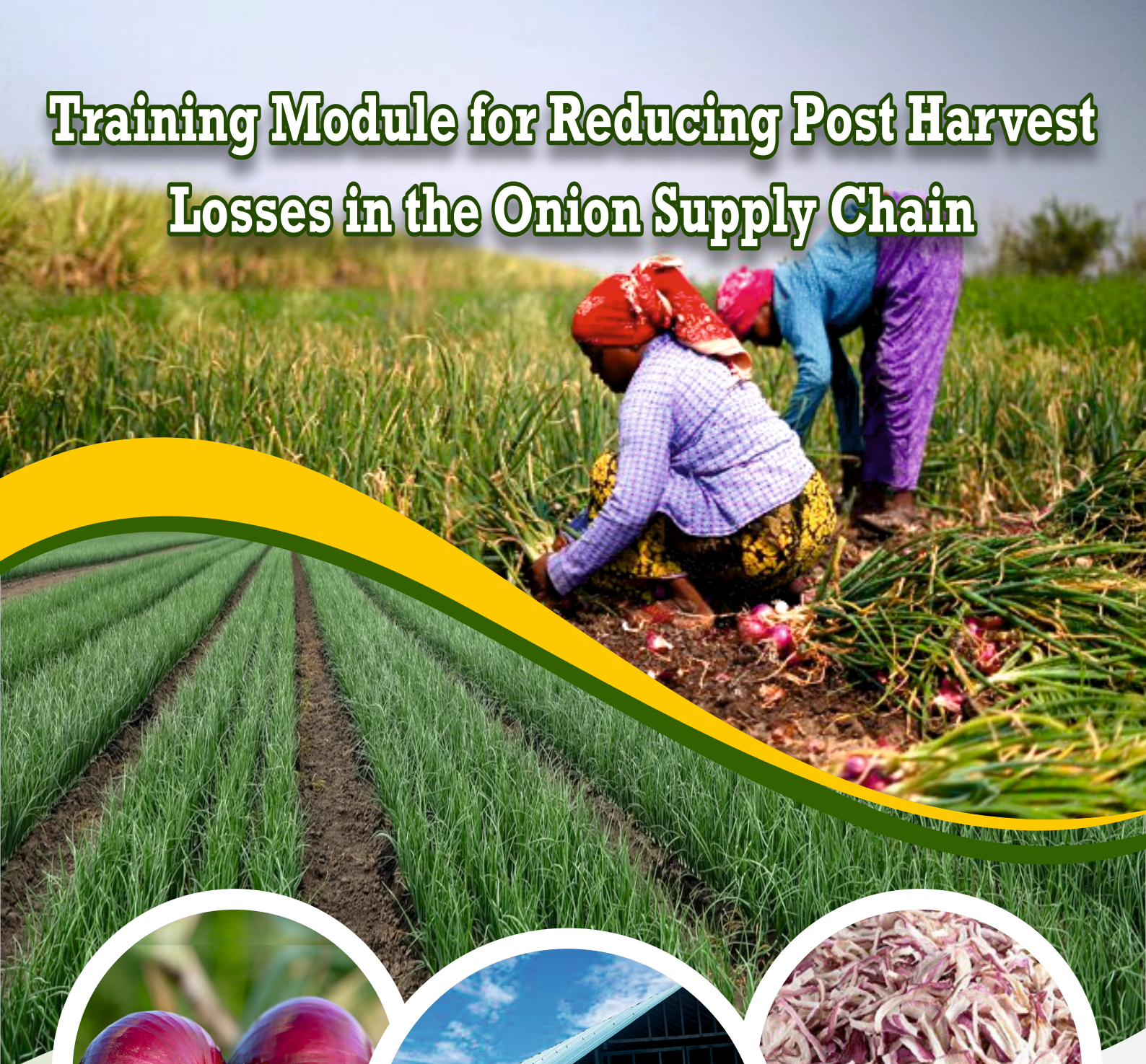
Training Module for Reducing Post Harvest Losses in the Onion Supply Chain





BAIF Development Research Foundation

DOGR

Training Module for Reducing Post Harvest Losses in the Onion Supply Chain

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Introduction

Onion is an important vegetable for Indian culinary system and is consumed year round. India is the leading producer of onions in the world with a share of 28% in the global production[1]. Despite the high production, onion incurs high postharvest losses in India annually as per latest government estimates. [2]Onion postharvest losses significantly impact production, prices, quality, and farmer livelihoods.

WRI India in partnership with BAIF undertook a survey study to assess postharvest losses, causes, and opportunities to reduce postharvest losses in the onion supply chain in Maharashtra. One of the preliminary findings identified is lack of awareness and capacity among farmers on postharvest losses in the onion supply chain. To address this challenge of postharvest losses, this training manual is developed to equip farmers with the knowledge and skills necessary for effective onion postharvest management. This manual aims to:

- Enhance onion farmers' understanding on onion postharvest losses, causes, and postharvest management practices
- Provide technical know -how to assess and minimize postharvest losses in onion
- Promote best practices for improving quality and marketability of onions

Scope

This manual covers essential topics related to the onion supply chain, including:

1. Assessment of postharvest losses
2. Production
3. Harvesting and curing
4. Sorting and grading
5. Storage
6. Value addition
7. Policy and schemes - Maharashtra

Target audience

This manual is designed specifically for onion farmers including small, marginal farmers and women farmers, agricultural extension workers, and other stakeholders involved in onion production and marketing.

How to use this manual?

This manual is designed for self-study and group training. Farmers can use this manual as a reference guide to improve their postharvest management practices. By using this manual, farmers will gain the knowledge and skills necessary to optimize onion production, quality, and marketability.

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[1] FAOSTAT Database 2022-23, (FAOSTAT) accessed on 20th December 2024
[2] NABCONS 2022 (study_report_of_post_harvest_losses.pdf)

Module 1: Assessment of postharvest losses (PHL)

What is postharvest loss?



Postharvest loss is the decrease in the quantity or quality of food resulting from decisions and actions by food suppliers in the segments of the chain excluding retail, food service providers, and consumers[3]. Qualitative losses include those that affect the nutrient/caloric composition, the acceptability, and the edibility of a given product. For example - change in onion colour. Quantitative losses refer to those that result in the loss of the amount of a product, for example - rotted and sprouted onion is discarded.

Why reduce postharvest losses in onion?

Reducing postharvest losses offer multiple benefits[4] for the farmers, such as:

- Improve farmer income through increase in marketable surplus, quality and shelf life of produce. The storage life of onions also increases with the opportunity to sell at better prices.



- Postharvest losses, such as losses during storage lead to mounting distress of repayment of any loan and other household expenses. Small and marginal farmers whose primary source of livelihood is from agriculture can benefit in reducing such risks, distress in the household by minimizing postharvest losses.
- Reducing postharvest loss offers an opportunity of efficient use of our resources. When any produce is lost, all the resources that went into its production (such as - land, water, soil, fertilizer, labour, and seed) are also lost.
- Postharvest loss, especially quantitative loss creates additional work of disposing the discarded produce after spoilt, for example dumping the rotted onion properly to avoid reinfestation in the next season.
- Learnings from onion supply chain can be adapted to other food supply chains. For instance, right instructions and overseeing of labourers during sorting and grading activity.

Postharvest losses in onion occurs due to following reasons.

Bruising, cutting, stem (neck) is cut too close to the top of the bulb susceptible to bacterial and fungal infection, improper harvesting techniques, incorrect harvesting time, inadequate curing.

Improper sorting, negligence from workers, improper handling.

Postharvest weight loss, sprouting, decay loss, poor storage facility, improper curing, handling and transportation, poor packaging, rainfall, duration of storage.

Assessment of PHL

Measurement is critical to understand the scale of the problem, identify hotspots and taking appropriate actions to reduce food loss and food waste. Farmers can self-measure using the following steps -

What you need: Pen and paper, measuring tape, containers, weighing scale, harvesting tool (if any)

[3]FAO, The State of Food and Agriculture 2019; The State of Food and Agriculture 2019
[4]World Resources Institute 2019, Reducing Food Loss and Waste: Setting a Global Action Agenda; Reducing Food Loss and Waste: Setting a Global Action Agenda | World Resources Institute
[5]NABCONS 2022 https://www.mofpi.gov.in/sites/default/files/study_report_of_post_harvest_losses.pdf
[6]NABCONS 2022
[7]NABCONS 2022
[8]Technical Bulletin publish by ICAR DOGR on onion cultivation (Marathi version)

Step 1: Sample

- Select field and then randomly identify 5mx5m plot for measurement. If sampling area is large, take three replication for more accuracy.
- Mark the selected plot.
- Harvest all the produce in the selected plot or collect the produce from each sample separately.

Step 2: Sort, weigh and analyze measured samples

- Determine sorting criteria and sort samples into three categories: marketable (that fetch good returns), edible but not marketable (salable but do not fetch good returns), and inedible (discarded).
- Weigh sample of each category from each sample and record (remember to subtract container weight).

Table 1- Percentage of losses calculation

Unit – kilogram/gram	Sample 1	Sample 2	Sample 3	Average
Marketable				The sum (S1 + S2 + S3) divided by 3
Edible, but not marketable				"
Inedible				"
Total				Average of each category divided by total

- Record in the above format and calculate percentage of each category in the total sampled category to find out percentage of produce incurring quality loss and quantity loss (Using indicated formula in red).

Waste disposal: It is critical to effectively dispose of discarded produce from the supply chain to avoid any negative impacts, including environmental pollution. For example -any infested produce, if discarded in the same farmland can infest the next crop.

Table 2- Waste disposal Do's and Don'ts

Do's	Don'ts
Appropriately compost any discarded produce.	On farm open dumpwhich can increase chances of infestation.
Redirect edible surplus produce to different sources.	Animal feed – the onion peel due to its strong aroma cannot be utilized as a fodder not as fertilizers[9].
Sell or donate edible surplus produce.	Dumping in water body.

[9]Valorisation of peel waste: from trash to treasure https://www.sciencedirect.com/science/article/abs/pii/S0045653523024487#:~:text=The%20onion%20peel%20due%20to,as%20harmful%20to%20the%20environment.

Season - Sowing, transplanting and harvesting timings of onion in Maharashtra shown in Table 1 below.

Table 3 - Onion season in Maharashtra

Sr No	Seasons	Time of sowing	Time of transplanting	Time of harvesting
1.	Kharif	May-June	July-Mid August	October-December
2.	Early Rabi or Late Kharif	August-1st week of September	September –October	Mid of January to end of February-March
3.	Rabi	October- mid of November	December-First week of January	April-May[10]

Varieties

Table 4 - Recommended varieties for Rabi Season

Varieties	Colour	Yield potential (Rabi Season)	Storability
Bhima Shakti	Red	28-30 t/ha	Good (5-6 Months)
Bhima Kiran	Light Red	28-32 t/ha	Good (5-6 Months)
Bhima Red	Red	30-32 q/ha	Medium (3-4 Months)
Bhima Shweta	White	26-30 q/ha	Poor (2-3 months)
Bhima Raj	Dark Red	25-30 t/ha	Poor (2-3 Months)[11]
Arka Niketan	Light Red	34 t/ha	Good (5-6 Months)[12]
Agrifound Light Red	Light Red	30-32 t/ha	Good (5-6 Months)[13],[14]



Bhima Kiran



Bhima Shakti

[10] ICAR-DOGR E-Book- https://dogr.icar.gov.in/images/ebook/ebookdogr.pdf
[11] ICAR-DOGR Technical Bulletin No 21 Improved Cultivation Practices for Onion - https://drive.google.com/drive/folders/1TE_1MQmmjxlCPCTHhdhTfPBoU5F3RdCR
[12] ICAR- Indian Institute of Horticulture Research https://iihr.res.in/onion-arka-niketan-0#:~:text=Light%20red%20bulbs%20of%20medium,5%20months%20under%20room%20temperature.
[13] National Horticulture Board -https://www.nhb.gov.in/pdf/vegetable/onion/oni013.pdf
[14] ICAR - DOGR Technical Bulletin (Marathi version) Onion Cultivation



Bhima Red



Bhima Raj

Table 5 - Production practices Do's and Dont's

Practices	Do's	Don'ts
Production	• Use seedlings of proper age i.e., 50-55 days after sowing. • Before transplanting, dip the seedling roots for 2 hours in the solution prepared with 1 gm of Carbendazim and 2 ml of Carbosulfan per litre of water. • Transplant of seedlings at 10x15 cm spacing.	• Do not use age old seedlings more than 55 days as it results in poor quality yield. • Close planting results in small bulbs whereas wide spacing leads to doubles and thick necked bulbs.
Irrigation	• Irrigate at the time of transplanting, three days after transplanting and subsequently at 7-10 days interval depending upon soil moisture. Rabi crop needs 12-15 irrigations. • Stop irrigation when the crop attains maturity (15-20 days before harvest, when approximately 5% neckfall occurs). • Irrigate through drip irrigation. Drip Irrigation at 100% pan evaporation significantly improve the marketable bulb yield (15-25%) with higher per cent A grade bulbs besides saving 35-40% water and 25-30% labour as compared to flood irrigation.	• Don't do excess irrigation as it increases rotting percentage during storage. • Don't allow the field to dry spell with limited irrigation as it results in splitting of the outer scales and formation of doubles also increases sprouting percentage during storage.
Fertilizer	• Apply essential plant nutrient sulphur as a basal dose at the time of transplanting [15]for improving yield and the pungency of onion bulbs. • Apply NPK @110:40:60 kg/ha. Apply Nitrogen in three splits up to 60 days after transplanting. Apply P, K and S as basal dose. • Fertigation can be done using water soluble fertilizers or nitrogen through urea at 10 day interval after transplanting up to 60 Days after transplanting.	• Don't apply excessive nitrogen (urea) as it leads to soft onion bulbs, wide neck bulbs and make them more susceptible to disease, increases rotting percentage during storage.

15 ICAR-DOGR Technical Bulletin No 21 Improved Cultivation Practices for Onion https://drive.google.com/file/d/1sLc4zwL_Zkjh3cENa7ELQHerFKKLgYYb/view?usp=drive_link

Practices	Do's	Don'ts
Pests and disease management	• Add spreader@0.5-1.0 % to spray solution. • Follow crop rotation practice to avoid fungal viral, bacterial diseases. Practice three years or longer rotation between onion crops to avoid viral diseases. • Apply pesticides in the early morning or late evening to avoid excessive drift (wind is normally lower during these time periods), and to prevent exposing beneficial insects like bees and ladybugs to the effects of them. • Add recommended doses of pesticides and spray using fine nozzle. • Use hand gloves and mask during spraying and wash hands after spraying.	• Avoid repeated application of pesticides belonging to the same class. • Do not go into a treated field until recommended[16]. • Do not use improper doses as it results in por control of diseases and pests and require more sprays.

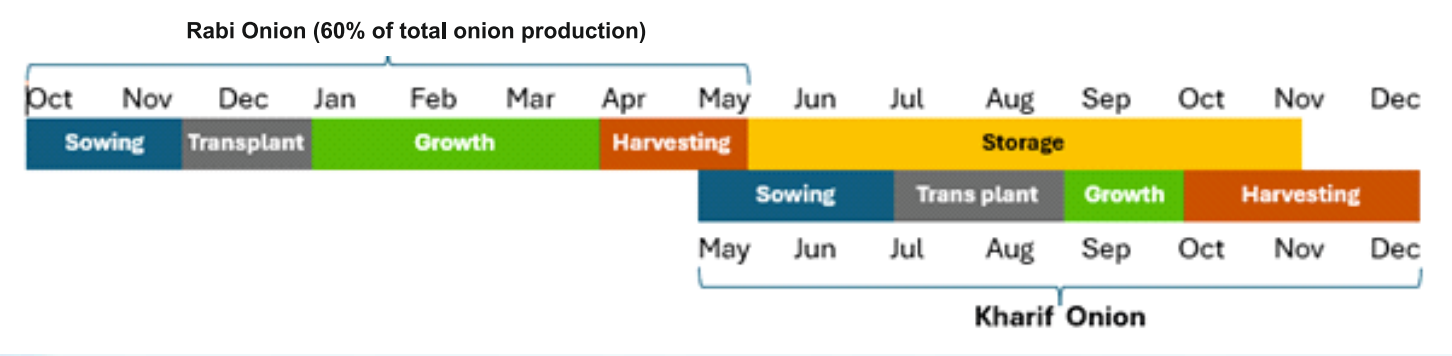
Table 6 - Good practices pre-harvest and post-harvest

Pre-harvest care/ practices	Post-harvest care/ practices
Selection of suitable varieties (season specific, region specific) that prolongs the storage time and capacity.	Proper field curing after harvest for 3-5 days by covering the bulb with leaves. De-topping the bulb by leaving 1-2 inch at the top of the bulb.
Proper irrigation from time to time without any dry spell.	Field curing of 3-5 days followed by Shade curing for 10-14 days.
Application of recommended dose of fertilizers at proper time. Excess application of nitrogen is reported to increases the rotting losses during storage. Use micro nutrients based on soil test report.	Sorting and grading before storage and storage according to grades.
Neck fall is an indicator of maturity stage hence, best time to harvest is at 50%-70% of neck fall maturity.	Disinfection of storage structure before loading of onions. May give sulphur fumigation from the bottom.





16 ICAR-DOGR Technical Bulletin No 21 Improved Cultivation Practices for Onion
https://drive.google.com/file/d/1sLc4zwL_Zkjh3cENa7ELQHerFKKLgYYb/view?usp=drive_link



Harvesting time: For the Rabi onion, ideal harvesting months are April-May.

The condition of onion leaves (Neck fall) and yellowing of leaves is a good indicator of the maturity and general state of the bulb.

Days - Bulbs generally mature within 120-130 days from transplanting, depending on the cultivar and the weather.

Onion crop should be harvested after 50 % - 70% top/neck fall. Bulbs develop from the leaf bases and when the onions are fully formed, the leafy green tops begin to turn yellow and eventually collapse at a point a little above the top of the bulb, leaving an upright short neck. When the tops "go down" in this way, the bulbs are ready for harvesting. Storage losses in crop harvested at optimum maturity are normally lower than those harvested before the top collapse. For attaining maximum storage life, onion harvesting should be done after 50%-70% neck fall. In India, onions are generally harvested manually by digging. It should be done carefully by pulling or digging onions up from the ground with the tops intact and gently shaking the soil from around the bulbs. Care should be taken to avoid mechanical injury to the bulbs during harvest. Stop irrigating at the time of 5% neck fall and about 15-20 days before harvest.

Table 7 - Types of harvesting

Manual harvesting	Mechanical harvesting
• Manual harvesting is most common method used by farmer's currently. • This is normally carried out by levering the bulbs with a khurpi to loosen them and pulling the tops by hand.	• Effective field capacity of the Punjab Agricultural University root harvester equipment was reported to be 0.107 ha/h with 77.60% field efficiency for onion harvesting as soils in Punjab are loamy. • There is saving of 172-man hours/ha by using this machine over conventional method in onion harvesting. • This is faster than hand pulling, reduces labour cost and can be used in large scale farming. • There is Higher initial investment, may damage onions if not used properly.[17]

[17] ICAR DOGR E-Book - https://dogr.icar.gov.in/images/ebook/ebookdogr.pdf



[18]

Tractor operated onion harvester (Reference ICAR DOGR E-Book)

Here are the do's and don'ts for onion harvesting:

Table 8 - Onion harvesting Do's and Don't

DO's	Don'ts
Harvest onions when the tops begin to yellow and fall over (around 120-130 days after transplanting).	Don't harvest onions too early, as they may not cure properly.
At the time of harvesting dry and clear weather is more suitable.	Avoid direct pulling onions out of the ground, as this can damage the bulb.
If soil is hard, use khurpi/kudali to soften and easy harvesting.	Don't leave onions in the field for extended periods, as this can lead to sprouting.
Collect onions during cooler parts of the day (early morning or evening) to reduce risk of sun scald, water loss.	
Harvesting is very easy when cultivated on raised beds.	

Curing (drying): Curing is a drying process carried out to remove excess moisture from the outer skins, roots and neck tissues of harvested onion bulbs. It improves the keeping quality of onion bulbs and reduces the chance of infection by disease causing organisms during storage. The term "curing" is preferred because the removal of moisture is only from the outer scale, rather than from throughout the bulb. After harvesting, onions need to be cured to extend their

[18]ICAR DOGR E-Book https://dogr.icar.gov.in/images/ebook/ebookdogr.pdf

shelf life.Curing need to be done until the neck is tight, and the outer scales are dried until they rustle. The formation of dry skin on the outer surface prevents the water loss from the flesh and obstructs pathogens from entering the bulb. Curing increases hardness of the bulb and also helps to develop colour of the bulb. Onion curing can be done in the field with natural convection of air or with forced circulation of hot air using artificial curing chambers.

Field curing

After harvesting, curing of onion by covering the bulbs with foliage should be done for 3-5 days till foliage turn yellow. Avoid direct sunlight on onion bulbs to reduce sunscald, fading of colour and quality deterioration. After field curing detopping/neck cutting need to be carried out.

Detopping/ neck cutting

The cutting of the onion leaves to separate the bulb is carried out after curing. Generally, the detopping is carried out manually using sickle and it is also a laborious and time consuming unit operation. Detopping by leaving 2-3cm stalk above the bulb is recommended to avoid pathological infections and excessive moisture loss through the neck part during storage.

Shade curing

Shade curing after field curing is essential to remove the field heat and excess moisture from the surface of bulbs before packing, transportation or storage. Shade curing for 10 to 14 days has been recommended for longer shelf life , development of proper colour and to reduce the field heat.

Table 9- Types of onion curing practices

Natural Curing	Artificial Curing
Natural curing is generally preferred for onions, as it helps to preserve their flavour and texture.	Artificial curing should only be used when necessary, and under controlled conditions.
Filed curing has limitation due to unexpected rains during harvesting time.	Artificial curing could be beneficial during wet weather. Mostly in kharif season.
Field curing: by windrow method for 3-5 days till foliage turn yellow is recommended. This makes bulbs firm and dry and helps in improving their shelf life.	Outside air may be used for onion curing or the air may be artificially heated to 24-30°C if outside air is to cool or humid.
Shade curing: after field curing, shade curing is essential to remove the field heat and excess moisture from the surface of bulbs before packing, transportation or storage operation. After 3 days of field curing, the tops should be removed leaving 2.0-3.0 cm stalk above the bulbs. And bulb should be shade cured for 10-14 days days in a heap of 3-4 feet height for better storage.	During this forced ventilation, the bulbs should lose 3-5% of their pre-storage weight, the neck should become dry and the outer scales brittle. Over-curing will cause excessive loss of outer scales and weight loss and excessive humidity or temperature during curing may cause staining the outer scales and rotting of bulbs in storage.

Table 10 - Onion curing

Do's	Don'ts
· Cover the onion bulbs with leaves properly. · Practice windrow method for proper field curing.	Don't cure onions in direct sunlight. Direct sunlight can degrade quality of onions, as it increases the cracking on the outer.

Module 4: Sorting and grading

Sorting

Removing the undesirable material and rotted, sprouted and under sized bulbs at the time of storage as well as during the storage will keep the onions clean and reduce damage to onion bulb during storage. The thick neck, bolted, doubles, injured and decayed bulbs and also deformed bulbs are removed.

Grading

Onions after curing are graded (manually/ mechanically) before they go in to storage or or marketing. Grading onion before storage will be beneficial for fetching better market price.

The grading specifications are different according to consumer preference, varietal characters etc. the common Indian onion is generally graded in three grades i.e. A, B and C. The A grade should have more than 60 mm diameter, while B and C grades should be of 50-60 mm and 35-50 mm diameter, respectively. ICAR-DOGR has developed manual and motorized grading machines for grading of onion bulbs. Mechanical grading can significantly reduce the drudgery of women[19].

Market preference: Different grade requirements.

Export: 40-60mm Gulf Countries, Mauritius).

35-40 mm South East Asian countries and Nepal

30-35 mm Bangladesh

40-45 mm Sri Lanka

>60 mm European Countries

Domestic market: 50-60 mm (General Demand), 60 mm (Urban/metro cities)[20]

Local market - Varies depending on prevailing prices

Hotels restaurants and catering - Higher preference to Grade A(>60mm) and Grade D (<30mm and Joint onions) of onions because of size and price advantage in the market.



[19]ICAR-DOGR Technical Bulletin 21 Improved Cultivation Practices for Onion https://drive.google.com/drive/folders/1TE_1MQmmjxlCPCTHhdhTfPBoU5F3RdCR

[20]Onion Grading in India Dr PC Tripathi Senior Scientist NRC for Onion & Garlic punehttps://www.researchgate.net/publication/304791556_Onion_Grading_in_India

Methods of grading:

Table 11 - Methods of grading

Manual	Mechanical (manual operated and motorized)
This method not suitable for large scale farming but still a common practice.	The grading with machine reduces labour charges and increase precision.
70% accuracy average.	90% accuracy.
This is labour intensive method.	Mechanical grading is significantly faster than manual grading.
Low initial investment, low maintenance cost.	High initial investment, high maintenance cost.
Manual grading requires minimal energy, as it relies on human labour.	Need high energy.
It requires higher labour and less precision.	Lack of availability of proper grader and cost of grader are the main concern.

Onion grader developed by ICAR-DOGR



Manual onion grader

[21]Capacity: 1.0 /hr. /2 person



Motorized grader

Capacity 1.5 - 2t/ha/person





[21]National horticultural research and development foundation http://www.nhrdf.com/pExport_o.html
Commodity profile on onion prepared by Raka Saxena and Rohit kumar and consultancy project coordinated Dr Shivkumar https://agmarknet.gov.in/Others/Onion.pdf
Citrusfrieght.com step by step guide on how to export onion from India https://www.citrusfreight.com/resource/blog/how-to-start-onion-export-from-india
Good Agricultural practices in onion and Garlic
Productionhttps://www.google.com/search?q=ebook+dogr&oq=ebook+dogr&gs_lcrp=EgZjaHJvbWUyBggAEEUYOTIHCAEQIRigATIHCAIQIRigATIHCAMQIRiPAjIHCAQQIRiPAtIBCDI5MTZqMGo3qAIIsAIB&sourceid=chrome&ie=UTF-8

Module 5: Storage and packaging

Storage is imperative to ensure availability of onions throughout the year. It is identified as a critical loss point with high moisture loss, sprouting and rotting.

In contrary to other vegetables, onion under ambient storage requires high temperature and low relative humidity conditions for longer storage life. Temperature of 25-30°C and relative humidity of 60-70% is recommended for longer storage life. Low temperature and high relative humidity increases the sprouting whereas high temperature and low relative humidity increases the weight loss. High temperature and high relative humidity conditions increase the rotting of bulbs during storage.

Various types of naturally ventilated onion storage structures were designed and constructed at ICAR-Directorate of Onion and Garlic Research, Pune. These structures (Fig.1&2) vary in their capacity and cost to fulfil the requirements of all income groups of farmers/traders. Onion is stored in bottom and side ventilated type of structures recommended by ICAR-DOGR in major parts of Maharashtra. Maharashtra government also provides subsidy for constriction of this storage structure as shown in figure 2. The size of structure can be decided upon the area and production as in one cubic meter 5 to 7 quintals of onion can be stored.



Fig 1. Low volume storage (5 MT)



Fig 2. High volume storage (50 MT) structure

Table 12 – Good practices for onion storage

Good practices for onion storage
• The site selected for onion storage structure should be well drained and should be easily accessible to good road. Ill drained and deep site should be avoided. • Onion storage structure should be naturally ventilated from lower and other sides. • There should not be tall civil work close to structure. It should be 1.5 times the height of onion storage away from onion storage structure. • The width of onion storage structure should be 610 cm for natural air circulation. In high humid areas width of storage structure should be less otherwise there should be provision of mechanism for air circulation [22]. • North-South orientation for single-row structures and an East-West orientation for double-row structures, ensuring proper ventilation and minimizing storage losses • The length of onion storage structure should be right angle to the direction of wind (East-West). Length of double row structure should not be more than 40 feet whereas there is no limit for single row structure. • Windward side of storage should have closed system during storm and heavy rain and opening facility when necessary. During storms and heavy rain windward sides of storage should not be open. The sides of the roof should be sufficiently forwarded to avoid rainwater and to resist heat. The sides should not be short. • There should be heat resistant material at the upper side of the roof of onion storage structure. Do not

[22] 1. Model_SchemeforOnionStorage.pdf

use galvanized iron sheets for the roof.
- Onion should NOT be washed before storing.
- Maintenance of stacking height to 100 cm for small and multiplier onions and hot weather and 120 cm for mild weather and for big onions to avoid pressure bruising.
- Providing cubicles instead of continuous stack and sufficient space for ventilation from all sides.
- Construction of more units instead of a single big structure in a zigzag manneris suggested instead of a single big structure.
- Avoid storing onion with other fruits and vegetables.
- Ensure proper hygiene in onion storage structure.
- Height of the bottom should be about 1.5 feet.
- Use wooden bottom or bamboo for side and bottom for construction.

Various abiotic factors like temperature, relative humidity affects the health of onions hence their balance must need to store the crop with minimum losses.
- High temperature (Above 32°C) + Low RH (Less than 60%) = **Weight loss**
- Low temperature (0 - 10°C) + Low RH (Above 70%) = **Sprouting**
- High Temperature (Above 32°C) + High RH (Above 70%) = **Rotting**
- Temperature (25-30°C) + RH (60-70%) = ***Recommended*** OR *Temperature (0-2°C) + RH (65-70%) = ***Recommended (Cold storage)***

Table13- Dos and don'ts in onion storage (Traditional/ naturally ventilated)

DO 's	Don'ts
Suitability of site with proper elevation, drainage and linkages by road.	Site in a low lying area with poor road communication must be avoided.
Adequate bottom and side natural ventilation facilities should be provided.	Any obstruction to the natural ventilation should be avoided or minimized.
No tall structures should be located nearer to the onion sheds.	Tall structures within a distance of 1.5 times the height of onion storage structures should be avoided.
For natural ventilation, storage width should be restricted to 610 cm. In the areas having high humidity, the storage width may be reduced/ necessary mechanical ventilation provision may be made.	Wider storage structures should be avoided.
Double row onion storage structures should be oriented to face wind ward direction.	Structures along the wind direction should be avoided.
Leeward side wall opening below the platform should be closed when there is high temperature.	Where storms and cyclones are expected, leeward side should not be closed when windward side is open.
During storm/ heavy rains, provision should be made to close the windward side and wherever necessary to open the leeward side.	During storm/ heavy rains, windward side should not be kept open.
Adequate overhang should be provided at the roof to prevent splashing of rainwater or sunlight falling on the onion.	Structures with small overhangs should be avoided.

Do's	Don'ts
The roof of material should prevent heat built-up at the top of the structure. Length of double row strutcture should not be more than 40 feet. If length is more the aeration to back side will not be proper Centre height should be up to 8-10 feet for proper ventilation. Approximately one inch gap should be maintained between each bottom or bamboo at side and bottom wall. Less gap affects air circulation whereas more gap leads to spilling of onion from storage.	Roof materials like corrugated GI sheets should be avoided.

Table14- Cold storage

Advantages	Disadvantages
Storage of onion bulb in cold store with optimum relative humidity extends shelf life of onion bulbs and reduces postharvest losses for 4-5 months.	Cold storage facilities may not be readily available in all areas, particularly in rural regions.
Optimal storage temperature in cold storage is 0-2° with 65-70% relative humidity. Under this condition storage losses after six month are only about 5%.	Very low temperature (<2 °C) may lead to freezing injury and high temperature (2-25°C) couples with high relative humidity (>75%) may cause rotting or sprouting.
Cold storage can extend the storage life of onions from 3-4 months to 6-8 months.	Cold storage requires a significant initial investment in equipment, infrastructure, and maintenance.
The use of gamma irradiation (cobalt 60) controls sprouting completely.	Cold storage requires a constant supply of energy to maintain the desired temperature, which can increase energy costs. Fluctuation in temperature to 4-5°C cause's lot of sprouting in onion. Although gamma irradiation checks the sprouting in cold stored onion but the gamma irradiation facilities are available at few places[24],[25].
Onion can be very well stored in cold storage.	Irradiated onion bulbs are not suitable for seed production crop.
	Preconditioning is required before taking out onion from cold storage to avoid condensation due to temperature difference in storage and outside environment. Chances of post-storage losses are high if not properly pre-conditioned. Cold stored bulbs are prone to sprouting within 8-10 days after removing from cold store.

[24]On Farm Storage Of Onion And Garlic: Success Story K.E. Lawande And P.C. Tripathi https://krishi.icar.gov.in/jspui/bitstream/123456789/17949/1/Final-SUCCESS%20STORY%20ON%20ON%20FARM%20%20STORAGE%20OF%20ONION%20%26%20GARLIC.pdf

[25]ICAR DOGR technical bulletin no 21 Improved Cultivation practices for onion https://drive.google.com/file/d/1mFBGPZEQPP0TU3Sn9_EWfyOQOITLTxLE/view?usp=drive_link

Irradiation of onion:

Object of irradiation is to control losses due to sprouting of onions during prolonged storage. Sprouting issue can be controlled by using irradiation technique with low dose: 0.06-0.2 k Gray. Benefits include economic gain due to reduced sprouting losses which could be as 10 - 15%.

Packaging

Bulbs need to be stored in 40-50 kg jute (hessian) bags, gunny bags, plastic netted bags or plastic and wooden baskets for better storage. Most of the farmers are using plastic/nylon netted bags for domestic as well as export purpose because these bags are more economical, easily available and attractive and can be reused after disinfection.

Table15- Types of packing material use for Onion

Type	Capacity per unit	Benefits	Drawback
Jute bag	40 kg	Durable	Single use
Leno bag	5,25,40 kg	Cost is low	Multiple use
Plastic crate	10 -40 kg	Multiple use, Stakability	Heavy Weight
Packaging specification Onion export			
Jute bag (Hessian Material)	1/5/40 kg	Versatile and less liable to breakage or tearing but may not reuse.	Flammable but not release noxious fumes or dangerous gases when burnt.
Leno bag (Polypropylene)	1/5/40 kg	Breathability, light blocking, reusable, onion visible from all sides.	Higher initial cost compared to plastic bag[23] Emits harmful gases when burnt.







[23]Packaging Specification for export of onion https://apeda.gov.in/apedawebsite/six_head_product/Brochure_05_Onion_&_Potatoes.pdf

Module 6: Processing and value addition



Value addition at the farm level offers a transformative solution by creating new revenue streams for farmers. Processing onions into value-added products such as flakes, powder, paste, and peeled onions enables farmers to diversify their income sources[26]. Instead of relying solely on selling raw onions at fluctuating market rates, farmers can produce higher-margin products that cater to premium markets, including food businesses, restaurants, and export businesses. Value-added onion products not only secure better financial returns but also position farmers as active participants in the broader agri-food value chain besides generating additional employment.

Value-addition of onions can be beneficial in various ways, like[27] :

- **Reduced market dependency-** During lean period farmers can store and sell value-added products over a longer period, avoiding losses during market glut and when prices are low specially during April-June.
- **Increased profit margins-** Processed onion products often fetch higher price compared to raw onions, significantly boosting returns.
- **Access to niche markets-** Export opportunities and demand from urban consumers for convenience products like peeled onions and paste can unlock untapped markets.
- **Livelihood generation**- On-farm processing units can create employment opportunities.

Challenges include -

- Suppliers require a minimum scale of processed products, which is difficult to meet for one farmer. So, there is a need for collectivization of farmers to sell processed products.
- There is a need for standardized quality and continuous supply of produce by suppliers. It is important for farmers to ensure proper process, quality checks to deliver required criteria consistently.
- Marketing is critical to ensure continuous market, profitability and business growth.



1 . Onion drying/ dehydration

1.1. Description- Dehydration is a key method for preserving onions, involving the removal of free water to prevent the growth and reproduction of microorganisms. The dehydration process involves applying heat to evaporate water and efficiently removing moisture-laden air from the drying chamber. Typically, onions are dried from an initial moisture content of approximately 86% (wet basis) to around 7% or less. This significantly enhances their shelf life, making them suitable for long-term storage and global trade. Dehydrated onions, available as flakes or powder, are high-demand commodities in

[26]Kiran, P. R., Aradwad, P., TV, A. K., Nayana N, P., CS, R., Sahoo, M., ... & Mani, I. (2024). A comprehensive review on recent advances in postharvest treatment, storage, and quality evaluation of onion (Allium cepa): Current status, and challenges. Future Postharvest and Food, 1(1), 124-157.
[27]Gulati, A., Wardhan, H., & Sharma, P. (2022). Tomato, onion and potato (TOP) value chains. In Agricultural Value Chains in India, edited by Gulati, Ganguly and Wardhan, 33. https://link.springer.com/book/10.1007/978-981-33-4268-2

international markets. India, as one of the largest producers of dehydrated onions, plays a vital role in global trade, with major importers including the UK, Japan, Russia, Germany, Netherlands, and Spain. These products are extensively used in the food processing industry for convenience and flavour enhancement, offering significant export potential[28] and also in domestic market in hotel industry, sauce and other spice product preparation.

1.2. Varieties that can be processed- White onion with total solid content 15-20% and having high pungency is strongly recommended. Some examples of acceptable Indian varieties are

1.3. Pusa Shobha from ICAR-IARI, New Delhi, Agrifound White from NHRDF, Nasik, Punjab-48 from PAU, Ludhiana, Arka Yojith [29] from IIHR, Bengaluru [30] , Bhima Shubra, Bhima Safed, Bhima Shweta from ICAR-DOGR , Phule Safed from MPKV, Rahuri.

1.4. Process-

Peeling/ topping/ tailing

⇩

Washing/ sanitization

⇩

Slicing (size reduction 1/8 - 1/4" thickness)

⇩

Osmosis (1-3% brine, 30 min)

⇩

Drying of onion slices (50 - 70 °C for 8-10 hr)

⇩

Onion flakes (can be ground to onion powder)

⇩

Packaging



1.5. Products that can be prepared- Onion flakes, onion powder. Onion flakes & powder can be used in soups, sauces, salad sprinkles, seasoning, pizza and others.

1.6. Shelf life- Approximately 1 year.

1.7. Output- 10kg of onion produces around 1 to 1.5kg of dehydrated onion[31] depending upon the total soluble solids of the onion.

1.8. Costing of drying- ₹37 to ₹59 per kg onion (solar drying)[32]

1.9. Export category- Onions, Dried, Whole / Cut / Sliced / Broken/In Powder But Not Further Prepared.

1.10. Key actors- Aarkay Food Products Ltd.

- Chhatariya Foods Pvt. Ltd.
- Coduras Exports Ltd.
- Jain farm fresh
- Euro Foods Industries
- Gujarat Dehyd Foods Ltd.
- Jain Irrigation Systems Ltd.
- L M P Gujarat Agro Exports Ltd.
- Orient Vegetexpo Ltd.
- S Y P Agro Foods Ltd.
- Tirupati Vegpro (India) Ltd.
- Many industries at Mahua, Bhavnagar, Gujarat

1.12. For more details :

- ICAR-DOGR
- ICAR-IIHR
- NIFTEM Institutes (Sonipat, Thanjavur)
- CFTRI, Mysore
- BAIF



[28]Mitra, J., Shrivastava, S. L., & Rao, P. S. (2012). Onion dehydration: a review. Journal of Food Science and Technology, 49, 267-277. https://link.springer.com/article/10.1007/s13197-011-0369-1

[29] [30]Indian Institute of Horticulture Research https://www.iihr.res.in/arka-yojith-white-onion-variety-developed-dehydration

[31]Richter, B., Selvendiran, P., Birner, S., & Larson, W. (2010). Water footprint assessments of dehydrated onion products of Jain Irrigation Systems Ltd - A report by IFC (https://documents1.worldbank.org/curated/en/772821468260360307/pdf/564590WP0Med1J10Box349496B01PUBLIC1.pdf)

[32]Savitha, S., Chakraborty, S., & Thorat, B. N. (2023). Drying of onion shreds in corrugated electric and solar-conduction dryers: Techno-economic evaluation and quality degradation kinetics. *Drying Technology,* 41(11), 1859-1877.(https://doi.org/10.1080/07373937.2023.2198592

2. Onion paste

2.1. Description- Onion paste is a semi-solid product that preserves the natural color, flavour, and freshness of onions. It is a ready-to-use form of processed onion, ideal for quick and convenient meal preparation. Onion paste can be made from either boiled or fried onions or serves as a versatile ingredient in gravies, curry bases, and flavouring for both vegetarian and non-vegetarian dishes. Onion paste and puree can be stored under refrigeration for more than six months when packaged and preserved correctly. Proper packaging and storage are essential to maintaining its color, flavour, and microbial safety. The availability of onion paste as a ready-to-use product not only enhances ease of cooking but also reduces overall meal preparation time, making it a valuable addition to the processed food market.

2.2. Varieties that can be processed- Red onion, white onion.

2.3. Process-

Peeling/ topping/ tailing
↓
Washing/ sanitization
↓
Grinding/ pulping
↓
Heating @ 110 °C and addition of preservatives
↓
Hot filling @75 - 80 °C
↓
Cooling and storage



2.4. Products that can be prepared- Onion paste, onion puree, onion juice, onion sauce, onion ketchup, onion vinegar.

2.5. Shelf life-Up to 20 days at refrigerated conditions (± 5 °C)

2.6. Output- 1 kg of fresh onions produces approximately 800–900 grams of onion paste. The slight weight loss (10–20%) occurs due to peeling, trimming, and removal of waste parts like roots , disc, and dry outer layers[33].

2.7. Export category- Other Vegetables & Mixtures of Vegetables, Prepared/ Preserved Otherwise Than By Vinegar/ Acid

2.8. Key actors-
- Hotwani Foods Pvt. Ltd.
- Pellagic Food Ingredients Pvt. Ltd.
- Jain Farm Fresh Food Ltd.
- ADF Foods Ltd.
- Vimal Agro Products Pvt. Ltd.
- Neo Foods Pvt. Ltd.
- MTR Foods Pvt. Ltd.
- ITC Limited (Foods Division)
- Desai Brothers Ltd. (Food Division)
- Mala's Fruit Products Pvt. Ltd.

2.9. For more details
- ICAR-DOGR
- ICAR-IIHR
- NIFTEM Institutes (Sonipat, Thanjavur)
- CFTRI, Mysore
- BAIF

3. Onion peeled/ sliced

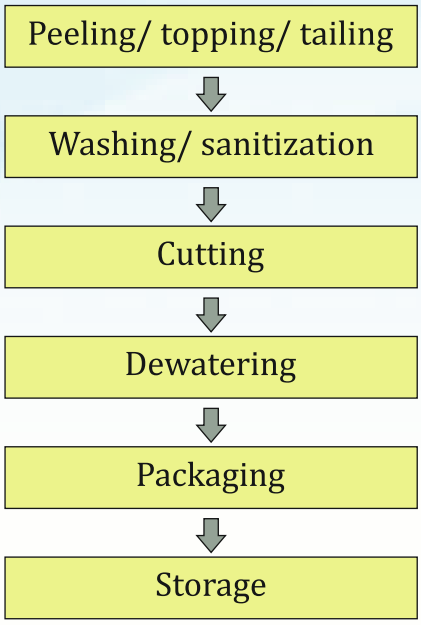
3.1. Description- Fresh peeled and cut onions are ready-to-use products designed to retain their freshness. They are packaged in suitable materials and stored under refrigerated or frozen conditions to ensure quality and extend shelf life. The demand for these products has risen significantly due to the convenience they offer, particularly for busy households and commercial kitchens. This market segment caters to consumers seeking fresh-cut, ready-to-eat, or ready-to-use onion products that enhance ease of use and save preparation time.

[33] Vasipalli, P., Parihar, P., Jain, P., & Mahajan, K. C. (2020). Standardization of a process for development of onion paste. IJCS, 8(2), 1301-1305. (https://doi.org/10.22271/chemi.2020.v8.i2t.8945)

Additionally, peeled and cut onions serve as raw materials for a variety of onion-based products, further expanding their utility. However, cutting fresh onions can cause mechanical injuries that trigger biochemical reactions, leading to potential quality changes during storage. Therefore, maintaining optimal packaging and storage conditions is critical to preserving their freshness, flavour, and overall quality throughout their shelf life.

3.2. Varieties that can be processed- Red onion, white onion, yellow onion.

3.3. Process-



3.4. Products that can be prepared- Peeled/ sliced onion (fresh or frozen), onion pickle, vinegar onion, canned onion.

3.5. Shelf life - Up to 20 days at refrigerated conditions (± 5 °C)

3.6. Output - 1 kg of fresh onions produces approximately 800–900 grams of peeled/sliced onion. The slight weight loss (10–20%) occurs due to peeling, trimming, and removal of waste parts like roots, discs and dry outer layers.

3.7. Costing of drying - NA

3.8. Export category - NA

3.9. Key actors-

- K. K. Exports
- Shreeji Dehydrates Pvt. Ltd.
- Mala's Fruit Products Pvt. Ltd.
- Parakh Agro Industries
- Sambavan Exports
- Jain Farm Fresh Foods Ltd.
- Vimal Agro Products Pvt. Ltd.

3.10. For more details

- ICAR-DOGR
- ICAR-IIHR
- NIFTEM Institutes (Sonipat, Thanjavur)
- CFTRI, Mysore
- BAIF





Table16- Policies and scheme (leaflet)

Policy name	Stage	Region	Implementation	Year (active)	financial support (yes then how much/no)	Material support (yes then what/no)	Criteria (smf, sc, st, women, qual)	More details (link)	Portal To Apply
Operation greens (Promote FPOS, agri-logistics, processing facilities and professional management)	Production (Better price realization to farmers reduced wastages, affordability of products for consumes)	Central	Ministry of Food Processing Under NAFED (National Agricultural Cooperative Marketing Federation of India.) E-Nam	2018-28	Short Term Intervention – 50% subsidy on transportation from surplus to deficient market -50% subsidy on storage, including cold storage		Food Processor, FPO, FPC, Cooperative Society, Exporter, state marketing / cooperative federation, Retailers, licensed commission agent	https://sampada-mofpi.gov.in/ https://www.mofpi.gov.in/Schemes/about-operation-greens	SAMPADA portal of the ministry.
Capital Investment Subsidy for Construction / Expansion / Modernization of Cold Storages and Storages for Horticulture Products	Cold Storage	Central	Agriculture Department National Horticulture Board	2005 - ongoing	credit linked back-ended subsidy at the rate of 35% of the capital cost of the project in general areas and 50% in case of North East, hilly & scheduled areas		storage of capacity above 5000 MT (and up to 10000 MT is available	https://pib.gov.in/PressReleasePage.aspx?PRID=2042243 https://mahadbt.maharashtra.gov.in/Farmer/SchemeData/SchemeData?str=E9DDFA703C38E51AC7B56240D6D84F28	MahaDBT Portal
Mission for Integrated Development of Horticulture	Low cost onion Storage 25 metric ton	Central	Agriculture Department	2014-ongoing	50% of project expenditure or minimum 3500 per metric ton		Farmer should have 7/12 certificate and 8–A certificate. Adhar card FPO, SHG, Farmers group	https://mahadbt.maharashtra.gov.in/Farmer/SchemeData/SchemeData?str=E9DDFA703C38E51AC7B56240D6D84F28	Maha DBT Portal

Policy name	Stage	Region	Implementation	Year (active)	financial support (yes then how much/no)	Material support (yes then what/no)	Criteria (smf, sc, st, women, qual)	More details (link)	Portal To Apply
Pradhan Mantri Sukshama Anna PrakriyaYojana (PMFME)	Processing	Central	Agriculture Department	2020-21 2024-25	35% of total project expenditure maximum 10 lakh		Farmer should have own /rental land for processing (dehydrated onion)	https://www.pmfme.mofpi.gov.in/pmfme/	MahaDBT Portal
Pradhan Mantri Krishi Sinchan Yojana - More Crops Per Drop (Micro Irrigation Component)	Drip Irrigation	Central	Agriculture Department	2021-2026	1) Small and Marginal Farmers – 55% subsidy amount is applicable. 2) Other Farmers – 45% subsidy amount is applicable.	After the farmer receives pre-sanction, he/she should purchase the micro-irrigation set from authorized seller and distributor, install it on the field and upload invoices of the purchase made within 30 days after receiving pre-sanction.	The facility is given only for 5 hector area. Farmer should have Aadhaar Card. Farmer should have 7/12 certificate and 8–A certificate. If farmer belongs to SC, ST caste category then required caste certificate. Farmer should have permanent electric connection for electrical water pump motor. For this, farmer should submit recent copy of electricity bill.	https://www.pmksy.gov.in/	MahaDBT Portal

Policy name	Stage	Region	Implementation	Year (active)	financial support (yes then how much/no)	Material support (yes then what/no)	Criteria (smf, sc, st, women, qual)	More details (link)	Portal To Apply
Sub-mission on Farm Mechanization	Financial Assistance for Procurement of Agriculture Machinery and Equipment **(Onion Harvester)**	Central	Agriculture Department	2014 – ongoing	Rs. 0.15 lakh per unit For SC, ST, Small & Marginal farmers, Women and NE States beneficiary Rs. 0.12 lakh		The Subsidy is payable for only one component i.e. Tractor or Device/Equipment to the farmer. If farmer belongs to SC, ST caste category then required caste certificate.	https://mahadbt.maharashtra.gov.in/Farmer/PDF/Scheme-SubMissionOnFarmMechanization.pdf	MahaDBT Portal
PM Fasal Bhima Yojana	Crop Insurance (Provides comprehensive insurance coverage against crop loss on account of non-preventable natural risk	Central	Agriculture Department	2016	Actuarial/bided premium but uniform maximum premium of only 2%, 1.5% and 5% to be paid by farmers for all Kharif crops, Rabi Crops and Commercial/ horticultural crops respectively		All farmers growing notified crops in a notified area during the season who have insurable interest in the crop are eligible	https://pmfby.gov.in/pdf/New%20Schemes-english .pdf https://pmfby.gov.in/faq	PMFBY Portal , Bank Branches, CSC Centers
Subsidy Scheme for Export of Agriculture Commodities by Sea Route Transport and Marketing Assistance (TMA) scheme for agricultural exports by sea	Onion export by sea route to Mauritius	Maharashtra State Agricultural Marketing Board	Maharashtra State Agricultural Marketing Board	2019-31 March 2026	Rs. 50,000/- per container (20 feet/40 feet) as subsidy. The maximum subsidy per beneficiary will be Rs. 1 Lakh per year.		Co-operative Society, Farmers' Producer Company, company, firm, exporter, and farmer registered in Maharashtra.	https://www.msamb.com/Schemes/ExportScheme	APEDA Website



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