

Good Practices for Saffron Production in Kashmir

PRACTICAL MANUAL



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Preface

Saffron is a legendry crop of Jammu and Kashmir. Over the past several years, the 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 5 kg/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 sprinkler 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 will reflect the Good Practices to be followed in Saffron production in Kashmir that will ensure an average productivity of 5 kg 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.

Authors acknowledge the financial support rendered by Project Implementation Unit, NAIP and Ministry of Agriculture, Govt of India for publication of this practical manual. I hope this manual will serve a stepping stone for future success of saffron.

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Why Good Agricultural Practices

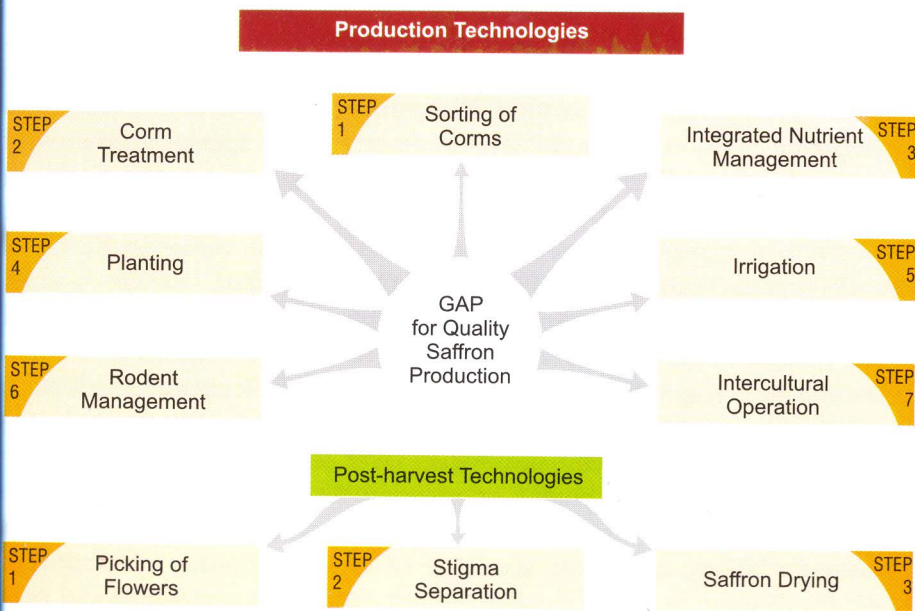
Good Agricultural Practice refers to any collection of specific methods, which when applied to agriculture produce results that are in harmony with the values of the proponents of those practices. Therefore, whether a practice can be considered “Good” or not will depend on the standard applied. In this context, good practices in saffron production mean all those agronomic and post harvest practices that are not only suitable for yield enhancement, but are also environmentally benign based on low external inputs and ensuring sustainable saffron production.

Saffron by nature is a low input demanding crop in terms of energy, water and nutrients and its cultivation 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 the paradise.” The Kashmiri Vaidas namely Veghbhata and Sushtra used saffron as an important ingredient in Ayurvedic medicines. It also finds its name in Kashmiri records which dates back to 5th century (Nauriyal *et al.*, 1977).

Saffron is a cultural asset associated with a considerable amount of indigenous knowledge. It is a niche crop of Tehsil Pampore in District Pulwama area expanding to new areas of District Budgam. Production technologies in saffron have not changed much, though new technologies and implements have been developed over time. Most of the farming practices are based on farmer’s knowledge. Good Agricultural Practices (GAP) in saffron production have emerged to overcome the drawbacks of longer planting cycle, low seed rate of unsorted corms, infestation of corm rot disease, poor soil health, rainfed cultivation and traditional post harvest practices through a pragmatic research programme pursued at Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir. GAP in saffron not only improves saffron production but also the saffron quality and adoption of these practices should enhance economic benefits to saffron growers and ensure their livelihood security on long term basis.

In Jammu and Kashmir, Saffron is a source of livelihood for more than 16000 farm families and at present this industry is incurring a loss of

more than 50 per cent. The state at present produces 9.5 M.T as against a potential of 18.57 M.T that can further be increased to 28.50 M.T after regaining the glory of actual traditional saffron area of 5,700 ha with an average productivity of 5 kg/ha. The income from this industry can improve from ₹ 237 crores to ₹ 463 crores with an estimated price of ₹ 2.5 lacs/kg of laccha saffron. Therefore, the major strength to achieve this goal rests mainly on the adoption of available technologies ensuring high quality saffron production. Appreciating these facts, Ministry of Agriculture, Govt of India sanctioned a mega project to J&K State for "Economic Revival of J&K Saffron Sector" under National Mission on Saffron with a total financial allocation of ₹ 373 crores. In order to achieve higher productivity, using available technological opportunities, adoption of GAP would make a significant contribution. GAP for quality saffron production is schematically shown below:



Production Technology

Temperate climate with sunny days during the flowering period is favorable for good yield. Rains during September are favorable to initiate timely growth of roots and floral/aerial vegetative shoots. Localities covered with snow during winter at an altitude ranging from 1,500 to 2,400 m amsl provide necessary chilling for commercial cultivation of saffron. Saffron requires medium textured soil with good drainage capacity. Soil

with neutral reaction is best suited for saffron cultivation. Integrated Nutrient Management (INM) together with adequate plant population with suitable planting geometry, irrigation schedule, mechanized intercultural operations and rodent management are the technological approaches for improving production and productivity of quality saffron in J&K State.

Production technology in saffron involves seven steps. The existing practice and the good practice for these steps is given below:

Step-1: Sorting of Corms

Corm size in saffron varies from 1 to 20 g. Corms weighing upto 2 g have no flowering potential and upto 8g their potential is limited. However, corms weighing more than 8 g are productive and maximum flowering ability is shown by corms weighing more than 14 g. On the basis of corm weight, the corms are classified into 4 groups, viz., < 4 g (small), 4–6 g (medium), > 6–8 g (large), > 8 g [very large (Corms with 2.5–3 cm diameter have 8 g weight)]. Corms weighing more than 8 g, free from injuries and disease lesions are sorted out and the outer loose scales are removed before planting.



Different Grades of Saffron Corms—(a) > 15g, (b) > 8 g, (c) 5-8 g, (d) < 5 g

Existing Practice

Under traditional practice no sorting of corms is practised.

Good Practice

Since there is a direct relationship between corm size and flower production, large corms (> 8 g) are ideal for higher saffron production and productivity.

Step-2: Corm Treatment

Since last several years, a major biotic stress faced by the saffron crop is the corm rot fungal infection, a soil borne disease caused by *Fusarium moniliforme* var *intermedium* an unidentified mycelium of *Basidiomycetous* fungus. About 46 per cent of the soil in the traditional saffron fields is infected with the fungus and the infection is spreading steadily. Saffron fields are also highly infected with plant parasitic nematodes that cause chlorosis of radical leaves and they turn yellow leading to complete corm rot.

The diseased corms show dark brown sunken and irregular patches below the corm scales. The rot lesions are usually 1 mm deep having raised margins and are usually located in root and bud regions. In severe cases, the entire corm turns into black powdery mass with outer fibrous scales in position. In some corms, white or yellowish white fungal mass is observed. Diseased corms produce foliage giving "Die Back" like symptoms. No spots are observed on leaves. Yellowish foliage can be easily pulled out from the diseased corms.



Healthy Saffron Corms



Infected Saffron Corms

Existing Practice

Management practice is not being followed by the farmers for the control of saffron corm rot in the existing crop or for the fresh plantation

Good Practice

Cultural Management

- Cultivation of Saffron under shorter planting cycle of 4–5 years
- Plantation of healthy corms free from rot, lesions/injuries

Chemical Control

Fungicidal suspension is prepared by dissolving 50 g (0.1%) of carbendazime 50 WP and 150 g of Mancozeb 75 WP (0.3%) in 50 litres of water. Graded saffron corms free from lesions and loose scales are dipped in the fungicidal suspension (maximum 1.5 q) for a period of 5–10 minutes. Saffron corms are taken out from the suspension using a willow basket and allowed to dry in shade for a period of 15–20 minutes to drain off excess moisture. Same suspension can be used 2–3 times.

Step-3: Integrated Nutrient Management

Existing Practice

The practice of growing saffron year after year without supplementation of nutrients has drastically reduced the fertility of the soils in the saffron fields. Except potassium, the organic carbon, nitrogen and phosphorous of these soils has declined. Consequently, the size and vigour of the corms produced every season is reduced, directly affecting the crop stand and flowering potential of the plant.

Good Practice

In order to address the decreasing productivity of saffron due to decline in fertility status of soils, Integrated Nutrient Management is considered a better option for sustainable development of crop for livelihood security. The concept of INM implies, evolving strategies which utilize major nutrients through commercial fertilizers in a balanced proportion on one hand and use of organic manures on the other along with adequate biofertilizers depending on their availability/feasibility for a given location.



INM For Good Saffron Crop

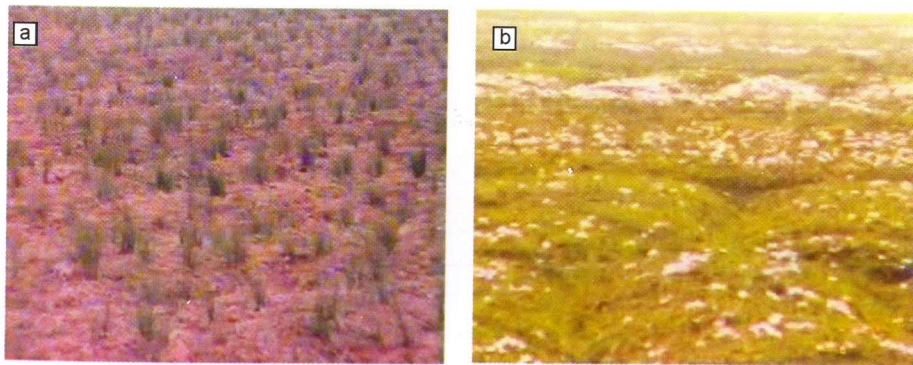
One kg of total dry matter of saffron has been reported to remove 12 g N, 3 g P and 22 g K from the soil. Recommended INM module used in the farmer's field through participatory approach, conducted over 4.2 ha of saffron area of Kashmir, has shown improved soil health in terms of physical, chemical and biological properties and improvement in overall factor productivity/unit area together with improvement in water holding capacity and bulk density.

INM Schedule

- Inorganic fertilizers=N : P₂O₅ : K₂O :: 90 : 60 : 50 kg/ha
 - Nitrogen in the form of urea @145.728 kg/ha (7.286 kg/kanal)
 - Phosphorous in the form of DAP @ 132 kg/ha (6.600 kg/kanal)
 - Potassium in the form of MoP @ 83 kg/ha (4.150 kg/kanal)
- Well decomposed farmyard manure @ 10 tons/hectare (5 quintal/Kanal)
- Vermicompost @ 5 quintals/ha (25 kg/ha)

Method of Application

- Band placement of fertilizers
- Half dose of nitrogen (urea) and full dose of well rotten manure (FYM), phosphorous (DAP), potassium (MoP) and Vermicompost to be applied as basal dose during 2nd hoeing (August/September) in existing crop and at the time of planting in fresh crop
- Another half dose of nitrogen to be applied immediately after flowering with the onset of vegetative phase in the last week of November, ensuring availability of moisture.



Effects of Poor Soil Health—(a) Poor Vegetative Growth (b) Sparse Flowering



Profuse Foliage Growth



Flowers In Clumps

Step-4: Planting

Existing Practice

Planting cycle, planting time, planting method and seed rate are the critical factors for saffron productivity. Mother corms once planted are retained in the field for many years, allowing these to produce daughter corms which continue the production cycle without interruption, though at the cost of declining productivity. The planting cycles are generally of 10–12 years duration.

Prior to the plantation of saffron corms deep ploughing is done using bullock drawn plough. Every month from January-September ploughing is carried out to keep the field clean. After the field is ready, corms of different grades are planted in September by hand dropping of saffron corms behind bullock drawn plough. The field is laid out into 2 m × 2 m beds with deep drainage channels on both the sides.

Good Practice

Shorter planting cycle of 4–5 years is recommended. Deep ploughing is recommended involving tilling the soil to a depth of approximately 30 cm using bullock drawn plough and planking is recommended. This operation can be mechanized using tractors and matching ploughs and harrows. Ploughing is done in the same furrow to achieve required depth as well as to keep the field clean. Operation can be carried out in August instead of long operational calendar being completed over a period of 4 months under traditional practices. Saffron corms are planted in rows at a spacing of 20 × 10 cm and at a depth of 15 cm with 1corm/hill or with a planting geometry of 25 × 15 cm with 2 corms/hill maintaining a planting density of 5 lakh corms/ha with a seed rate of 50 quintals/ha. Alternate furrows can also be operated by which the soil from each new



Manual Row Plantation (a&b), Mechanised Row Plantation (c&d)

furrow is directed to the previous furrow with corms already located in the furrow.

Plantation depth varies from 10 to 20 cm. Shallow planting generates greater number of buds which produce greater number of corms. In deep ploughing, there are less sprouts but of larger size. Position of corms with apical bud upward is important for planting of corms. The most suitable machines for this operation are onion planter/potato planter/tulip planter. To avoid water stagnation, to which saffron is sensitive, the field is laid out into 2 m wide and 10–20 m long strips across the field slope with 30 cm wide and 15 cm deep drainage channels on both sides.

Step-5: Irrigation

Existing Practice

Saffron in Kashmir is grown under rainfed conditions as no water source is presently available in saffron Karewas. Farmers are dependent on September rains for a good flush of flowers and delayed rainfall (late October) is detrimental to the crop as it is accompanied with low minimum and maximum temperature leading to flower abortion.

The region used to receive 600 to 1000 mm rains annually, part of which would occur during August to mid-October and then in November, the two critical stages for normal flowering and good crop for the next year. However, since the last several years, the weather has become quite erratic. Rains are either scanty or irregular, thus adversely affecting flowering and subsequent plant stand.

Good Practice

For the accelerated growth of roots and floral primordial and post flowering vegetative and corm multiplication, saffron crop should be sprinkler irrigated @ 700 m³/ha. (7 lac litres/ha) to be distributed over 10



Rainfed Saffron



Irrigated Saffron

irrigations at weekly interval. First seven irrigations are most crucial for the accelerated growth and facilitation of flowering. Timing of this phase of irrigation (pre flowering or pre-sprouting) is very important and should be started from the last week of August till 15th October based on climatic conditions, otherwise flowering and vegetative growth may coincide which may interfere with the picking of flowers. For first seven irrigations about 490m³(4.90 lac litre/ha) of water is required. To boost vegetative phase for enhanced corm production 3 irrigations with a total water requirement of 210 m³ (2.10 lac litres/ha) should be applied starting from 8th November.

Step 6: Rodent Management

Existing Practice

Rodents cause considerable annual loss to the saffron crop by damaging the saffron corms. Management of rodents using rodenticides is sporadic and not taken as a campaign and with missionary zeal. However, farmers mostly smoke the burrows using cowdung and grass.



Pitymys lucuru



Porcupine

Good Practice

Saffron rodents (*Pitymys lucuru*) can be managed through six day management schedule. However, no such schedule can be practised for control of porcupine, a wild pest that, of late, has been damaging saffron fields

Chemical Management

- Day 1: Plugging of burrows.
- Day 2: Identification of live burrows/pre-baiting with 10–15 g bait/burrow (containing 48 g Broken rice, 48 g crushed wheat, 2 ml mustard oil and 2 g sugar).
- Day 3: Identification of live burrows/zinc phosphide baiting with 5–10 g bait/burrow (containing 48 g broken rice, 48 g crushed wheat, 2 g Zinc Phosphide, 2 ml mustard oil and a pinch of sugar).

- Day 4: Collection and burying of dead rodent. Close all burrows.
- Day 5: Identification of Live Burrows
- Day 6: Fumigate live reopened burrows with Aluminum Phosphide pellets @ 2 pellets/ burrow or 5–10 g Aluminum Phosphide Pouch (56% Poison)/burrow and cover with wet mud.

Mechanical Management using Burrow Fumigators

- A burrow fumigator is available that is efficient prototype for control of rodents using cow dung cakes



Traditional Burrow Fumigator



Improved Burrow Fumigator

Step 7: Intercultural Operations

Existing Practices

Weeds cause significant losses to the saffron crop through depletion of nutrients. Farmers generally do not practice weeding and allow the weeds to grow with the crop and harvest weeds as a fodder in May when saffron foliage dries. September hoeing is practised by every saffron farmer with some exceptions for June hoeing.

Good Practice

Saffron crop needs good soil aeration for which hoeing should be done in the second fortnight of June with the help of short handled hoe called Zooni. Second hoeing should be done in the first week of September. Soil from drainage channels should be borrowed and proper levelling of beds should be ensured. The soil has to be developed to a fine tilth to ensure emergence of sprouts. However, mechanical hoeing using available



Mechanised Planting



Mechanised Weeding/Hoeing

diesel/petrol operated weeders with a tilling depth of 3–5 inches (adjustable), working width of 18–27 inches and tilling width of 17–21 inches operated through 12–16 tynes is a suitable substitute for manual hoeing. Weeding of saffron in November and February/March is essential to ensure good growth of foliage and corms. No chemical weedicide is recommended under Kashmir conditions due to its residual effect on saffron. However, in future some organic weedicides can be an option for control of weeds.

Impact of production technologies in terms of income

- The INM module with a proper planting density, planting geometry and management practices reveal a B : C ratio of 2.67 : 1
- Management schedule against rodents will save the industry from an annual saffron corm loss of 3% amounting to ₹ 4.73 crores with an estimated cost of ₹ 17,000/quintal of saffron corms
- Saffron mechanization using furrow ridgers and weeders ensures saving of ₹ 45,000/ha per year
- The production technologies once adopted by the saffron farmers Under “National Mission on saffron” approved by Govt of India over a period of 4 years of project will keep rejuvenation and improve the overall production to 26 tons with an average productivity of 7 kg/ha. 500 recommended weeders will be distributed among the saffron farmers to popularize mechanization, thereby, reducing the cost of cultivation.
- Adoption plan of technologies under National Mission on Saffron

| Year | Planned Area under Rejuvenation (ha) | Plan for distribution of weeders |
|---------|--------------------------------------|----------------------------------|
| 2010–11 | – | 125 |
| 2011–12 | 1,520 | 125 |
| 2012–13 | 1,150 | 125 |
| 2013–14 | 1,045 | 125 |
| Total | 3,715 | 500 |

Post-harvest Technologies

Kashmir saffron is well known for its intrinsic high quality but traditional post harvest practices followed by the farmers result in post harvest losses to the tune of 30% with inferior product quality. Present Post Harvest Practices result in a recovery of 20–22 g of saffron per kg of fresh saffron flowers with colouring power ranging from 100 to 150 at 440 nm (8–10%) thus fetching low price in the export market. Post Harvest Technology is aimed at improving recovery and quality with a bench value of 30 g/kg of saffron flowers.

The following three steps are important for post-harvest interventions.

Step1. Picking of Flowers

Existing Practice

Most of the farmers pick flowers without any picking schedule or flower age. Collection material is also improper and no hygiene is followed while picking up flowers.

Good Practice

Age of saffron flowers and collection material has direct impact on laccha yield and saffron quality. Picking of saffron flowers on the



Un-hygienic Flower Picking



Recommended Flower Picking

2nd day of emergence gives substantial saffron recovery and quality. Flowers should be picked up in early morning hours using hand gloves in craft paper bags or plastic baskets or willow baskets with proper aeration.

Step 2. Stigma Separation

Existing Practice

Stigma separation is delayed due to lack of sufficient family labour leading to loss of recovery.

Good Practice

Stigma should be separated within 10–12 hours of flower picking to achieve maximum pistil recovery. Delay in separation by 36–72 hours results in loss of recovery from 37 g/kg of fresh saffron flowers achieved under quick separation and controlled drying to 7 g/kg of fresh saffron flowers.

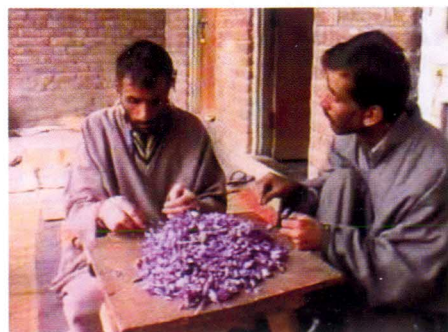
Step 3. Saffron Drying

Existing Practice

Farmers dry saffron under shade which takes about 27–53 hours. Such a long period is responsible for enzymatic degradation of crocin.

Good Practise

Drying saffron at a temperature range of 40–50°C in hot air dryers or solar dryers takes about 4–7 hours for drying and show pigment concentration very close to that found in fresh saffron with a very good texture, flavour and bitterness. Quality drying ensure high values of coloring power (>300), flavour (>70) and bitterness (>120).



Delayed Stigma Separation



Quick Stigma Separation

Solar saffron dryer

Solar saffron dryer has a drying tray with a meshwire bottom and a roof on top to protect from inclement weather dirt and dust. A glass shielded solar collector with corrugated black coated GI sheet absorber creates air flow above ambient through natural convection. Fresh saffron (1 kg) when dried for 8 hrs shows a moisture content of 8-10%. The common practice of sun drying takes 3–4 days to reduce the moisture content to the desired level. Its approximate cost is ₹ 6,500.

Hot air saffron dryer

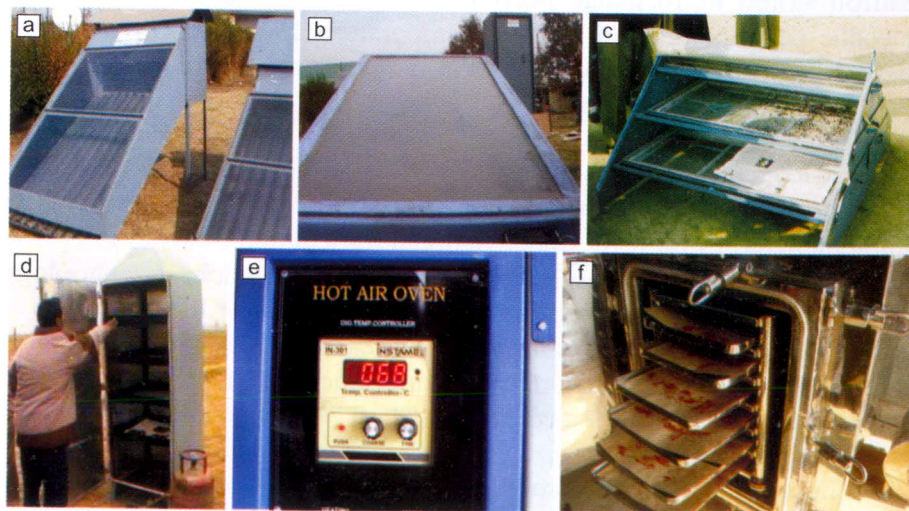
It is a tray dryer having four trays of 1 m² each. Heated air (45 ± 5°C) with supplement heating using LPG stove is circulated by a blower. Hot air saffron dryer can dry saffron even in an inclement weather.

Modified hot air saffron dryers

It is an improved model of hot air saffron dryer having four trays of 1 m² each and 100 cm chimney. It has thermally insulated body for conserving energy.

Solar tunnel saffron dryer

It has four drying trays with a meshwire bottom and a polythene cover on the sides to conserve the solar energy and to save the saffron from inclement weather, dirt and dust. The output temperature in the solar



(a) Low Cost Solar Dryer, (b) Commercial Solar Dryer, (c) Solar Tunnel Saffron dryer, (d) Low Cost Hot Air Dryer, (e) Commercial Hot Air Dryer, (f) Vacuum Dryer

dryer rises from 17°C–30°C in the 1st hour and subsequently to 45°C in the 2nd hour. It takes 3–4 hours for effective drying of saffron (moisture content of dried material approx. 8%) the solar dryer is effective in increasing the temperature by 23–24°C.

Likely Benefits

- The Post Harvest Technology shall be adopted by more than 16,000 farm families under the project covering an area of 3,715 ha in J&K. Under National Mission on Saffron, 8,000 dryers shall be distributed.

Adoption plan of NAIP processing technologies under National Mission on Saffron

| Year | Plan for distribution of Dryers | Area under Processing Technology (ha) |
|---------|---------------------------------|---------------------------------------|
| 2010–11 | 1,400 | 650 |
| 2011–12 | 2,200 | 1,022 |
| 2012–13 | 2,200 | 1,022 |
| 2013–14 | 2,200 | 1,021 |
| Total | 8,000 | 3,715 |

Packaging and Storage:

Saffron samples with initial moisture content of 8% can be stored at around 10°C in air tight containers safely for six months. The stability of colour in general is inversely related to moisture content and temperature. Saffron stored in 10 gauge polythene bags, aluminium foil packs and metallic containers at an ambient temperature 15–35°C over one year period, leads to loss of colour (crocin pigment) by 56.9 to 70.2 per cent (at 10–12% moisture dry basis)

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