) during the dormant period and gradually warmed to around 15-20°C (59-68°F) during the flowering phase. A cold room or a temperature-controlled greenhouse will allow you to adjust the temperature as needed. Humidity Control: Humidity levels should be moderate. Keep the humidity at 50-70% during the vegetative stage and around 40-60% during flowering to prevent mold and ensure healthy growth.

CO2 Regulation: -CO2 Levels: Like most plants, saffron can benefit from elevated levels of CO2, which can enhance photosynthesis and growth. Keeping CO2 levels at around 400-600 ppm (parts per million) in the cold room can stimulate better yields. You can achieve this by installing CO2 generators or tanks.

Ventilation: Ensure proper ventilation to prevent the buildup of excess CO2 or other gases. The airflow should be consistent but not too strong, as saffron flowers are delicate.

Lighting Requirements: -Photoperiod: Saffron is a photoperiod-sensitive plant, meaning it requires a specific amount of light to flower. During the vegetative phase, the plant needs around 12-14 hours of indirect light per day. During the flowering phase, gradually reduce light exposure to about 10 hours a day to trigger blooming.

Artificial Lighting: In a controlled environment, use LED grow lights that mimic natural sunlight. Full-spectrum lighting can support photosynthesis during the entire growth cycle.

Growing Medium and Soil Requirements

Soil Composition: Saffron grows best in well-drained, loamy soil with a slightly alkaline pH of 6-8. You can use a mix of peat moss, perlite, and sand to improve soil aeration and

drainage. Ensure the growing medium is sterile to avoid pests or fungal diseases.

Containers: Plant the saffron corms in wide, shallow containers or raised beds to ensure good drainage and prevent water logging.

Watering and Irrigation

Watering Schedule: Saffron is drought-tolerant, so avoid overwatering. Water the corms sparingly during the initial vegetative phase and reduce watering once they enter the flowering stage. Ideally, the soil should be kept just slightly moist but never waterlogged.

Irrigation System: Drip irrigation systems work best for saffron cultivation in a controlled environment. They allow you to monitor the exact water needs of the plants without flooding them.

Fertilization and Nutrient Management

Nutrients: Saffron plants have minimal nutrient needs but may benefit from a light application of organic fertilizers. Compost or well-rotted manure can be added to the growing medium at the start of the vegetative period. Additionally, a balanced NPK (Nitrogen, Phosphorus, Potassium) fertilizer can be applied in very low doses.

Avoid Overfertilization: Too much fertilizer can lead to excessive leaf growth, which may reduce the quality of the saffron threads (stigmas). Use fertilizers sparingly to avoid this issue.

Managing Saffron Growth Stages

Dormancy Period (Summer): Saffron corms typically go dormant during the hot summer months. During this phase, keep the cold room at lower temperatures (5-10°C), and do not water the corms.

Vegetative Growth (Autumn): Once the cooler temperatures of autumn begin, you can start watering the corms to encourage vegetative growth. The plants will produce narrow leaves at this stage.

Flowering (Late Autumn to Early Winter): About 6-8 weeks after vegetative growth, saffron flowers begin to appear. Harvesting must be done by hand, as the delicate saffron stigmas (threads) are collected for use as the spice.

Post-Harvest Care: After harvesting, allow the corms to remain in the soil to prepare for the next growing cycle. Reduce watering, and let the leaves die back naturally before entering the next dormancy phase.

Harvesting and Post-Harvest Processing

Harvest Time: Saffron flowers bloom in the early morning, and the flowers must be harvested immediately for the highest quality threads.

Stigma Collection: Once harvested, carefully pluck the red stigmas (saffron threads) from each flower. This must be done by hand, as machinery can damage the delicate threads.

Drying: After collection, the stigmas should be dried in a warm, well-ventilated area or using a dehydrator set to a low temperature. Proper drying is essential to preserve the flavor and aroma of the saffron.

Economic Considerations: Growing saffron indoors is an intensive process, but the high market value of saffron can offset these costs. A single gram of saffron can fetch prices as high as $10-20, depending on quality. By producing saffron in a controlled environment, you can grow multiple cycles each year and avoid issues like weather-related crop failures. Saffron cultivation in a controlled environment is an innovative solution for producing this valuable spice in non-traditional climates. By replicating the ideal growing conditions—using cold rooms, CO2 regulation, proper lighting, and meticulous care—anyone can successfully grow saffron indoors. With careful planning and investment, indoor saffron cultivation can become a profitable and sustainable venture for both commercial farmers and home growers alike. By following these steps, you can cultivate high-quality saffron anywhere in the world, turning a precious and traditional crop into a modern agricultural success

Key differences between outdoor and indoor farming. Saffron is a perennial crop that lasts about 10-15 years after sowing. Traditionally, farmers start preparing the land one year before sowing the corms. This initial stage involves a significant amount of labour, with two sowing cycles followed by demarcation and bed preparation. Traditional saffron farming begins with land preparation on elevated table lands known as “Wudar” in Kashmiri. Given saffron’s perennial nature, it requires eight to nine cycles of deep land preparation before planting saffron corms (seeds). These corms vary in size from 1 to 20 grams: those up to six grams are used for multiplication, while those weighing seven grams and above are needed for flower production.“Sowing typically occurs from July to August, with saffron corms planted with a gap of four to six centimetres between them,” explains expert, a saffron farming expert. Flowering begins in late October, followed by leaf emergence. While it may seem that nothing is happening during this period, the corms are actually multiplying and developing for the next cropping season. The expert adds that flowering generally starts around October 25th and can continue until November 10th, depending on favourable conditions, such as adequate rainfall and irrigation. “Flowers are usually harvested around midday, and it’s crucial to separate the stigma—the female part of the flower containing the valuable red filaments, often called ‘red gold’—within 12 hours of picking to avoid post-harvest losses,” he says.

Indoor saffron farming offers an alternative suitable for farmers with small landholdings. It requires corms weighing eight grams or more and allows for flower cultivation in compact spaces with controlled conditions. With the right setup, a 20 ft x 20 ft structure can yield 900-1100 grams of saffron. This indoor approach begins with corms placed in trays installed in vertical multi-tier racks in an aeroponic system. The room is kept dark for about 90 to 100 days to promote the physiological changes needed for sprouting and flowering, achieved by covering windows with black cloth or cardboard. After the 100-day mark, lighting is turned on to stimulate flower opening. Harvesting from indoor setups takes place from October to November 10th. Afterward, the corms are moved to open field soil for a chilling phase, following an

ultra-high-density module with no gaps between them. "The corms need about 1,100 hours of chilling to ensure they multiply and remain viable for the next year's crop," expert concludes.

Success story: Harsh Patil's family cultivates bananas, watermelon, and cotton on 120 acres of land in Nandurbar village in Maharashtra. However, productivity has been decreasing owing to climate change and extreme weather events."In December 2022 when our cotton crop was being harvested, it suddenly started raining. Due to these unseasonal rains, we suffer huge losses," he says.Seeing his worried father, Harsh wanted to explore novel technologies and methods of farming. "Besides, I did not want to do jobs in the corporate world, I was more inclined to do business as jobs in the tech field are at constant threat of recession," he adds.In the third year of his college, Harsh started looking for business opportunities across various industries. "But my parents were against this idea. They wanted me to focus completely on my studies first. I did not quit on that idea but instead started exploring business opportunities in agriculture so that my parents understand the work and did not object," he adds.So, while pursuing his higher education in computer science in Navi Mumbai, Harsh started looking for new technologies and methods of farming. "When I started researching, I came across new crops like dragon fruits, sandalwood, and saffron farming. Unlike other crops, I knew I would be able to easily tap into the market with saffron as it is the most expensive spice in the world. This would save me time and energy to completely focus on the production," he adds.Harsh cultivates saffron in a controlled environment using the aeroponics technique in a 15×15 room.In India, saffron is widely cultivated in Kashmir owing to its ideal temperature and climatic conditions. It is also known as the world's second-largest producer of saffron. To be able to cultivate saffron in the warm climate of Maharashtra was a challenge for Harsh. So, he turned to cultivating saffron in a controlled environment using the aeroponics technique in a 15×15 room.

A step-by-step guide to growing saffron: Far from the valley, Harsh was able to harvest 350 grams of saffron of 'mogra' variety in a tiny room, earning Rs 1 lakh. "The first experience was a little scary for me as well as exciting. I was doubtful if I would achieve success or not but I gave my 100 percent and got good results," he says.Seeing his success, farmers have been approaching Harsh to understand the nitty-gritty of indoor saffron farming. So far, he has trained 50 farmers through online workshops.Harsh was able to harvest 350 grams of saffron of 'mogra' variety in a tiny room.Harsh shares a step-by-step guide for farmers willing to replicate the method:

Establish a controlled environment: Harsh was able to grow saffron in warm Nandurbar village as he set up a controlled environment. "For this, I insulated the room to control the temperature. You can insulate the room using thermocol or puff panels if practising saffron in an open area," he says. "You also need to invest in proper machinery to ensure a similar climate like Kashmir. Install chillers from cold storages and humidifiers to control the temperature," he adds.Harsh says a temperature of 15-20 degrees should be maintained in September during the sprouting period and 5-7 degrees from November to October at the time of flowering. "We cannot provide direct harsh sunlight to saffron, so we used grow lights instead," he adds.

Procure bulbs: Harsh advises procuring saffron bulbs for sprouting only after preparing the unit. He sourced bulbs of 'mogra' variety from Kashmir. "It costs between Rs 600 and Rs 800 per kg. There are additional expenses for transportation. Farmers can start saffron cultivation from 100 kg of bulbs to get a yield of about 30 to 40 grams," he adds.Harsh advises preferring plastic trays over wooden ones as they will be less prone to fungus attacks.

Bulb treatment process: Harsh says saffron bulbs are prone to fungus attacks and require special care during transportation. "Firstly, sort the bulbs as per their size and remove dirt and mud. Thereafter, dip them in neem oil solution to remove bacteria. Dry them naturally inside the room under the fan," he says."Place these bulbs on trays for sprouting. Prefer plastic trays over wooden ones as it will be less prone to fungus attack," he adds.

Maintenance of temperature and sanitization: Harsh uses the aeroponics technique where bulbs are grown in soilless media and nutrients are supplied through air. In this setup, he has also installed humidifiers and air conditioners to provide a proper climate for saffron."In 15×15, I installed air conditioners that automatically regulate temperature. For instance, if the desired temperature is attained then it automatically switches off, and as soon as the temperature reduces by three degrees, it restarts. The power expenses amount to around Rs 6,000 to Rs 7,000 per month. We can harness solar energy as well to reduce power costs," he says. Harsh says cultivating saffron is easy provided proper temperature and cleanliness are ensured. "Farmers need to regulate the temperature and humidity, which varies from sowing to the flowering stage. Maintain humidity between 60 and 70 percent in the unit," he adds.He also warns, "Do not let anyone enter the unit, and if necessary, wear masks and apply sanitisers so that there's no risk of diseases affecting the bulbs. However, in case of fungus attack, remove the affected bulbs from others and treat them with neem oil."

Harvest stigma sticks: Harsh says farmers can harvest saffron once a year as saffron has a life cycle — dormancy, flowering, and multiplication stage. "Saffron is ready to harvest in late October. You can pluck stigma sticks (flower's thread-like structures) from saffron crocus. You'll get three stigma sticks from each flower. Place them on a clean cloth and dry them naturally under the fan," he says.Harsh adds that farmers can earn up to Rs 700 per gram by selling saffron stigma sticks. "It is easier to tap into the market and earn handsomely. Currently, the market is dominated by cheap imports from Iran. You can seize the opportunity by selling authentic red saffron, which does not dissolve in water and leaves a shiny golden colour," he adds."After harvesting comes the multiplication stage of daughter corms. This process requires soil and cocopeat media. It takes up to four months for the process, wherein a bulb gets multiplied into two. These bulbs can be saved for the next cycle," he notes. Kashmir, the world's second-largest producer of saffron has faced a decline in saffron cultivation over the past two decades.Some farmers in the region are experimenting with indoor saffron farming which uses lesser water and chemicals, offers greater control over environmental

conditions and minimises crop vulnerability to extreme weather conditions.Indoor farming currently yields less than traditional methods, but farmers remain hopeful. They believe this is just the beginning and with time and further refinement, the yield from indoor farming will increase.

Saffron flower

Saffron flower

Saffron corms (bulbs)

Problems of saffron cultivation

- Climate change impacts like erratic rainfall and rising temperatures, which affect both yield and quality.
- The degradation of soil quality due to industrial and residential expansion,
- The high cost and limited availability of quality corms (bulbs)
- The labor-intensive nature of harvesting and processing and the unavailability of labor can cause delays in operations and negatively impact production.
- Market issues like adulteration and the influx of cheaper, possibly fake, saffron from other countries further impact the profitability of Kashmiri saffron
- Inadequate post-harvest techniques and storage methods can lead to a decline in the quality and value of saffron, particularly the crocin content.
- There's a need for greater awareness among farmers regarding modern techniques for cultivation, harvesting, and storage.
- Farmers are facing declining prices for their saffron, making it less financially viable to cultivate.
- Outdated farming techniques and lack of access to modern technology hinder the efficiency and productivity of saffron farming
- Cement factories in close proximity to saffron fields emit large volumes of dust, damaging both quality and quantity of saffron yield.
- Usage of machines for ploughing also affects saffron cultivation, which is highly dependent on a favourable climate.
- Saffron farmers face financial difficulties as the spice'smarket becomes less lucrative
- Increasing porcupine infestation.
- Damage by rodents.
- crocus would flower three to five times in a growing season, now that's down to two or three.
- Poor weed management In Kashmir the growth of saffron is started around October November and after that it lasts until April and for this much time fields of saffron remains vacant because of inactive phase which is from April to September and this long time gap provides an open space for weeds in the fields of saffron which spreads over and entire fields without any interference that can be encountered in presence of crops the saffron plants are short with the narrow and upright foliage and it offers the little competition with the weeds
- Poor post harvesting handling
- Urbanization and pollution

Way Forward

- Implement and enforce strict environmental regulations to mitigate the impact of cement factories on saffron fields.
- Ensure regular monitoring and penalties for industries contributing to pollution near saffron cultivation areas.
- Facilitate collaboration between the government and saffron growers to address concerns and find sustainable solutions.
- Support initiatives for diversifying the livelihoods of saffron farmers, offering alternative sources of income.
- Allocate funds for research and development in saffron cultivation, focusing on creating varieties resilient to environmental challenges.
- Invest in technology that minimizes the impact of pollutants on saffron crops, ensuring sustainable growth and maintaining quality.

Government initiatives for saffron production

The National Saffron Mission: In year 2010-11the national saffron mission is introduced by union agriculture which is

really making impact and under this mission the farmers of saffron cultivation were given a subsidy of (Rs.2,64,000 per acre) which is given by the way of technical and material support for recreation and modification of saffron crop. So far out of 3765 hectares of saffron land 1876 hectares of saffron land has been rejuvenated. And the 90% of total saffron production is come out from Pampore uplands which are locally called (wudar). The total amount of this mission is 371.18 crore rupees in which the 286.06 crores as the center government shares and the 85.12 crores rupees as farmers share which is totally executed in four years to revive the production of saffron in the state Jammu and Kashmir and in this mission everything is covered regarding the saffron like (drip irrigation), (mechanization), (research), and (marketing support) to come out from the crises. From the total amount of the 39.43 crores is being utilized during the year and the main objectives of this mission is to improvement in the production and the quality of saffron and the support which is given by the government. And like irrigation facility which is through tube wells and sprinkles which is better for crop production and for the improvement in the production of saffron 253 tube wells would be setup and the quality control lab is established in Pampore at a cost of Rs 8.90 crores which ensures quality testing of saffron and also marketing and the NSM is also develop the appropriate organized body between growers and traders. And it is expecting that after the completion of the saffron mission the income presently which is comes from the state is 236.55 crores it will increase to 4642.50 crores.

The saffron mission is one of the great important imitative taken by the government, the government put forth many steps to enhance the market availability of the saffron. The government restricted the imported saffron especially from Iran exporters because it was less expensive then the native saffron it leads the availability of market of the native saffron and directly impact the state economy. Govt. gives a helping hand to saffron growers of Kashmir due to the recent floods. Kashmiri saffron growers face many problems of production and also by erratic weather but with the help of insurance and relief scheme the govt. helping him out from this disastrous slump. The saffron growers of Jammu and Kashmir have got a helping hand by introducing the weather-based crop insurance scheme by the government from the year 2015and at least 16000 families which is around 200 villages that are involving in the producing saffron. And throughout India its only the state Jammu and Kashmir where the saffron is grown and it is highly valued spice, but by the floods of 2014and the erratic rain in Kashmir which is responsible for the 75% shortfall in saffron production but besides it government announces the insurance scheme and it provides the greater relief and according to the government orders the formers whose production has been damaged due to erotic weather that all are entitled to relief funds and in these funds the farmers who lost 33%of their crops due to the erratic rainfall and other natural disaster will also entitled for relief. And the scheme of crop insurance was supposed to start from sep. 2014 but by the floods which is worst in six decades effectively stalled the implementation of this scheme and now it got implementation in 2014 and the formers of Jammu and Kashmir have got the compensated for 70%of the crops which they lost in the erratic rainfalls. And the peoples of Jammu and Kashmir are happy that the crops are insured and all the peoples are deposit the premium of the insurance. (ii) The insurance scheme. Altaf Andrabi, the joint director of agriculture in the Jammu and Kashmir says that the main reason of reducing income of farmers are the various weather factors which is responsible for the crop failure in recent years. And he told that in this scheme the crops would be covered for dry spells and heavy rainfall or insufficient and if it happens the department would share 50% of its premium and the other 50% formers have to pay insurance companies. According to this scheme the one hectare of land which is saffron cultivated would be insured against (Rs 200,000) and the 12% of the insured sum would be paid for the premium.

Over the past several years, the saffron industry is running in loss on account of low saffron productivity and unorganised market. Though technologies ensuring high saffron quality with a productivity of around 5kg /ha are available but implementation of technologies by the farmers is a big question due to high input cost. Efforts by the policy makers at the State and Central Level has precipitated a mega project, “Economic Revival of J&K Saffron Sector” under RKVY Schemes for Integrated Development of Saffron. The project aims at rejuvenation of entire saffron area of 3715 ha, providing irrigation facilities through creation of bore wells and spinkler distribution system, providing dryers for quality saffron, construction of vermicompost units, improvement of soil health, capacity building and enhancing research and extension capabilities. Spice park that has emerged under the project will serve as a centre for brand promotion and e-trading making saffron trade a success. Under the project, efforts will also be made to develop technologies for producing saffron in the non-traditional areas for improving the overall production.
Under National Agricultural Innovation Project, funded by ICAR, Sher–e-Kashmir University of Agricultural Sciences and Technology of Kashmir has developed production and post-harvest technologies that not only ensure yield gains but lead to quality improvement and reduction of post harvest losses. Technologies have been developed through farmers participatory research approach. Practical manual, published by Ministry of Agriculture, Govt of India will reflect the good practices to be followed in saffron production in Kashmir that will ensure an average productivity of 5 kg per ha. Over a period of 4-5 years with the reduction in input cost. Technologies reflected in the manual will serve as a guide for rejuvenation of the traditional saffron area as well as serve as a stepping stone for future success of saffron. While initiatives like the National Mission on Saffron (NMS) and efforts to obtain Geographical Indication (GI) tags for Kashmiri saffron are underway, farmers emphasize the need for enhanced funding and support to address the challenges they face.It is an autonomous body under the Department of Science & Technology, Government of India supported a pilot project to explore the feasibility of growing saffron in the North East region of India, with the same quality and higher quantity.

SUGGESTIONS

- Government should create an advisory committee in the agriculture department which will give special inputs to government regarding the problems of saffron cultivation faced by saffron cultivators.
- Government should limit the import from foreign countries which will reduce the competition in the native market.
- Government should introduce new policies in their annual budgets related to the saffron production which will help and innovate the farmers to take interest in the saffron cultivation.

- Government should provide high yield variety (HYV) corm to the farmers this will increase the production of saffron in the region.
- Government should check and regulate the market mechanism of saffron, which will save the private entrepreneurs from loses and to take risk.

CONCLUSION

Farmers distant themselves from the saffron cultivation, because the production was reduced due to some climatic conditions. The government took numerous initiatives to catch the attention of the people for cultivation and to increase the saffron production in Kashmir, the marked initiatives are: Weather Based Crop Insurance Scheme and national saffron mission plan. As in case of weather based crop insurance scheme government covers the losses due to natural climatic disasters like flood, drought, dry weather, excess of rainfall. Under national saffron mission plan government aims to double the saffron production and the government avail numerous facilities to the farmers like: good quality of corms, improving soil health by INM and IDM practices, Strengthening the Irrigation System for saffron fields i.e. water pumps, water sheds, Quality testing and marketing mechanism. Saffron being the most expensive and valuable spice is known as for its good quality throughout the entire globe. This valuable item is also known as red gold. The saffron is the second dominant agricultural economic activity in the state Jammu and Kashmir is the largest producer of the saffron which accounts 30 to 40 crores annual turnout. The saffron cultivation has lost a little bit market shares and it has increased the share of unemployment in the region. the cultivable land has lost its fertility due to excess use of fertilizers and less availability of water in the region in order to alleviate these issues the government has proposed many schemes to enhance and faster the production of saffron in the region. Saffron mission plan and insurance scheme are the two major initiatives which are taken by the government for the saffron cultivators of Jammu and Kashmir it is because when Kashmiri saffron growers are suffered by a disastrous slump of saffron due to the floods and the erratic weather but the government gives the helping hand to the saffron growers with an insurance scheme and other relief schemes. The insurance scheme is known as weather based crop insurance. The saffron mission plan is the another initiatives taken by the government for the maximizing production of saffron it has been sanctioned by government of India and the total cost of this scheme is 372.18 crores and its proposal is to be completed in 4 years. The main reason for introducing the saffron mission plan is to produce more saffron because the area which is under saffron cultivation has declined its production from 5707 hectares to 3715 hectares from 1996 to 2009-10. The main recommended interventions which are in this plan are initial corm treatment to control corm rot disease, the plantation of graded corms. In September the pre flowering irrigation etc.

Saffron is a legendray crop of Jammu and Kashmir state and a traditionally grown crop also. Due to it's high value, the crop is one of the most important crops to the residents as well as the crop has also cultural importance in this area. Many farms family's livelihood also depends on this crop's cultivation. Due to this crop's high earning potentiality, the farmers and farm families prefer to cultivate the crop, but in recent days many augmenting problems preventing them or discouraging them to cultivate the crop. Among the problems, the most remarkable and identifiable problem is global warming or climate change. As a result, climatic disturbances and erratic rainfall, prolong dry spell etc. causing havoc damage/loss to this crop and making harvesting a question mark. In this background, how this crop can be cultivated smoothly and how to be a really lifeline of many farms family's survival, it must be thought carefully, wholeheartedly and continuously. Governments (central & state) taking lot of initiatives or measures in this regard, farm families, they are also cautiously taking many measures to protect the crop, but the last answer is in the hand of climate/weather. Actually, farmers are living by the grace of climate/weather. In this arena, indoor saffron cultivation is a path to progress, survival, prosperity and up to a certain extent social justice. Hence, govts., researchers & farmers and farm families must think on indoor saffron cultivation procedures and infrastructure development with minimal cost.

Develop indoor saffron farming in such a way that in near future it will be a cottage industry or home craft and will be a source of permanent income. If cultivation is secured, income will be secured, because, the crop is a high value crop or high demand crop, having no problem in marketing. In this way the crop gradually become a really legendry crop. Youths of Jammu and Kashmir state who are unemployed, they can think about this profession of survival. When unemployed, brain is directionless, over thinking happens and negative mentality grows, do destructional activities, even hold weapon against country. Instead, if they focus their mind on earning oriented activities, their life will be settled and they become the part of construction instead the part of destruction. We all Indians, will try to our level best to protect our country and prosper our country, then it is possible to form a good country, livable country where all people live peacefully and do their professional best for country's betterment. Our ultimate motto will be nation first, if nation is safe, we are safe. Another way of raising income of people of Jammu and Kashmir State is tourism. Luckily, the state has got the most beautiful part of our country. Use that beautifulness in raising income by tourism.

If all the people of J&K, state govt. think on it deeply, concentratedly and analytically, they will find it that tourism is a high potential hidden opportunity. For development of tourism, it needs to develop tourism infrastructure day by day gradually, but, confirmly. Now-a-days, income level of countrymen has raised quietly and a part of population want to go visiting various beautiful places and places of importance. If this opportunity is caught by the people of J&K & state government., obviously, one day the state will be a developed state of India. In this respect, prime requirement is removing terrorism from the valley/the state. Terrorism and tourism cannot go simultaneously. Central govt. and state govt. have taken lot of measures to delete terrorism from the state of J&K. Along with, if the common people of the state, every citizen of the state want heartily to eradicate terrorism completely from the land, it is possible not in oneday, but one day it will be possible. Then flood of money will flow in this state, because, our country having over 140 crores of population. Then all the citizens of the state will get all the basic facilities of survival and farmers will able to cultivate the saffron crop indoor by developing indoor farming infrastructure. That day and forward, the state's economic development will happen in every respect, in every angle.

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