Onion and Garlic Storage for Value Addition and Supply Chain Management

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Onion and garlic are important spice commodities consumed in India almost every day in every house. Unlike other vegetables, their requirement is daily in the kitchen and therefore augmentation of daily supply in the market at reasonable prices for both produces as well consumers in highly essential. However, they are harvested once or twice in a year. Unless stored for some time, daily supply, irrespective of season is not possible. Therefore, storage of onion and garlic becomes inevitable for regular supply to consumers as well as value addition for farmers and exercising control over price fluctuations.

Need for storage

India produces amount 187 lakh tons of onion. Among the total production 71% is used for domestic consumption, 20% goes as waste during storage and handling, 5% is used for export, 3% for processing and 1% bulbs are used for seed production. The country needs almost 11 lakh tons of onion every month. Garlic production is to the tune of 12.97 lakh tons. About 90% garlic is consumed domestically.

The total production of onion is available in three different seasons. About 20% production is from kharif crop in the month of Oct-Nov., 30% onion is available as late kharif crop during Jan-Feb., and 50% produce is available as rabi crop or main crop countrywide during April-June. Kharif and late kharif produce is consumed during one or two months as there is heavy demand for domestic market as well as export and therefore does not require storage. Further, the produce of kharif and late kharif has no storage capacity and hence required to be marketed immediately. Rabi harvest is in April-June and is in high quantity available countrywide.

Since availability and supply is more, the rates are low from April to July. Since, there is no next harvest till November, these bulbs need to be stored for augmenting regular supply till November and further till February if kharif fails due to monsoon vagaries. The farmers, if they sale during April to July are looser as the prices are low, the need to store their produce to add value on it.

In case of garlic, it is harvested from March-May almost all over major producing belts. Almost 90% produce is required to be stored for continuous supply till next harvest. Therefore, storage of onion and garlic becomes absolutely necessary for management of supply chain, price stabilization for consumers and value addition for farmers. Therefore country needs to store around 60 lakh tons of onion and 8-10 lakh tons of garlic.

Reason for price fluctuations

Country needs about 11 lakh tons of onion every month for domestic consumption. However, harvests are in limited months. In Oct-Nov 37 lakh tons is available, in Jan-Feb 56 lakh tons is available and about 94 lakh tons is available in April-June. If kharif fails prices start shooting up right from September onwards. If late kharif fails, the prices increase beyond imagination till March. If late kharif is good and there is bumper harvest, the prices crash down from Feb to July. If the area is low in rabi due to policy of irrigation water, if rabi crop is damaged by pre-monsoon rains, hailstorms and if storage is low, the prices rise right from August till next harvest is available. In augmenting regular supply vis-a-vis price stabilization, scientific management of onion production in all the three seasons and storage of rabi onion is highly essential. Productivity of kharif onion in Maharashtra, Karnataka, Tamil Nadu, Rajasthan and Madhya Pradesh need to be ensured as per recommendations of DOGR, Rajgurunagar, selection of correct varieties, planting on raised beds and drip irrigation ensures higher

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productivity in kharif onion. There is need for national demonstrations through front line demonstration schemes. Late kharif crop is good in quality with bumper harvest. It should be diverted to export as there is a critical gap in supply of onion during these months in importing countries. Rabi onion is the mainstay in the country. Ensuring higher productivity of good storage varieties developed by DOGR through bed planting and fertigation technique and storage about 60 lakh tons of onion and 8-10 lakh tons of garlic will ensure nation for a steady supply with price control vis-a-vis high remuneration to farmers (Fig. 1 & Fig. 2).

Nature of storage losses

Onion and garlic both are living commodities and respire minutely. Any respiration commodity losses energy in the form of water besides some metabolic changes also occur during post harvest storage. Generally, these types of losses occur in both onion and garlic. In case of rabi onion weight loss is to the tune of 20-25% depending on variety and storage environment. Rotting losses due to storage diseases are 10-12% and sprouting losses 10-12%. In kharif onion rotting and sprouting losses are to the tune of 50-60% and therefore kharif onion need to be marketed immediately.

In the case of garlic total storage losses are 10-12% due to weight loss, and decay due to various diseases.

Factors affecting storage life of onion and garlic

The storability of onion and garlic is influenced by several factors such as genetic makeup of the varieties, pre and post harvest management practices, growing season and storage environment. The genetically controlled factors, which may influence the storage performance, include dry matter content and pungency, skin colour, number of adhering scales and length of natural dormancy period of the variety. The pre harvest factors, which contribute to storage quality includes the nutrient management, levels and types of irrigation, foliar application of growth retardants and fungicides. The time and method of harvesting, curing, storage environment and packing materials also have considerable impact on storage life of the onion besides growing season also plays important role in storage. An integrated approach right from selection of varieties, balanced nutrition, time schedule of application of nitrogenous fertilizers, balanced use of irrigation water, field and shade curing of bulbs and proper storage environment helps in reducing storage losses from 50 to 20% in onion and 20-10% in garlic. Onion stored in kharif do not store well, rabi season onion can be stored for 4-6 months. Similarly late kharif produce can also be stored very well.

1. Genotypes

The inherited qualities, which lead to give good storage life of onion, are high dry matter content, pungency and long dormancy. The varieties having several layers of dry skin have better chances of performing well during storage. It is found that the rabi season produced onion have better storage life than kharif and late kharif produced onions. As far as the size of bulbs is concerned, the medium size (50-60 mm diameter) and thin necked onion perform better in storage than bigger and smaller onions. The light red coloured varieties have better storage life. Therefore light red colour cultivars, such as N 2-4-1, Arka Niketan, Agrifound Light Red, Bhima Kiran, Bhima Shakti have better storage life. Dark Red coloured varieties grown in kharif have poor storage. In case of garlic G 41, Bhima Omkar, Bhima Purple has better storage than other genotypes.

2. Cultural Practices

The cultural practices during crop growth and development and bulb maturity stages affect the storage life of onion and garlic. Among them, fertilizers, irrigation, time of harvest etc. play significant role in post harvest storage life of both the crops. A sufficient quantity of organic manures added during field preparation to enhance storage life. The excessive nitrogen application has been found to increase the rotting in storage and produce thick neck in onion which is more prone to storage losses. Application of higher degree of nitrogen particularly in the later stage of growth reduced storage life. Further the application of sulphur (50 kg/ha) and additional of K (30 kg/ha) applied increase storage life. The method and time of irrigation is also closely associated with storage losses. It is generally recommended that irrigation at 10-15 days interval and it should be stopped 2-3 weeks before harvest. Use of drip irrigation rather than flood or sprinkler irrigation enhances the storage life of onion. Time of harvest is important for yield maximization and quality production. Delayed harvest may result in reduction in skin quality, sprouting, rotting and reduction in firmness, more number of bolt and spitted bulbs. Such bulbs do not store well during storage. It is generally recommended that onion should be harvested when 50% plants show neck fall. This is an indication of physiological maturity, such mature bulb develop dormancy and store well. The foliar application of fungicides (Bavistin – 0.2%) at 10 to 15 days before
harvesting helps in reduction of pathogens load and helps in reduction of post harvest diseases in storage. The use of sprout suppressants such as Cycocel 2 to 4 week before harvesting have been found successful in controlling sprouting in storage.

Onion should be dried with intact leaves for 3-4 days after harvesting in the field itself. While cutting the leaves, 2-3 cm long neck should be kept along with the bulbs. These bulbs should be kept under shed for 2 to 3 weeks for proper drying of bulbs. This is called shed curing. Shed curing normally takes from 5 to 20 days and done in well ventilated curing sheds. A properly cured onion has a dried, shrunken neck and dry outer scales without punctures or splits. In case of garlic, immediately after harvest bulbs should be graded and tied in bundles along with tops of 20-25 plants. The tops should be divided in three segments and they are interwoven tightly. Such bundles are kept in upright position in shed for curing for 15 days. Then the bundles are stored in storage structures.

The onion is graded in three grades i.e. A (60-80 mm), B (50-60 mm), C (35-50 mm) grades according to their size if the bulbs. Only A and B bulbs should be kept in store. In India grading of onion is usually performed manually either before storage or before marketing. The drudgery of human labour involved for grading of onion has been reduced by hand operated as well as motorized onion grader developed by DOGR. The accuracy of grading is 90% as compared to 70% in manual grading. It has been observed that medium size bulb store longer than big and small bulbs. Extreme size bulbs should be marketed immediately.

There are several post harvest treatments recommended for reducing storage losses in onion and garlic. The fumigation of bulbs with sulphur before storage decreases the infection of moulds. The treatments of well cured onions with 60Gy to 90Gy gamma irradiation within one month of harvesting completely eliminate the problem of sprouting of onion during storage.

Dry onions are stored, cleaned, sized and graded just prior to packaging. The onion is generally packed in hessian/performed jute bags of various sizes for marketing. Now the use of lino bags and consumers pack (1 to 5 kg) is also gaining popularity. Garlic can be packed be hessian cloth bags performed jute bags/open mesh jute bags and can be stored for 4-6 months.

3. Storage Environment

The temperature and relative humidity are the prime important factors associated with storage of onion. The ideal storage environment is 65-75% relative humidity with temperature of 25-30°C. Thus the onion storage structure should be planned and designed in such a manner that it can achieve and maintain the desired storage conditions in lowest possible cost within the available resources. The onions are stored in heaps/stakes under ambient conditions in our country. Various types of structures are used for the storage of onion. Most of these structures are the traditional type. Several modified onion storage structures have been design and tested. These structures help reducing storage losses. In garlic, the small quantity of untopped garlic is stored by hanging the bundle but large quantity of garlic may be stored in circular heaps of 1 m diameter and 1 to 1.5 m height. The stacking height and width of bulbs has impact on storage life. Height more than 5 feet, width more than 4 feet increase temperature and humidity at center and increase storage losses.

Storage structures designed, tested and recommended by ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune.

(i) Bottom and side ventilated double row structure

Double row storage structure developed by ICAR-DOGR, MPKV and NHRDF are permanent/semi permanent type and usually constructed with capacity of 25-50 tons. These structures have length of 30-50 feet and 12 feet width with two rows. The width of roof is 4 feet and 4 feet free space kept in between the two rows for walking. The length should not be more than 50 feet as increase in length increases rotting percentage. These structures are constructed at 2 feet above ground level to provide bottom ventilation supported over RCC pillars. The bottom and sidewalls can be made of bamboo or wooden bantams. The door side and opposite is covered with green shed net to protect from rain. The roof is made with asbestos sheets. Generally the storage losses in this structures ranges from 30 to 40% in four month of storage.

(ii) Top and bottom ventilated structure with mud plaster on side walls

This is a distinct type of onion storage structure designed and tested by DOGR. This structure is constructed with G.I. framework. The floor is ventilated and constructed with wooden bantams. The sidewalls are made of bamboo and plastered with clay and cow dung paste. The ventilation is
provided at lower portion of western sidewall and upper portion of the eastern sidewall. The lower portion ventilator of western sidewall has control flaps to regulate the entry of hot winds in summer and high humid winds in rainy season. Plastered sidewalls control humidity in rainy days, while maintain temperature inside during summer. The structure can be constructed with 25 to 50 tons capacity. The storage losses in this structure are 28-30% for four months of storage. This structure is better suited for humid and high temperature areas.

(iii) Bottom and side ventilated single row low cost storage structure

Low cost bottom ventilated single row structure has been designed by DOGR for small and marginal farmers. The structure is constructed with bamboo/wooden framework provided with bottom ventilation. The bottom and sidewalls can be made of bamboo or wooden bantams. The roof is made up of thatch from dried sugarcane leaves or grasses. The storage losses in this structure are 30-35% for four months of storage.

Points to be considered for construction of naturally ventilated storage structures

1. It should be constructed in such a manner so that it can maintain the required temperature and relative humidity.
2. The width of one stake should not be more than 4 feet. The maximum height and length should not be more than 5 and 15 feet, respectively.
3. Bottom ventilation of 2 feet should be provided for proper aeration.
4. The floor and sidewall should be constructed with wooden bantam or bamboo and there should be space in between two bantams.
5. The roof should be constructed with asbestos sheet or Mangalore tiles.
6. The roof should be extended 3 feet after sidewalls from all sides as it provides protection against rain splashes.
7. The structures should be constructed at an elevated place. There should not be any water stagnation, waste material and weeds around the storage.
8. The single row should be constructed in North-South direction, while double row structure should be constructed in East-West direction.

(iv) Cold Storage

Onion and garlic can be stored in cold storage for 6-9 months by maintaining ≥ 0-2°C and 65-70% relative humidity. The storage losses are absolutely nil in cold storage. However, post cold storage is a major constraint in cold storing of onion. Bulbs when taken out of cold store, start sprouting immediately due to vernalization. Sprouting is 100% during one week and sprouted onions or garlic do-not fetch good market price. Irradiation of properly cured bulbs with 60-90Gy gamma rays 100% suppress sprouting, even after cold storage. ICAR-DOGR, Rajguru Nagar, Pune conducted number of experiments and recommended irradiation before storage under any environment. Unfortunately irradiation facilities are very limited and every farmer cannot reach to that facility. Traders can avail such facilities. The cost of cold storage is very high and individual farmers cannot afford. Further, lower capacity cold storages are not economically viable. Traders or corporate cooperatives also can create cold storage facility in strategic growing areas. Country needs to store about 60 lakh tons of onion and 10 lakh tons of garlic every year. However, permanent storage capacity is not more than 30 lakh tons. It is mostly on farm storage or traders' storage system cold storage is very meager. In fact, there is need to create cold storages near metropolitan cities and in areas where onion and garlic is not grown commercially to the tune of 10-20 lakh tons. This will help Government in regularizing supply and control price fluctuations as well.

Cold storage technology for onion and garlic is in primitive stage and needs lot of investigations viz, (i) variety per se protocol, (ii) protocol standardization for pre cooling, (iii) post cold storage conditioning, (iv) mobile irradiation protocol, (v) bulk and bin storage, (vi) development of standard operating procedure (SAP) for cold storage, (vii) economics of cold storage vis-à-vis on farm storage, (viii) mechanical sorting, grading and packing, etc. There is need for public private partnership in this endeavour. The concerned partners are doing in isolation with casual approach.

Economics of onion and garlic storage

Storage of onion and garlic not only adds and ensures year round availability but it also add value to farmers these who afford and dare to store and wisely sell studying market trends. A hypothetical model of economics of storage of rabi onion and garlic is presented in Table 1 & 2, respectively.
Table 1: Economics of *Rabi* Onion Storage (25 tons)

<table>
<thead>
<tr>
<th>Period of storage</th>
<th>Storage losses (%) in naturally ventilated store. Based on DOGR studies</th>
<th>Quantity available for sale in tons</th>
<th>Storage losses (%) in cold store</th>
<th>Quantity available for sale in tons</th>
<th>Model price Rs/Kg at Lasalgaon market base year 2015</th>
<th>Income under naturally ventilated store (Rs. lakh)</th>
<th>Additional income Rs. lakh</th>
<th>Income under cold store</th>
<th>Additional income Rs. lakh</th>
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<tr>
<td>May</td>
<td>0</td>
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<td>2.99</td>
<td>0</td>
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<td>May-June</td>
<td>8</td>
<td>23.00</td>
<td>1</td>
<td>24.75</td>
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<td>3.58</td>
<td>0.59</td>
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<td>May-July</td>
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<td>22.00</td>
<td>2</td>
<td>24.50</td>
<td>21.18</td>
<td>4.66</td>
<td>1.67</td>
<td>5.18</td>
<td>2.19</td>
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<tr>
<td>May-Aug</td>
<td>23</td>
<td>19.25</td>
<td>3</td>
<td>24.25</td>
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<td>7.94</td>
<td>4.95</td>
<td>10.00</td>
<td>7.01</td>
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<tr>
<td>May-Sept</td>
<td>25</td>
<td>18.75</td>
<td>4</td>
<td>24.00</td>
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<td>17.50</td>
<td>5</td>
<td>23.75</td>
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<td>5.69</td>
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<td>May-Nov</td>
<td>45</td>
<td>13.75</td>
<td>6</td>
<td>23.50</td>
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<td>2.89</td>
<td>(-) 0.10</td>
<td>4.94</td>
<td>1.95</td>
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<tr>
<td>May-Dec</td>
<td>55</td>
<td>11.25</td>
<td>7</td>
<td>23.25</td>
<td>17.72</td>
<td>1.99</td>
<td>(-) 1.00</td>
<td>4.12</td>
<td>1.13</td>
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Table 2: Economics of Garlic Storage (25 tons)

<table>
<thead>
<tr>
<th>Period of storage</th>
<th>Storage losses (%) in naturally ventilated store (%)</th>
<th>Quantity available for sale in tons</th>
<th>Storage losses (%) in cold store</th>
<th>Quantity available for sale in tons</th>
<th>Model price Rs/Kg at Indore market</th>
<th>Income under naturally ventilated store (Rs. lakh)</th>
<th>Income under cold store</th>
<th>Additional income under naturally ventilated store Rs. lakh</th>
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<td>March</td>
<td>00</td>
<td>25.00</td>
<td>0</td>
<td>25.00</td>
<td>23.46</td>
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<td>Mar-April</td>
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<td>24.50</td>
<td>1</td>
<td>24.75</td>
<td>24.17</td>
<td>5.92</td>
<td>5.98</td>
<td>0.25</td>
<td>0.11</td>
</tr>
<tr>
<td>Mar-May</td>
<td>3.0</td>
<td>24.25</td>
<td>2</td>
<td>24.50</td>
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<td>7.07</td>
<td>7.08</td>
<td>1.20</td>
<td>1.21</td>
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<tr>
<td>Mar-June</td>
<td>5.0</td>
<td>23.75</td>
<td>3</td>
<td>24.25</td>
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<td>9.33</td>
<td>9.52</td>
<td>3.46</td>
<td>3.65</td>
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<tr>
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<td>4</td>
<td>24.00</td>
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<td>5</td>
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<td>45.17</td>
<td>9.94</td>
<td>10.72</td>
<td>4.07</td>
<td>4.85</td>
</tr>
<tr>
<td>Mar-Sept</td>
<td>15.0</td>
<td>21.25</td>
<td>6</td>
<td>23.50</td>
<td>42.28</td>
<td>9.10</td>
<td>9.93</td>
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<td>Mar-Oct</td>
<td>17.0</td>
<td>20.75</td>
<td>7</td>
<td>23.25</td>
<td>43.33</td>
<td>8.99</td>
<td>10.07</td>
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<tr>
<td>Mar-Nov</td>
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<td>20.00</td>
<td>8</td>
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<td>15.81</td>
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<td>Mar-Dec</td>
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<td>13.43</td>
<td>17.71</td>
<td>7.56</td>
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It has been assumed that 25 tons of onion and garlic are stored in naturally ventilated store designed and recommended by ICAR-DOGR, Rajguru Nagar, Pune and cold store hired on rental basis. It is accepted that onion and garlic both are stored in cold storage after gamma irradiation to prevent sprouting losses after cold storage. Major harvest of onion and garlic is in the month of April-May and material is loaded in store in May and stored till December, in case of onion and till March in case of garlic. Month-wise storage losses in naturally ventilated storage have been confirmed by ICAR-DOGR with N 2-4-1 variety. These losses may vary per se variety, cultural practices while growing, proper curing and preciseness of storage structure and conditions. In case of onion, storage losses range from 0 to 55% from May to December as per DOGR studies. It is evident from table 1 that market rates are highest in the month of August, September and October. The storage losses are between 25 to 30% in these months. It is evident that if farmers store his onion in naturally ventilated store till September to October he earns maximum than selling in earlier months or selling immediately after harvest. When storage losses increase beyond 30% it is not economical to store further, rather farmers will be losers. There is value addition by almost 2-5 times just by holding the stock for 4-5 months. If the farmers skillfully manage storage losses below 25% till September by way varietal change, more organic, better storage and handling they will be still in more profit. There is additional income of Rs. 4-5 lakhs.

In the case of cold storage the storage losses are not more than 5% provided bulbs are properly dried and irradiated. It is seen from the table 1 that maximum benefit of cold storage is in the months of August-September. There is additional income of Rs. 6-7 lakhs in these months. When two storage conditions are considered and compared cold storage pays 2 lakh additionally than naturally ventilated storage. However, the cost of cold storage of onion per ton will be higher than naturally ventilated storage. Yet, it will be profitable to store onion in cold storages provided these facilities are made available. Cold storage can be more profitable for farmer producers association or company and traders.

In the case of garlic, storage losses ranged from 0 to 20% in naturally ventilated stores and in cold store from 0-9% from March-December. Garlic is harvested from February-March all over the country. After curing it is stored for year round supply till next February-March. It is clearly evident from the Table 2 that if the farmers store his garlic till November-December he earns 7-8 lakh additional income under naturally ventilated store where as under cold store he can earn 9-11 lakhs as additional than selling in March-April. Storage under both the conditions adds value to the product.