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for Perishables

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DEVELOPMENT OF IMPROVED TECHNIQUES FOR BIG ONION STORAGE IN MAHAWELI SYSTEM B (SRI LANKA)

by

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MARD PROJECT
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| AADF       | Associated Agricultural Development Foundation |
| ai         | Active Ingredient                               |
| ARTI       | Agrarian Research and Training Institute         |
| C°         | Degree Centigrade                               |
| cft        | Cubic Foot                                      |
| cm         | Centimetre                                      |
| CWE        | Cooperative Wholesale Establishment             |
| DAI        | Developmental Alternatives Inc.                 |
| diam       | Diameter                                        |
| DOA        | Department of Agriculture                       |
| F°         | Degree Fahrenheit                               |
| ft²        | Square Foot                                     |
| FYM        | Farm Yard Manure                                |
| g          | Gram                                            |
| h          | Hour                                            |
| ha         | Hectare                                         |
| H          | Height                                          |
| IARI       | Indian Agricultural Research Institute          |
| IIHR       | Indian Institute of Horticultural Research      |
| Kg         | Kilogram                                        |
| Lft        | Linear Foot                                     |
| L          | Length                                          |
| MARD       | Mahaweli Agriculture and Rural Development       |
| MASL       | Mahaweli Authority of Sri Lanka                 |
| MEA        | Mahaweli Economic Agency                        |
| MPAU       | Mahatma Phule Agricultural University           |
| MH         | Maleic Hydrazide                                |
| MS         | Maharastra State                                |
| MT         | Metric Tonne                                    |
| m²         | Square Meter                                    |
| MM         | Millimetre                                      |
| No/Nos     | Number/Numbers                                  |
| PPM        | Parts Per Million                               |
| RARC       | Regional Agricultural Research Centre            |
| RH         | Relative Humidity                               |
| TSS        | Total Soluble Solids                            |
| USAID      | United States Agency for International Development |
| w          | Width                                           |
| "          | Foot                                            |
| "          | Inch                                            |
EXECUTIVE SUMMARY

This report summarises the current status of postharvest handling of Big Onion in Mahaweli Systems B and G, and other onion growing areas in Sri Lanka. Guidelines to minimise postharvest onion loss by developing adequate curing technology and on-farm storage are provided. Reduced loss in storage will make it possible for farmers to receive handsome remunerative prices in off-season. During my two month stay with MARD project, four improved onion storage structures were constructed, and farmers were guided in postharvest handling of Big Onion.

I have explained the principles of postharvest technology and the feasibility of storing Big Onion. I have also presented current handling procedures and have made recommendations to improve onion storage. I hope this report will help the agricultural extension agents, researchers and farmers to develop improved onion technology, thereby improving the economic status of onion growers of the country.

The Summary of Recommendations are:

1. CROP IMPROVEMENT

Storage of onion in different onion growing pockets of Systems B and G and other areas of the country is not adequate. Because varieties grown in System B (e.g. Rampur Red, Pusa Red, and Poona Red) are dissimilar in skin colour, maturity, size, shape, and storability it is recommended that:

1.1 Good storing varieties with similar size, shape, colour and maturity be developed

1.2 Seeds of good keepers, possessing high TSS, dry matter, pungency be distributed among the farmers

1.3 Seeds meeting required standards for better yield and storage be obtained from reliable, genuine and authentic sources and distributed to the farmers

1.4 The variety Pusa Red, and cultivars Rampur Red and Kalipitiya-1 be popularized because they have good production and storability. However, research needs to be performed, especially at RARC, Aralaganwila to screen the varieties for higher yield and postharvest quality

2. PREHARVEST CROP MANAGEMENT

2.1 Nursery management practices are adequate and farmers are aware of existing technology. However, to control seedling mortality due to fungal rot it is recommended to dip seedlings before transplanting in fungicide solutions of
either captan @ 0.2%, thiram @ 0.2% carbendazim @ 0.1% or thiopanthate methyl @ 0.1%.

2.2 Nitrogen and irrigation play important roles in governing the keeping quality of onion. Therefore, it is recommended that balanced fertilizers be applied with no delays. Top dressing with nitrogenous fertilizers must be completed 50-60 days after transplanting. Use of FYM (field yard manure) is encouraged. Irrigation must be stopped 15 days prior to harvest.

2.3 To achieve quality production of bulbs and to improve storage quality, suitable plant disease and insect protection measures should be followed. Mancozeb @ 0.25%, should be sprayed for the control of purple blotch and Stemphylium blight. Stickers should be used to increase the efficacy of chemicals.

2.4 To suppress fungal rot and sprouting in storage, preharvest applications of carbendazim @ 0.1% 90 days after transplanting and maleic hydrazide @ 2500 ppm 75 days after transplanting is recommended. Experiments are needed to screen for more fungicides and bactericides and their adaptability/feasibility should be confirmed by conducting large scale trials at research farms or farmers fields.

2.5 Timing of harvest plays an important role in governing keeping quality of onion bulbs. It is recommended to harvest onion after proper maturity, i.e. one week after 50% top fall.

3. POSTHARVEST CROP MANAGEMENT

Proper curing is important for successful storage of onions. Curing bulbs releases excess moisture from scales and the neck region; the outer scales develop colour and become compact which improves bulb storage quality.

3.1. Onion must be cured properly for 3-5 days after windrow harvesting; either in the field or at a farm house.

3.2 Onion bulbs should not be cured in direct sunlight and should be thinly spread.

3.3 Onion growers should be properly educated to encourage adoption of improved curing practices.

3.4 After curing, onion foliage (tops) should be cut, leaving a 1" (2 - 2.5 cm) neck.

3.5 It is strongly recommended that onion bulbs be cured 7-10 days in the shade to remove field heat before storage.

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3.6 Onion bulbs should be handled with extreme care while sorting, grading, packing etc. to avoid bruising.

3.7 To meet market standards and storage requirements it is necessary to sort out diseased, bruised, decayed, split, thick necked, bolted, off coloured, oversized, immature and undersized bulbs.

3.8 Healthy, globular bulbs of medium size (45-60 mm diam) with closed necks are preferred for storage. Bulbs of this size allow good air circulation which reduces sprouting and enhances water loss.

3.9 Increased storage capacity is needed to provide a supply of onion during lean periods when prices escalate.

4. STORAGE STRUCTURES

Suitably designed structures are a prime factor when storing a perishable commodity such as onion. The structure should be cost effective and scientific. The focus must be on the storage environment i.e. aeration, temperature and humidity. Cost efficient materials must be used. Therefore it is recommended that:

4.1 Improved onion godowns based on the principles outlined in text be constructed at the small-hold farm fields.

4.2 Medium capacity storage structures be constructed for large scale onion growers and traders.

4.3 Large capacity godowns be constructed for cooperative organizations and commercial traders.

5. RESEARCH AND DEVELOPMENT

5.1 Data is needed on the extent of postharvest onion loss during short term (1-3 months) storage. No systematic study on storage loss has been carried out in System B. This work can be taken up at RARC, Aralaganwila.

5.2 A comparison of current cultural practices with the improved package of practices suggested by the DOA/MARD/MEA should encourage the farmers to adopt the improved practices.

5.3 Comparative studies of loss in different types of storage structures and of different methods of storage should be conducted.

5.4 Experiments should be conducted on improved postharvest technology, i.e. curing methods, storage of graded vs.
ungraded onions, effect of seedling dips and preharvest fungicidal and bactericidal sprays. These technologies should be demonstrated to the farmers.

5.5 It is important for MARD/MEA to train onion growers in the proper postharvest handling of onion bulbs.
ACKNOWLEDGEMENTS

I wish to express my deepest sense of gratitude to DAI, USAID, MASL, MEA and MARD for providing me with the opportunity to work as a Big Onion storage consultant in the Mahaweli System B of Sri Lanka.

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While preparing this report, literatures and publications on onion cultivation and storage were cited, mostly Indian publications of AADF Nasik, some from abroad. Reports of MARD, and personal communications from Mr. W. Ratnayake Addl. Dy. Director (TT) DOA, and Report of RARC Mahailluppallama, were also cited, which I gratefully acknowledge and I extend my sincere thanks to the respective authors. My thanks are also due to all persons, officers, scientists and farmers, who have extended their help to me in various ways.

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MARD Project, Pimburattewa

(K.J. Srivastava)
1. INTRODUCTION

1.1 ONION PRODUCTION – A GLOBAL REVIEW

Onion is one of the most important vegetable crops grown all over the world. Common onion (Allium cepa L.) is a major crop in many tropical countries valued for its flavour and for its medicinal and nutritional value. Onion supplies minor minerals and trace elements in the human diet.

A global review of area and production of major vegetables reflects that among seven vegetables (i.e. onion, garlic, cauliflower, green peas, cabbage, tomato and green beans) onion ranks second in area of cultivation and third in production in the world.

Approximately 27.92 million MT of onions are produced in the world on 1.98 million ha of land. Among major onion growing countries, India ranks first in area (0.32 million ha) and second in production (3.35 million MT). Other top ranked onion producing countries are China (highest production of 3.93 million MT), USA (2.45 million MT) and Turkey (1.55 million MT). In productivity, Japan tops the list with 44 MT/ha followed by USA (42.53 MT/ha), Spain (36.02 MT/ha) and the Netherlands (34.38 MT/ha).

1.2 ONION PRODUCTION IN SRI LANKA

Big Onion (Loku Loonu) was introduced to Sri Lanka in 1971 and was produced on a small scale until 1983 when there was a noticeable increase in production. Now the country is producing about 27,879 MT of Big Onion on 2395 ha with an average production of 11.64 MT/ha (Table-1).

Multiplier onion, (Red onion, Ratu Loonu and Podi Loonu) is cultivated as a traditional crop in the Island. During 1992 an area of 7733 ha produced 54,515 MT of red onion. (Source: ARTI Data Bank). Big Onion is produced mainly in the districts of Matale, Anuradhapura, Kalawewa, and Polonnaruwa including Mahaweli System B. The highest producing district is Matale, which accounts for nearly 56.68% of the country’s production. Other major onion growing districts are Kalawewa (33.43%), Polonnaruwa (3.87%) and Anuradhapura (2.79%).
Table 1: Extent (Area), Production and Yield of Big Onion in Sri Lanka (1980 - 1992)

<table>
<thead>
<tr>
<th>Year</th>
<th>Extent (ha)</th>
<th>Production (MT)</th>
<th>Yield (MT/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>27</td>
<td>230</td>
<td>8.52</td>
</tr>
<tr>
<td>1981</td>
<td>87</td>
<td>822</td>
<td>9.45</td>
</tr>
<tr>
<td>1982</td>
<td>156</td>
<td>1129</td>
<td>7.24</td>
</tr>
<tr>
<td>1983</td>
<td>217</td>
<td>2173</td>
<td>10.01</td>
</tr>
<tr>
<td>1984</td>
<td>279</td>
<td>2890</td>
<td>10.34</td>
</tr>
<tr>
<td>1985</td>
<td>172</td>
<td>2063</td>
<td>11.99</td>
</tr>
<tr>
<td>1986</td>
<td>504</td>
<td>5555</td>
<td>11.02</td>
</tr>
<tr>
<td>1987</td>
<td>421</td>
<td>4037</td>
<td>9.59</td>
</tr>
<tr>
<td>1988</td>
<td>607</td>
<td>6661</td>
<td>10.97</td>
</tr>
<tr>
<td>1989</td>
<td>900</td>
<td>9000</td>
<td>10.00</td>
</tr>
<tr>
<td>1990</td>
<td>1580</td>
<td>15,903</td>
<td>10.07</td>
</tr>
<tr>
<td>1991</td>
<td>1447</td>
<td>14,046</td>
<td>9.71</td>
</tr>
<tr>
<td>1992</td>
<td>2395</td>
<td>27,879</td>
<td>11.64</td>
</tr>
</tbody>
</table>

Source: 1. Figures for 1980 - 1989, collected from the paper presented at DOA onion workshop, January 8, 1990 by Mr. K.A. Mettananda and Mr. Arulmandy (P.17)
2. Figures for 1990 - 1992, are from ARTI, Data Bank, Dept. of Census and Statistics.

2. MAHAWELI ECONOMIC AGENCY - BACKGROUND

Mahaweli Economic Agency (MEA) is working to uplift settler-farmers through crop diversification i.e. instead of growing only traditional paddy crop, the farmers are encouraged and guided to also grow remunerative cash crops including Big Onion, to increase their financial status. The Mahaweli Agriculture and Rural Development Project (MARD) is helping MEA to achieve this goal.

2.1 BIG ONION STATUS IN MAHAWELI SYSTEM "B"

Big Onion production in Mahaweli System B was introduced after the inception of MARD project. System B, encompassing nine blocks, cultivates onion on 116 ha with an annual production of 1400 MT, sharing 5% of the country’s area as well as production. The blocks contributing to the production of Big Onion in System B are: Wijayabapura, Dammilenna, Ellewewa, Dimbulagala, Sevanapitiya, Senapura, Aselapura, Bakamuna and Singhapura. The area of highest production is Bakamuna which contributes about 50% of onion production in System B.
Table 2: Area and production of Big Onion in Mahaweli System B (1990 and 1993)

<table>
<thead>
<tr>
<th>Year</th>
<th>Area (ha)</th>
<th>% Increase</th>
<th>Production (MT)</th>
<th>% increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>45.84</td>
<td>---</td>
<td>458.40</td>
<td>--</td>
</tr>
<tr>
<td>1993</td>
<td>116.065</td>
<td>253.20</td>
<td>1392.70</td>
<td>303.84%</td>
</tr>
</tbody>
</table>

Source: Cultivation census MARD, and MEA Project (Welikanda)

A perusal of the data presented in Table 2 reveals a considerable increase in the area from 1990 Yala (45.04 ha) to 1993 Yala (116.065 ha) which is nearly 2.53 times that of Yala 1990. The total production has also increased from 458 MT in 1990 to 1392 MT in 1993 (3.04 times).

It appears that farmers in System B have realised the value of Big Onion as a cash crop and are putting maximum effort into cultivation of onion for higher yields in order to obtain maximum returns.

2.2 SEASONS OF ONION CULTIVATION IN SYSTEM B

Big Onion and red onion are cultivated in Yala (dry) season (April-October) and Maha (wet) season (November-February). The details of nursery sowing, transplanting and harvesting time are given in Table 3.

Table 3: Seasons of Onion Cultivation

<table>
<thead>
<tr>
<th>Seasons</th>
<th>Nursery sowing</th>
<th>Transplanting</th>
<th>Harvesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yala B</td>
<td>Mid March - April End</td>
<td>April - Mid June</td>
<td>August - Sept</td>
</tr>
<tr>
<td>R</td>
<td>(Irrigated)</td>
<td>Early May - Mid June</td>
<td>August - Sept</td>
</tr>
<tr>
<td>R</td>
<td>(Rainfed)</td>
<td>March - April</td>
<td>June - July</td>
</tr>
<tr>
<td>Maha B</td>
<td>with sets</td>
<td>Mid Dec - Early January</td>
<td>April - May</td>
</tr>
<tr>
<td>R</td>
<td>(Irrigated)</td>
<td>Mid Dec - Mid January</td>
<td>March - April</td>
</tr>
<tr>
<td>R</td>
<td>(Rainfed)</td>
<td>Sept - Nov</td>
<td>Dec - Jan</td>
</tr>
</tbody>
</table>

B - Big Onion  R - Red onion
2.3 PRODUCTION AND SEASONAL GLUTS

It is evident that August and September are the peak harvesting months of Big Onion in Yala when produce from the entire onion growing belt of the country is flowing to the market. The resulting glut in the market reduces onion prices, which correspondingly reduces the profit margin for the farmers.

In order for farmers to compete with the glut caused by the heavy arrival of onion in the market, withholding (storing) stock has emerged as an essential tool. Storage of Big Onion can stabilise the market and a supply of onions can be assured during the off season i.e. October through December and up to mid-January or till the next harvest of red onions.

3. STORAGE OF ONION

3.1 BACKGROUND

Perishable commodities such as onion need proper storage to prevent qualitative and quantitative losses. Loss occurs from pests, from rotting due to insufficient ventilation and aeration, and from fungus caused by excess moisture.

Approximately 40% of onions are estimated to be lost during various processes of handling. Thus, adequate storage facilities with modified ventilation becomes a prime requisite; reducing losses, and bringing stability to market prices by preventing glut. It is, therefore, all the more important to have suitably designed onion storage structures. The commodity is perishable and deterioration starts from the moment of harvesting unless proper care is taken in postharvest handling and storage.

The purpose of storage is not only to prolong the life of the commodity, but to regulate the supply during lean months by extending the marketing period. Good storage requires quality onion. Good storage requires proper preparation as well as an adequate structure. Thus an understanding of improved preharvest and postharvest technology is essential.

3.2 FACTORS AFFECTING STORABILITY OF ONION

Various factors determining storage behaviour of onions are: a) varieties or cultivars, b) cultural practices including judicious use of fertilizers, c) irrigation, d) time of harvesting, e) plant protection and f) postharvest handling, including neck cutting, curing, sorting, grading as well as g) temperature, humidity and aeration of storage structures in the different areas.

Proper bulb preparation and suitable storage conditions are important factors which affect the quantity of bulbs recovered.
To meet these requirements, an understanding of a few biological factors, which govern keeping quality, and deterioration of onions is essential. The factors are:

3.2.1. Respiration

Respiration is the metabolic process by which stored organic materials are broken down with a release of energy as "vital heat". The deterioration rate of harvested commodities is generally in proportion to their respiration rate. With increased temperature the respiration rate of onion rises more slowly than it does in most crops. Respiration however, results in continuous loss of stored food (dry matter) and in production of heat. Respiration is low in dormant onions.

3.2.2. Growth and development

Sprouting of onions greatly reduces their value and accelerates deterioration. Dormancy of onion is prolonged either by low temperature (1-2°C) or at high temperature (26-30°C). Dormancy disappears at a temperature range of 12-16°C. Increased humidity causes rooting which eventually elongates or distorts the bases thus causing scales to break away, giving rise to bulbs with a shabby appearance.

3.2.3 Transpiration and natural water loss

Transpiration results from a difference in relative humidity between cells and air. It can be a major cause of onion deterioration since it results in weight loss, and shrivelling; changing both texture and appearance. Under low humidity and high temperature bulbs continue to loose moisture at a relatively constant rate.

3.2.4 Physical damage

Physical damage is not only unsightly but also accelerates water loss and favours disease incidence. Curing in strong sun causes sun injury. Faulty harvesting, loading, unloading and transportation also cause damage.

3.2.5 Pathological breakdown

Pathological breakdown is one the most important causes of deterioration. Pathogens can infect healthy tissues following mechanical injury or physiological breakdown.
3.3 PREHARVEST FACTORS

3.3.1 Varieties

Onion cultivars vary considerably in their suitability for storage. Successful storage requires selection of onion cultivars well suited for keeping. Varieties are classed as very poor keepers, poor keepers, fair keepers, good keepers and very good keepers. For example, Italian Red is classed as very poor, California Red and Early Grano as poor keepers, White Sweet Spanish, Sweet Spanish and Prize-taker as fair. American varieties are classed as good keepers while White Creole and Australian Brown are ranked as very good keepers. Among the Indian varieties, Pusa Red, N-2-4-1, Agrifound Light Red, and Arka Niketan are classed as good keepers. It is interesting to note that the varieties classed as very poor and poor keepers are considered mild onions, while good and very good keepers are strong and pungent. The relative pungency of varieties appears to be related to some extent to the concentration of dry matter. Varieties with low TSS (Total Soluble Solids), low dry matter and high rates of water loss immediately after harvest tend to soften, shrivel and sprout more than varieties possessing high TSS, high dry matter and a low rate of water loss. The description of some Indian varieties suitable for storage are:

Pusa red

A very popular short to intermediate day length variety developed at IAR (Indian Agricultural Research Institute), New Delhi. Bulbs are medium in size, averaging 70-90 g, bronze red in colour, flat to globular shaped and lightly pungent, with good keeping quality. Plants mature about 160 days after sowing. TSS is about 12-13%. Average yield is 25 MT/ha.

Agrifound light red

Developed by mass selection from a local stock of red onion grown in the Dindori area of Nasik by the Associated Agricultural Development Foundation, Nasik. Bulbs are of globular shape with tight skin, light red colour and 4-6 cm in size. It has good keeping quality, with a TSS of 13%. Maturity is 160 - 165 days after sowing. Average yield is 30-32.5 MT/ha.

Arka niketan

Developed through mass selection from a local collection (IIHR 153) at the IIHR, Banglore. Bulbs are globular, with thin necks, an attractive colour, and 4-6 cm in size. Pungency and dry matter is high, with a TSS of 12-14%, it has good keeping quality. Maturity is 150-160 days. Yield is 34 MT/ha.
This variety was developed at MPAU (Mahatma Phule Agricultural University), Rahuri, Maharashtra State. Average bulb diameter is 4-6 cm, it has a globular shape, pungent taste and good keeping quality. Plants mature 160-165 days after sowing. Average yield is 25-30 MT/ha.

3.3.2 Status of cultivated onion varieties

A survey of different onion growing pockets in System B, Dambulla, Kimbissa, Minneriya and System H, showed that the varieties being cultivated by the farmers are of a mixed type i.e. light as well as dark red. The varieties being grown are Rampur Red, Poona Red or Pusa Red. However the varieties observed in the field or at traditional stores were not true to type in characteristics nor uniform in standards. It was interesting to note that the same variety/cultivar grown in Dambulla and Bakamuna was of light red/pink red colour, while in System B (Veheragama and Kalingawila) the colour of bulbs was dark red. Further, variations were noted in maturation time, neck thickness, and bulb size. TSS recorded from bulbs in these areas was found to range from 11.7 - 12.38. This TSS falls in the desired range of storage quantity, but other characteristics like variation in maturity and size, affect the keeping quality.

RECOMMENDATIONS:

a. Seed varieties which store well, with high TSS, dry matter and pungency etc. should be distributed among the farmers. Good storability is necessary so that in case of glut situations or a crash of prices, it can be stored till the market resumes normality and prices become remunerative.

b. Seed from very reliable, genuine and authentic sources should be obtained to overcome the problems discussed above.

c. Pusa Red, Rampur Red and Kalpitiya-1 have been screened for storability by Mettananda (Research Report RARC, Mahailluppallama, Maha 1992/9). These varieties should be popularised with seed of genuine quality.

d. Seed production technology of above improved varieties should be strengthened.

3.3.3 Nitrogen and irrigation

The effect of certain cultural practices (like irrigation and nitrogen applications) on the storage behaviour of onion is not clear. However, if not managed properly, these factors can increase postharvest loss.
Adequate nitrogen application promotes rapid and complete bulb maturity, which is very important for storability of onion. Over fertilization with nitrogen late in the growing season encourages thick necked bulbs. If onions with thick necks are stored, re-sprouting is possible and open thick necks allow the invasion of pathogens which will deteriorate the onion quality.

Irrigation during maturation period of onion bulbs also increases the succulence and diameter of the onion necks, thus making them more difficult to dry and susceptible to pathogens. Whereas, required and timely irrigation will help reduce black mould and bacterial rot damage to onion bulbs.

Farmers in System B are aware of the use of fertilizers. However, sometimes a late application of nitrogen is made in an attempt to increase bulb yield.

Irrigation in general practice is stopped 2-3 weeks before harvesting. Sometimes in order to increase bulb weight for marketing irrigation is given 3 days prior to harvest.

RECOMMENDATIONS:

a. Use of FYM should be encouraged and popularized.

b. Balanced doses of fertilizers should be applied, based on requirements after soil testing.

c. Application of nitrogen must be completed within 50-60 days of transplanting.

d. Late application of nitrogen, in any case, should be discouraged.

e. Irrigation must be stopped 15 days prior to harvest.

3.3.4 Diseases and insect pests of onion

Growing a healthy and vigorous crop is the ultimate aim of all farmers because a poor and diseased crop deprives them of expected income. Diseases, infection and insect pests in the field reduce the storability of onion. Details of disease and insect pest problems which prevail in the places surveyed, and my recommendations are as below:

A. FIELD

a. Damping-off

This disease is caused mainly by soil borne fungi, *Fusarium oxysporum* and *Pythium* sp. The disease exhibits two forms.
Preemergence damping-off: The fungi kills the radicle and plumule before emergence from the soil.

Postemergence damping-off: The pathogens attack the collar region of seedlings on the surface of soil. The collar portion rots and ultimately the seedlings collapse and die.

CONTROL: For managing the disease, healthy seeds treated with thiram (0-2-3g/Kg of seed) should be sown. Continuous raising of seed in the same plot should be avoided. Soil treatment with 0 4-5g/M2 thiram has proved effective in controlling the disease. In case of postemergence damping-off incidence, soil drenching with thiram 0 2-3g/litre of water at fortnightly intervals should be followed.

b. Purple blotch

The disease is incited by Alternaria porri. The disease occurs under moist, humid and moderate temperature conditions. Common symptoms occur on leaves as small, sunken, eye shaped, whitish flecks with purple coloured centres, followed by large purple areas which form dead patches.

CONTROL: The effective management of the disease is achieved by spraying mancozeb 0 0.25% at fortnightly intervals, beginning one month after transplanting. Crop rotation for 2-3 years with non related crops should be followed. Stickers should always be mixed in spray solutions to obtain the best effects.

c. Stemphylium blight

Although this disease is very common in North India and other onion growing parts of Indian states, it is not as virulent in those Sri Lankan onion fields I surveyed. The disease caused by Stemphylium vesicarium is characterised by small, yellow to pale orange spots or streaks in the middle of leaves especially on one side. This disease is also managed effectively by spraying mancozeb 0 0.25% at fortnightly intervals starting just after the appearance of disease.

d. Onion thrips

Thrips (Thrips tabaci) is the most injurious insect pest of onion. It is found in the axil of green leaves where it sucks juice of the emerging leaf. The infested plants develop a spotted appearance on the leaves which become pale white blotches due to drainage of sap resulting in stunted growth with twisted leaves. Heavy infestation of thrips hamper bulb development completely.

CONTROL: Malathion 0 0.1%, methyl demeton 0 0.075% or cypermethrin 0 0.01% sprayed fortnightly protects the crop from
thrips. Application of phorate granules @ 1kg ai/ha is also recommended at the time of transplanting.

B. STORAGE

a. Black mould

This is the most common disease of onion in storage. Caused by Aspergillus niger, it is characterised by the black powdery mass of spores borne on the exterior of the scales and can be rubbed off easily. The black spore masses are also seen on inner scales. The disease also causes shrivelling of the affected scales which assume a brittle texture. Humid conditions favour the disease while a dry and cool environment seems to check it. It becomes more severe and causes rotting when associated with bacterial rots.

CONTROL: Black mould disease does not affect storage loss but infection reduces the marketing value of the produce. For effective control of the disease bulbs should be thoroughly cured after harvesting and should be protected from rains and moisture. Proper sorting and grading should be followed before storage and bruising of bulbs should be avoided.

b. Basal rot

This is a widespread disease occurring in storage caused by Fusarium oxysporum. The disease is soil borne, therefore it starts in the field. Yellowing of leaves and stunted growth of the plant is the first symptom and later on drying of leaves from the tip downwards is noticed. Most of the roots eventually rot off and in their places a mass of white mouldy growth is seen. The bulbs become soft and when cut a semi-watery decay is found, advancing upward from the basal portion of the bulbs. Sometimes the field infection could not be noticed due to unfavourable conditions and field infected bulbs when stored causes heavy loss.

CONTROL: Drenching with carbendazim @ 0.1% has been found effective in checking the growth of fungus in field. Five year rotations with unrelated crops is also recommended as the pathogen survives in soil. Rouging of wilted plants in the field should be followed to check the spread.

c. Bacterial brown rot

Bacterial brown rot caused by Pseudomonas aeruginosa is an important disease of stored onions. The major symptom of the disease is browning of the inner bulb scale which ultimately causes rotting. Disease development takes place below the epidermis and the adjacent cylindrical cells. The major portion of the bacterial population remains associated with cell walls.
In early stages the bulb shows intactness, but when pressed with a thumb, a dirty white bacterial oozing may be seen.

CONTROL: Proper curing and rapid drying of the bulbs after harvesting is essential for managing the disease. Bulbs showing diseased symptoms should be discarded before storage.

d. Bacterial soft rot

Soft rot in onion is commonly caused by *Pseudomonas allicola*. The bulbs may be attacked by this disease during the growth period. Outer scales of fully grown bulbs usually are rotted by this disease.

CONTROL: Freshly harvested bulbs should be thoroughly cured, sorted and graded before storage. Spraying of streptomycine @ 0.02% 90 days after transplanting has been found to check the disease.

e. White rot

White rot of onion caused by *Sclerotium rolfsii* on growing plants and stored bulbs is reported from India. The pathogen is soil borne and invades the roots and the basal parts of the bulb scales. In storage a white cottony growth associated with rotting is a common symptom of this disease.

CONTROL: Proper curing, sorting and grading before storage should be followed. Spraying of chemicals such as botron, thiophanate-methyl, or carbendazim @ 0.1% controls the disease.

3.3.5 Preharvest application of chemicals to control diseases and sprouting in storage

Several fungi and bacteria invade onion bulbs or survive in the field and cause menace during storage. The survey of onion fields revealed that in most of the fields at Veheragama, Kalingawila and Wijayabapura, onion bulbs were found affected with black mould, basal rot and some bacterial soft rots. During the experiments conducted by AADF on use of preharvest chemical applications for the control of diseases in storage, carbendazim application @ 0.1% 90 days after transplanting was found to be effective and economical (Plate-1). Dipping onion seedlings in captan @ 0.2%, or thiram @ 0.2%, carbendazim @ 0.1% or topsin M @ 0.1% will also reduce seedling mortality due to basal rot in the field. In India, sprouting in storage was controlled by use of maleic hydrazide (MH) @2500 ppm 75 days after transplanting. However, for use in Sri Lanka, experiments are needed to determine the dose of MH necessary for control of sprouting. In addition, the effect of MH treated bulbs on humans must be established before making recommendations to the farmers.
RECOMMENDATIONS:

a. Seedlings should be dipped for 10 minutes in fungicidal solutions viz. captan @ 0.2% thiram @ 0.2%, carbendazim @ 0.1% or thiophanate-methyl @ 0.1% just before transplanting to check basal rot and seecrotium bulb rot in the field.

b. Carbendazim @ 0.1% should be sprayed in the field 90 days after transplanting.

c. To control sprouting in storage, the effects of MH must be tested before recommendation.

Plate 1. Applying preharvest fungicide to an onion field.
3.3.6. Harvesting

In general, the highest yield of onion is obtained when the bulbs are allowed to remain in the field for complete drying of the green foliage. This stage provides maximum opportunity for the inhibitory substances present in the leaves to enter the bulbs. Development of red pigment and the characteristic pungency of the variety are also important harvest indices of onion. Fully mature bulbs cause less postharvest losses. Early harvested crops do not have close, thin necks. Undermature bulbs shrink, have more physiological loss of weight and more rotting in storage, whereas overmature bulbs have more sprouting, detachment of outer scales and splitting of bulbs in storage. Delayed harvest may increase the yield but bulb quality deteriorates. Susceptibility to disease is increased due to increased respiration. Rots and total losses are always lowest if bulbs are harvested with tops down and dry. Harvesting one week after 50% top fall is found to be the most appropriate stage for satisfactory storage behaviour.

RECOMMENDATIONS:

a. Onion should be harvested after proper maturity.

b. Top fall is considered one of the important harvest indices, harvesting must be done one week after 50% top fall.

3.4 POSTHARVEST FACTORS

3.4.1 Curing

The purpose for curing onion is to remove excess moisture from onion scales and neck, thereby reducing infection from disease carrying organisms, and minimising shrivelling by removing moisture from the interior. Curing also aids the development of bulb skin colour. Curing is achieved by exposing harvested bulbs to a required high temperature for a certain period.

For proper curing the bulbs should be arranged in "windrows" immediately after harvest and allowed to dry. Onions are considered suitable for storage when the neck is tight, the outer scales are dry and rustle when handled. Field curing results in a weight loss of three to five percent for bulbs harvested at proper maturity.

3.4.2. Curing practices being followed by farmers of System B and other onion growing pockets

The survey of onion growing areas of System B, Dambulla, Kimbissa and other areas revealed that farmers are harvesting onion bulbs and transporting them to their houses in big sacks
The onions are then spread densely to dry the leaves in open sun. It is very important to note that direct sun heat can kill the surface tissues, spoil the appearance of bulbs and allow pathogens to enter through the dead areas of the surface scales. Therefore, this practice can not lead to better storability of bulbs. When proper curing conditions for removal of excess moisture are not met, decay by fungal and bacterial rots in storage may occur. The reason farmers do not cure in the fields is the risk of having the crop stolen if it is allowed to remain in the field until mature.

**RECOMMENDATIONS:**

a. Considering the problem of field curing as outlined above, bulbs must be cured after harvest using the "windrow method" at the farmers house where a watch can be kept to avoid theft. The windrow method will allow shade (as covered with foliage of onion) as well as air circulation for curing, development of colour and removal of moisture from the bulbs, without sun scalding. At least 3-5 days curing in windrow must be performed to achieve good storability.

b. Curing in direct sunlight and dense spreading must be avoided.

c. Proper guidance to the farmers must be extended regarding the curing practices.

3.4.3 Cutting of the tops

Cutting the top close to the bulb provides entry of moisture thereby more losses are evident due to decay.

**RECOMMENDATIONS:**

a. To cut tops leaving a 1" (2-2.5cm) neck.

b. To cure bulbs for 7-10 days in the shade after cutting the tops. This will remove field heat and achieve the best storage performance.

3.4.4 Handling

Onion bulbs intended for storage must be free from cuts and bruises and so must be handled with extreme care during sorting, grading, packing, and transportation. Bruising may cause increased respiration, accelerated weight loss and may encourage infection by disease organisms. Onion bulbs are damaged by a drop of 30 cm (1') on hard surfaces. Therefore, care must be taken to restrict the height of fall during all handling operations. However, when onions are dropped on onion, less damage occurs because of the cushioning effect between onions.
These factors therefore, are critical when preparing onion bulbs for storage.

3.4.5 Sorting and grading

Onion bulb quality is composed of many characteristics. External and internal characteristics, as well as physical and chemical characteristics determine the appearance, texture, flavour and nutritive value of onions. Sorting and grading are important factors responsible for conserving the quality of onion in storage.

As a common practice farmers sort and grade onions only for double and rotten bulbs. No quality standards are followed for removing extra-big, small, undeveloped, thick necked or elongated bulbs. Such bulbs, if stored, reduce the life of stored stock since large bulbs and undeveloped bulbs have more moisture loss, sprout early, and are more prone to fungal and bacterial infections, causing decay.

RECOMMENDATIONS:

a. Sorting should be done to separate diseased, bruised, decayed, split, thick-necked, bolted, off-coloured, oversized, immature and undersized bulbs in order to meet the market standards and storage quality.

b. Better sorted and graded produce will fetch good rates in the market, generally one or two rupees more than ungraded onions. Therefore farmers must be taught strict sorting and grading procedures.

c. While sorting and grading for storage, the above factors are of immense importance.

d. Medium size bulbs of uniform colour, thin-necked, and true to type are good for storage as compared to small, immature and bigger bulbs. This knowledge must be extended to the farmers to reduce losses in storage.

3.4.6 Transportation

Transportation of perishable commodities plays an important role in marketing. Therefore the following recommendations are to be followed strictly.

RECOMMENDATIONS:

a. Careful handling while packing, loading and unloading should always be taken to avoid injury to onions and wear/tear of packing materials.
b. Only onions of high quality, produced using the latest technology, properly cured, sorted and graded should be put under dispatch for distant markets.

3.4.7 Optimum storage conditions

Under ordinary conditions onion can be stored for a period of 4-6 months. Sufficiently ventilated structures with adequate air circulation are needed for storage under ordinary conditions. The purpose of storage is to protect bulbs from direct sunlight, dampness and rain. The essential tools of successful storage are: ventilation, uniform and comparatively low temperature and a moderately dry atmosphere, including a moderate relative humidity. Proper aeration is necessary to avoid problems resulting from high temperatures. Free air circulation without much exposure to dry air helps reduce losses due to driage, sprouting, rooting and decay.

3.4.8 Temperature and humidity - effect on storage

Storage temperature and humidity affect sprouting and rooting, driage loss, descaling, respiration rates, rot incidence and severity and many other quality parameters.

Onion sprouting is affected by temperature. Temperatures between 10-12°C to 25°C increase sprouting. Rooting is influenced by relative humidity (RH). High RH promotes rooting, and weight loss is more when the temperature is above 35°C. The most suitable temperature for onion storage under ambient conditions is 25-35°C (30-35°C) with a RH of 60-75% (65-70%). In cold storage, 0-2°C temperature and 60-75% RH is suitable. Under ambient conditions RH should not be less than 50% to avoid skin loss, and the preferable range is 60-75%. An air flow rate of 165 M³/h/MT is optimum for storage.

4. ONION STORAGE - PRESENT STATUS

As emphasized earlier, a specific storage environment is necessary to obtain the maximum recovery of marketable bulbs after prolonged storage.

During the survey of onion storage structures and storage methods in System B (Veheragama, Kalingawila, Track 8 and Siyambalawe), Minneriya, Dambulla, Ebbankatuwa, Porangwewa, Pelwehera, Velihane colony, Kimbissa and Palutawewa, the following methods of storage were observed. (Plates 2 through 7)

a. Hanging method - in house - no proper ventilation

b. Spreading on the floor (mud) - thin layer - improper ventilation
c. Heap on the floor (mud) - up to 2 ft

d. Onion bulbs are stored on gunnysacks spread on two-three tier platforms of wood sticks or bamboo mats in the house.

e. Onion kept on tiers as above but in thatch hut outside the house.

f. Kept on wooden timber slats - no bottom ventilation.

g. Hanged in polysack/bags, in a room having one window, no proper ventilation

h. Hanging of onion bulbs surrounding a round timber, up to 5' height and 1' thick. No proper ventilation.

Plate 2. Conventional storage: hanging and spreading on house floor
Plate 3. Conventional storage: spread on house floor

Plate 4. Conventional onion storage: spread on ground in thatch hut, ventilation on 3 sides only
Plate 5. Onion storage: spread on wooden slats in tiers, no proper ventilation from below.

Plate 6. Onion storage: spread on wooden sticks on house floor, in tiers without proper ventilation.
Plate 7. Onion storage: spread on wooden sticks and gunnysacks, no proper ventilation

These observations and Plates 2 - 7 show that farmers are aware of the benefits of storage, but are unaware of proper storage technology. Some farmers spread onion in their house in such a way that a very narrow space is left for movement. Others hang the onion bulbs even in the kitchen, where fumes and heated air affect the onions.

Onion, a highly perishable commodity, needs very careful handling and storage with good ventilation, free air movement and other required climatic conditions.

Hanging is certainly a good method but cannot be advocated for large scale storage unless a very huge ventilated shed is available. Hanging in small houses without ventilation will add to loss from fungi, bacterial rot and weight loss. Discussions with the farmers revealed that about 30-50% of onion bulbs are lost during 1-3 months storage.

4.1 GENERAL OBSERVATIONS ON POSTHARVEST HANDLING AT FARMERS FIELDS

It was observed during field visits that proper sorting, grading, selection/preparation of bulbs for storage is not followed. Each and every bulb, either mature, immature, thick necked, with outer skin exposed, extra big, small, or medium are tied in bunches and hanged from the roof of the house or spread...
in heaps on the house floor. This results in fast deterioration of these undesirable bulbs, from rotting, sprouting and weight loss. Therefore, the recommendations outlined below must be adopted in a true and strict sense to reduce postharvest losses of onions.

4.2 PREPARATION OF ONIONS FOR STORAGE: RECOMMENDATIONS

a. To achieve better returns after storage it is essential to choose bulbs which are sound, free from mechanical injuries, well covered by outer scales with thin, close necks, well dried, ripe and homogeneous. Immature, soft and thick necked bulbs are not suitable for storage, even for a short period.

b. Onions should be harvested at proper maturity i.e. 50% top fall with yellow tops, necks thin and soft, drooping leaves and bulbs which are covered with well differentiated outer scales signifying that they are in a state of physiological rest.

c. Harvesting should be done in such a way that onion bulbs are neither bruised nor damaged. Double bulbs, those with flower stems, and those not covered by outer protective scales should not be stored.

d. During the period of senescence, inhibitors found in the leaves, which preserve dormancy, pass into the bulbs. Thus proper curing is strongly recommended.

e. To check sprouting, use of MH @ 2500 ppm at 56% top fall stage is recommended. The experiments conducted at RARC, Mahalluppallama by Mettananda also suggest the same but the doses of MH are not specified in the Research Report (Maha 92/93).

f. To check fungal and bacterial diseases like black mould, basal rot, bacterial soft and brown rot, a spray of carbendazim @ 0.1% + streptomycine @ 0.02% 15 days prior to harvest has been found effective in India. Experiments should be conducted at RARC to determine if this regime would be effective in System B and then recommended.

g. Onion skins become discoloured and mould develops if the weather remains wet for a few days at harvest. Any surface moisture will cause loss of dormancy and sprouting will be facilitated. Therefore, before storage, onion bulbs should be dried till a rustling sound is obtained when touching the onion in order to eliminate excess external moisture as well as moisture in the outer scales, rootlets and the neck.

h. Seven to ten days of curing in the shade following field curing is essential to remove field heat before storage.
i. Sprouting and water loss during storage are affected by the size of the bulbs. Over-sized and immature, small-size bulbs sprout faster than small, mature ones but small bulbs loose weight rapidly. Splits and descaling commonly occur with large bulbs in storage. Delayed harvest also leads to increased sprouting in storage.

j. Medium sized (45-60 mm diam.) globular bulbs are most suitable for storage and are the most preferred. Healthy, globular, medium sized bulbs with close necks keep well and facilitate better air circulation.

k. The correct mix requires proper sorting and grading. This should be done with a minimum of handling so as not to disturb the intactness of outer scales.

5. STORAGE STRUCTURES - CONSTRUCTED/PROPOSED

A steady supply of onion from storage makes increased income possible during lean periods. Thus it is essential to develop suitably ventilated storage structures for keeping onion bulbs longer periods in good condition.

Onion storage structures need to be cost effective and scientific. The focus must be on the judicious utilization of space, while attaining the desired storage environment (i.e. aeration, temperature and humidity). Cost efficient materials must be used for the construction.

An improved onion storage structure, therefore, must fulfil the following conditions:

a. A raised platform not less than 1' from the ground so that moisture and dampness due to direct contact with soil is essential when constructing an onion godown.

b. A roof of thatch, mangler tiles or asbestos will help prevent high temperatures inside the godown.

c. Increased height and the required roof slope will provide good air circulation and prevent a humid microclimate inside the godown.

d. Bottom ventilation will provide free and faster air circulation, preventing the formation of humid pockets between the onion layers.

5. Direct sunlight must be avoided to prevent sunscald, colour fading and deterioration of quality.

6. A stacking height of not more than 4' is essential in order to avoid pressure-bruising of the bottom layer, resulting in storage losses.
7. A properly oriented godown, preferably in an East-West direction will minimize exposure to direct sunlight and facilitate maximum air circulation. Planting and correctly positioning trees to protect the godown from rain showers and water accumulation near the godown is desired.

Suitably ventilated storage godown models have been prepared in System B following these basic principles.

5.1 DETAILED SPECIFICATIONS OF ONION STORAGE GODOWN OF 2 MT CAPACITY - CONSTRUCTED AT VEHERAGAMA (DIMBULAGALA BLOCK)

**Structure**

Brick is needed for the plinth, and round wooden timbers for vertical support, secondary support, roof support, side wall support and floor supports. Round wooden timbers of eucalyptus or other jungle wood is suggested. Use bamboo reefers for side walls and the floor. Coconut thatch or paddy straw is suggested for the roof. (Figure 1)

**Specifications and dimensions:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plinth</td>
<td>14' (L) x 6' (W) x 1'(H)</td>
</tr>
<tr>
<td>Net size of the godown</td>
<td>12' (L) x 4' (W) x 10' (h)</td>
</tr>
<tr>
<td>Gap for bottom aeration</td>
<td>1' from plinth level (bottom tier) and 1' from top of the bottom tier (top tier)</td>
</tr>
<tr>
<td>Nos of compartments</td>
<td>2</td>
</tr>
<tr>
<td>Centre height from ground level</td>
<td>10'</td>
</tr>
<tr>
<td>Side height from ground level</td>
<td>6'</td>
</tr>
<tr>
<td>Slope of roof</td>
<td>1'</td>
</tr>
<tr>
<td>Extension of roof</td>
<td>2' from all four sides</td>
</tr>
</tbody>
</table>
Fig. 1 PROPOSED MODEL DESIGN OF ONION STORAGE GODOWN FOR SMALL FARMERS
CAPACITY 2/4 mt.

FRONT ELEVATION
SIDE ELEVATION

PLAN
SCALE: 2 FEET TO AN INCH

Fig. 1

Perspective Plan
### Estimated costs for 2 MT storage structure

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Rate (Rs)</th>
<th>Amount (Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wooden round timber for columns (4&quot; diam 8' size)</td>
<td>10 nos</td>
<td>50/10</td>
<td>500.00</td>
</tr>
<tr>
<td>Wooden round timbers for side support and central beam (3&quot; diam 16' size)</td>
<td>3 nos</td>
<td>50</td>
<td>150.00</td>
</tr>
<tr>
<td>Wooden round timbers for floor supports (4'6&quot; size, 2&quot;) diam</td>
<td>10 nos</td>
<td>10</td>
<td>100.00</td>
</tr>
<tr>
<td>Wooden round timbers for central beams (3&quot; diam &amp; 4' 6&quot; size)</td>
<td>3 nos</td>
<td>25</td>
<td>75.00</td>
</tr>
<tr>
<td>Wooden round timbers for roof support - vertical columns (3&quot; diam 3' size)</td>
<td>3 nos</td>
<td>25</td>
<td>75.00</td>
</tr>
<tr>
<td>Round wooden rafters (8' size 2&quot; diam)</td>
<td>20 nos</td>
<td>10</td>
<td>200.00</td>
</tr>
<tr>
<td>Bamboo reapers (13' x 1&quot;) (4'6&quot; x 1&quot;)</td>
<td>70 nos</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Bamboo</td>
<td>15 nos</td>
<td>50</td>
<td>750.00</td>
</tr>
<tr>
<td>Cadjan</td>
<td>100 nos</td>
<td>450/100</td>
<td>450.00</td>
</tr>
<tr>
<td>Coir</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labours &amp; carpentry</td>
<td>10 man days</td>
<td>75/day</td>
<td>750.00</td>
</tr>
<tr>
<td>Used super poly sacks</td>
<td>25/nos</td>
<td></td>
<td>200.00</td>
</tr>
</tbody>
</table>

| Total expenses                                                  |          |           | 3575.00     |
| Plus contingency                                                |          |           | 125.00      |

**Grand total**

| Total quantity to be stored                                     |           | 2000 Kg = 2 MT |
| Cost of storage/MT                                              |           | Rs 1850.00    |
| Cost of storage/Kg                                              |           | Rs 1.85/Kg    |
5.2 ACTUAL COST OF STORAGE STRUCTURES CONSTRUCTED AT FARM HOUSE OF VEHERAGAMA FARMERS

Locally available materials were used for columns and side wall supports of onion storage structures erected at the houses of Mr. G.P. Tilakaratne and Mr. R.D. Jayathilaka. Only coconut leaves (cadjan), coir and nails were purchased. However, carpentry and labour expenses were incurred. (Plates 8/9)

Expenses incurred:

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>Cadjans (100)</td>
<td>Rs 450.00</td>
</tr>
<tr>
<td>Nails/coir</td>
<td>Rs 120.00</td>
</tr>
<tr>
<td>Carpentry/labour expenses</td>
<td>Rs 500.00</td>
</tr>
<tr>
<td><strong>Total expenses</strong></td>
<td><strong>Rs 1070.00</strong></td>
</tr>
<tr>
<td>Quantity stored</td>
<td>2000 Kg</td>
</tr>
<tr>
<td>Cost of storage/kg</td>
<td>Rs 0.54/Kg</td>
</tr>
</tbody>
</table>

From the above statement it appears that if farmers use the locally available materials, the storage cost can be minimized to a considerable extent.

While preparing these structures provisions have been made to increase the piling height of onions i.e. 1' to 1' 6" in bottom tier and nearly 2' in top tier, which can be increased by fixing bamboo reapers on side walls. Thus the total storage capacity of the above godown will be around 3.5 - 4 MT.

Plate 8. MARD Chief of Party visiting with farmer at Veheragama storage structure
Plate 9. Two-tier improved onion storage structure at Veheragama

5.3 MODEL OF ONION STORAGE GODOWN FOR 8 MT CAPACITY

The present on-farm storage structure is designed for use by farmers of medium sized crops. It contains two compartments and two tiers. A roof of cadjan thatch is proposed (Figure:2).

Specifications and Dimensions of proposed two tier onion shed.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plinth</td>
<td>14' (L) x 12' (W) x 1' (H)</td>
</tr>
<tr>
<td>Net size of godown</td>
<td>12' (L) x 10' (W) x 11' (H)</td>
</tr>
<tr>
<td>Gap for bottom aeration</td>
<td>1' from ground level and 1' for top tier</td>
</tr>
<tr>
<td>No of compartments</td>
<td>4 (2 tiers on each side)</td>
</tr>
<tr>
<td>Gap in between two compartments</td>
<td>(2' for movement and working)</td>
</tr>
<tr>
<td>Centre height from ground level</td>
<td>12'</td>
</tr>
<tr>
<td>Side height from ground level</td>
<td>9.5'</td>
</tr>
<tr>
<td>Slope of roof</td>
<td>1'</td>
</tr>
<tr>
<td>Extension of roof</td>
<td>2' from all four sides.</td>
</tr>
</tbody>
</table>
PROPOSED MODEL
DESIGN OF
OR PAC 1
= Z
CE IN
STORE OF
8 MT. CAPACITY

Fig. 2

FRONT ELEVATION

PERSPECTIVE VIEW

PLAN

SIDE ELEVATION

SCALE: 8 FEET TO 1 INCHES
## Estimated costs for 8 MT structure

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Rate (Rs.)</th>
<th>Amount (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot; x 4&quot; hardwood rafters</td>
<td>280Lft</td>
<td>4.50/Lft</td>
<td>1,260.00</td>
</tr>
<tr>
<td>2&quot;x 2&quot; hardwood sawn timber</td>
<td>240Lft</td>
<td>6/Lft</td>
<td>1,440.00</td>
</tr>
<tr>
<td>Bamboo reapers (1&quot; wide)</td>
<td>1800Lft</td>
<td>2/Lft</td>
<td>3,600.00</td>
</tr>
<tr>
<td>6&quot; diam round timber</td>
<td>100Lft</td>
<td>4/Lft</td>
<td>400.00</td>
</tr>
<tr>
<td>2&quot; diam round timber</td>
<td>160Lft</td>
<td>2/Lft</td>
<td>320.00</td>
</tr>
<tr>
<td>1&quot; diam round timber</td>
<td>200Lft</td>
<td>2/Lft</td>
<td>400.00</td>
</tr>
<tr>
<td>Cadjans</td>
<td>150 nos</td>
<td>450/100</td>
<td>675.00</td>
</tr>
<tr>
<td>Yarns/nails</td>
<td>--</td>
<td>--</td>
<td>560.00</td>
</tr>
<tr>
<td>Bricks</td>
<td>750 nos</td>
<td>2</td>
<td>1,500.00</td>
</tr>
<tr>
<td>Earth filling</td>
<td>100 cft</td>
<td>--</td>
<td>250.00</td>
</tr>
<tr>
<td>Labour charges</td>
<td>20 man days</td>
<td>150/day</td>
<td>3,000.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>13,405.00</strong></td>
</tr>
<tr>
<td><strong>Plus contingency</strong></td>
<td></td>
<td></td>
<td><strong>670.00</strong></td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td></td>
<td></td>
<td><strong>14,075.00</strong></td>
</tr>
</tbody>
</table>

Total quantity to be stored = 8MT i.e. 8000 Kg
Cost of storage/MT = Rs 1759.00
Cost of storage/Kg = Rs 1.76

*The cadjan roof will work for one or two seasons (3 months each). In forthcoming seasons only the cost of cadjan roofs and labour charges will be incurred.*

#### 5.4 CONSTRUCTION /MODIFICATION OF STRUCTURE AT FARMERS FIELD (SIYAMBALAWE)

The proposed structure was not constructed, however an old hut of farmer Mr. A.W.V. Heenbanda in the village Siyambalawe (Bakamuna) was modified to accommodate 4 MT of onion in a single
The structure can be modified further by erecting another tier on top making it possible to store an additional 4 MT of bulbs.

The total cost of the remodelled 4 MT storage godown for Mr. Heenbanda was Rs 1360, including cadjan, nails, and coir ropes. Thus the storage cost comes to Rs 0.34/Kg.

Plate 10. Improved onion storage godown at Siyambalawewa (Bakamuna)

5.5 ONION STORAGE STRUCTURE OF 10 MT CAPACITY CONSTRUCTED FOR FARMERS ORGANIZATION AT KALINGAWILA (ASELAPURA)

Structure

The 10 MT structure is in an unused house with a mangler tiled roof, open on all four sides. The net area available for storage is 25′ (L) and 14′ (W). Four cubicals of 14′ (L) and 4′ (W) are proposed with two tiers each making a total of 8 cubicles. (Figure 3)
ONION STORAGE STRUCTURE OF 10 MT. CAPACITY FOR FARMERS ORGANISATION AT KALINGAWILLA

Fig - 3
Specifications and dimensions for 10 MT storage structure

Net size of the cubicals - 14' (L) x 4' (W) x 5' (H)
Gap for bottom aeration - 1' from plinth level (bottom tier) and 1' from top of the bottom tier (top tier)
No of cubicles (each tier) - 4
No of tiers - 2
Total no of cubicles - 8

Estimated cost for 10 MT storage structure

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Rate (Rs)</th>
<th>Amount (Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut rafter (14' length)</td>
<td>40 nos</td>
<td>8.50/Lft</td>
<td>4760.00</td>
</tr>
<tr>
<td>Coconut rafters (7' length)</td>
<td>24 nos</td>
<td>7.50/Lft</td>
<td>1260.00</td>
</tr>
<tr>
<td>Wooden battens (2&quot; x 2&quot;)</td>
<td>40 nos</td>
<td>37.50/no</td>
<td>1500.00</td>
</tr>
<tr>
<td>Bamboos for 1&quot; reapers 12' length</td>
<td>50 nos</td>
<td>50/no</td>
<td>2500.00</td>
</tr>
<tr>
<td>Nails</td>
<td>7 Kg</td>
<td>40/Kg</td>
<td>280.00</td>
</tr>
<tr>
<td>Labour/carpentry expense</td>
<td>24 man days</td>
<td>175/days</td>
<td>4200.00</td>
</tr>
<tr>
<td>Total expenses</td>
<td></td>
<td></td>
<td>14,500.00</td>
</tr>
<tr>
<td>Plus 5% contingency</td>
<td></td>
<td></td>
<td>725.00</td>
</tr>
<tr>
<td>Grand total</td>
<td></td>
<td></td>
<td>15,525.00</td>
</tr>
</tbody>
</table>

Total quantity to be stored = 10 MT
Cost of storage/MT = Rs 1522.50
Cost of storage/Kg = Rs 1.52
While calculating the cost, bamboo prices have been incorporated however bamboo was supplied free of cost from MEA, Welikanda.

The cost of construction for the mangler tile open shed has not been calculated.

The structure is durable, and will remain for 10-15 years with minor repairs.

5.6 PROPOSED MODEL OF ONION STORAGE GODOWN OF 480 MT CAPACITY FOR BIG TRADERS

Structure

A permanent shed with suitable pillars and asbestos sheet roof is suggested for storage of large quantities of onion. The proposed structure is open on all sides and contains 150 cubicals in two tiers. Suitable work space is provided for filling and emptying the storage bins and for bagging of onions after storage. The height of the roof is sufficient for adequate air circulation and provides space for increasing the number of cubicles if additional storage capacity is needed. (Figure 4).

Specifications and dimensions

<table>
<thead>
<tr>
<th>Specification</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net size of the shed</td>
<td>130(L) x 100(W) x 21'(H)</td>
</tr>
<tr>
<td>No of cubicles in each shed</td>
<td>150</td>
</tr>
<tr>
<td>Size of each cubical</td>
<td>10'(L) x 4'(W) x 2'(H) in each tier</td>
</tr>
<tr>
<td>No of tiers in each cubicle</td>
<td>2</td>
</tr>
<tr>
<td>Gap for bottom aeration</td>
<td>1'6&quot; bottom ventilation and 2' for top tier</td>
</tr>
<tr>
<td>Span between every set of two cubicals</td>
<td>3' (W) gap between each 2 cubicals and 1' gap between cubicals (both length and breadth).</td>
</tr>
</tbody>
</table>
Estimated cost for 480 MT storage structure

The estimated cost of proposed shed may be Rs 3,250,000.00 for 13,000/ft² area (130' long x 100' wide) @ Rs 250/ft²

Cost per cubical

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Rate (Rs)</th>
<th>Amount (Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot; x 4&quot; hard wood rafters</td>
<td>106 Lft</td>
<td>20/Lft</td>
<td>2120.00</td>
</tr>
<tr>
<td>2&quot; x 2&quot; hard wood rafters</td>
<td>40 Lft</td>
<td>8/Lft</td>
<td>320.00</td>
</tr>
<tr>
<td>2&quot; x 1&quot; hardwood rafters</td>
<td>900 Lft</td>
<td>3/Lft</td>
<td>2700.00</td>
</tr>
<tr>
<td>Allowance for wire nails etc.</td>
<td></td>
<td></td>
<td>60.00</td>
</tr>
<tr>
<td>Labour</td>
<td>4 man days</td>
<td>250/day</td>
<td>1000.00</td>
</tr>
<tr>
<td><strong>Total expenses</strong></td>
<td></td>
<td></td>
<td>6200.00</td>
</tr>
<tr>
<td><strong>Plus 10% contingencies</strong></td>
<td></td>
<td></td>
<td>600.00</td>
</tr>
<tr>
<td><strong>Total cost for construction of 150 cubicals (6800 x 150)</strong></td>
<td></td>
<td></td>
<td><strong>1,020,000.00</strong></td>
</tr>
<tr>
<td><strong>Grand total for construction of 480 MT shed with 150 cubicals</strong></td>
<td></td>
<td></td>
<td><strong>4,270,000=00</strong></td>
</tr>
</tbody>
</table>

Cost of onion storage/MT = Rs 8895.83
Cost of onion storage/Kg = Rs 8.896/Kg
Average life of the structure will be 20 years therefore storage cost per year per Kg will be = Rs 0.45.

Provision for increasing the tiers/height of onion bulb exists in the proposed structure. The quantity of stored onion bulbs can be increased as needed by extending the height of side walls, or by the addition of one tier.
6. ECONOMICS OF ONION STORAGE

Onion storage is feasible only if farmers get sufficient remuneration after storage. As emphasized earlier, onion being perishable in nature, is subject to damage by various pathogens and quality is affected by environmental conditions during storage. Therefore, studies of the cost benefit ratio at harvest and after storage is important.

Onion loss varies according to the period and the type of storage. It has been generally observed that onion stored by conventional methods spoils more than onion kept in well ventilated storage structures. A three year comparison study made in India of conventional (no bottom ventilation) vs. two-tiered model godowns (sufficiently ventilated structures), showed that: (Table 4).

Table 4: Extent of periodical losses in different types of godowns

<table>
<thead>
<tr>
<th>Period of storage in months</th>
<th>Conventional godown (% losses)</th>
<th>Two-tier model godown (% losses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.56</td>
<td>5.68</td>
</tr>
<tr>
<td>2</td>
<td>14.26</td>
<td>7.52</td>
</tr>
<tr>
<td>3</td>
<td>28.46</td>
<td>18.51</td>
</tr>
<tr>
<td>4</td>
<td>44.17</td>
<td>29.41</td>
</tr>
<tr>
<td>5</td>
<td>55.66</td>
<td>36.205</td>
</tr>
</tbody>
</table>

A perusal of the data presented in Table 4 shows that losses are higher side in conventional types of storage than in well ventilated storage godowns.

6.1 PRICING PATTERN

In order to determine the pricing pattern of Big Onion in the country, data from ARTI, Colombo has been collected and calculated. Average monthly rates of Big Onion for 9 years (1985 -1993) are presented in Table 5.
Table 5: Wholesale and retail prices of Big Onion (1985-1993)

<table>
<thead>
<tr>
<th>Month</th>
<th>Wholesale price (Rs/Kg)</th>
<th>Retail Price (Rs/Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>26.19</td>
<td>32.87#</td>
</tr>
<tr>
<td>February</td>
<td>19.24</td>
<td>26.01#</td>
</tr>
<tr>
<td>March</td>
<td>19.21</td>
<td>25.82#</td>
</tr>
<tr>
<td>April</td>
<td>19.61</td>
<td>25.34#</td>
</tr>
<tr>
<td>May</td>
<td>20.76</td>
<td>26.85#</td>
</tr>
<tr>
<td>June</td>
<td>19.74</td>
<td>24.01</td>
</tr>
<tr>
<td>July</td>
<td>18.41</td>
<td>23.96 x</td>
</tr>
<tr>
<td>August</td>
<td>17.76</td>
<td>23.76 x</td>
</tr>
<tr>
<td>September</td>
<td>14.13</td>
<td>20.80 x</td>
</tr>
<tr>
<td>October</td>
<td>15.36*</td>
<td>20.95 #</td>
</tr>
<tr>
<td>November</td>
<td>23.04*</td>
<td>30.78 #</td>
</tr>
<tr>
<td>December</td>
<td>25.57*</td>
<td>34.37 #</td>
</tr>
</tbody>
</table>

* Average price of 8 years (1985 - 1992)
# Average price for 8 years (1985,1987 - 1993)
x Average price for 8 years (1986 - 1993)
† Average price for 7 years (1986 - 1992)

Source: ARTI, Data Bank

A perusal of the data on pricing patterns indicates that the prices at the beginning of harvest (August) are on the high side and decrease in the peak harvest (September). A further rise in both wholesale and retail prices is evident from October through January in increasing order (wholesale price only).

6.2 COST OF CULTIVATION OF BIG ONION

Cultivation cost of Big Onion varied according to the source. During interviews with farmers in Veheragama, Kalingawila, Siyambalawe, Dambulla and Kimbissa areas Rs 5.29/Kg was reported including family labourers. However as per MARD extension bulletin "Let Us Grow Big Onion" by Mr. Y.P. de Silva (1992) the cost of onion cultivation comes to Rs 4.33/Kg. Since most of the onion growers in System B cultivate a small area i.e. quarter or half acres, it is obvious that onion cultivation can be managed by family labour and the cost of cultivation will be less than Rs 4.33/Kg. This cost will be used for further calculating the economics of storage.
6.3 COST BENEFIT RATIO AT HARVEST AND AFTER STORAGE

The present cost benefit ratio is calculated for cultivation/storage of 1000 Kg of onion. The average cost of cultivation has been considered as Rs 4.33/Kg, storage cost as Rs 0.50/Kg if farmer stored his onions in the conventional method and Rs 0.54/Kg if onions were stored in a suitably ventilated improved godown (example - Veheragama). The extent of loss has been based on the data presented in Table 4. The sale price is based on the average wholesale price of onion (Table 5). Considering above facts and figures a predicted calculation is presented to explain the cost benefit ratio at harvest and after storage for 3 months in both conventional (Table 6) and improved (Table 7) methods of storage. The data revealed that net profit and cost benefit ratio is higher after two -three months of storage in both conventional and model godowns but is less than the net profit at harvest if farmer sells his onion after one month. This low profit is the result of a very marginal difference between the average market rates in September (harvest) and October (1 month of storage). However, the data strongly indicates that the profit from bulbs stored in suitably designed ventilated structures is more than that from bulbs stored in the conventional method.

Thus farmers must be encouraged to construct small economic types of improved storage godowns, enabling them to fetch better market prices.

Table 6: Predicted cost benefit ratio at harvest and after 1-3 months of storage by conventional methods

<table>
<thead>
<tr>
<th>Description</th>
<th>Harvest (Sept.)</th>
<th>Storage period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Qty. of bulbs (Kg)</td>
<td>1 month (Oct.)</td>
</tr>
<tr>
<td>Production cost Rs.4.33/Kg</td>
<td>1000</td>
<td>924.40</td>
</tr>
<tr>
<td>Storage cost (Rs .5/Kg)</td>
<td>500.00</td>
<td>500.00</td>
</tr>
<tr>
<td>Storage cost including price at harvest (Rs)</td>
<td>4830.00</td>
<td>4830.00</td>
</tr>
<tr>
<td>Storage losses (%)</td>
<td>0.0</td>
<td>7.56</td>
</tr>
<tr>
<td>Sale rate Rs/kg</td>
<td>14.13</td>
<td>15.36</td>
</tr>
<tr>
<td>Gross revenue (Rs)</td>
<td>4130.0</td>
<td>14198.78</td>
</tr>
<tr>
<td>Net revenue (Rs)</td>
<td>9800.0</td>
<td>9368.78</td>
</tr>
<tr>
<td>Cost benefit ratio</td>
<td>1:2.262</td>
<td>1:1.939</td>
</tr>
</tbody>
</table>
Table 7: Predicted cost benefit ratio at harvest and after 1-3 months of storage in improved method of storage
(2 tier model)

<table>
<thead>
<tr>
<th>Description</th>
<th>Harvest (Sept.)</th>
<th>Storage period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 month (Oct.)</td>
</tr>
<tr>
<td>Quantity of bulbs (Kg)</td>
<td>1000</td>
<td>943.20</td>
</tr>
<tr>
<td>Production cost @ Rs. 4.33/Kg</td>
<td>4330.00</td>
<td></td>
</tr>
<tr>
<td>Storage cost (Rs) @ 0.54/Kg</td>
<td>540.00</td>
<td>540.00</td>
</tr>
<tr>
<td>Total storage cost including price at harvest (Rs)</td>
<td>4870.0</td>
<td>4870.00</td>
</tr>
<tr>
<td>Storage losses (%)</td>
<td>5.68</td>
<td>7.52</td>
</tr>
<tr>
<td>Sale rate Rs/Kg</td>
<td>14.13</td>
<td>15.36</td>
</tr>
<tr>
<td>Gross revenue (Rs)</td>
<td>14130.00</td>
<td>14487.55</td>
</tr>
<tr>
<td>Net revenue (Rs)</td>
<td>9800.00</td>
<td>9617.55</td>
</tr>
<tr>
<td>Cost benefit ratio</td>
<td>1:2.263</td>
<td>1:1.974</td>
</tr>
</tbody>
</table>

6.4 SOME PRACTICAL EXAMPLES ON COST BENEFIT RATIO

Described below are the actual profits received from onion which was properly cured, sorted and graded before being stored in ventilated storage godowns constructed by MARD.

6.4.1. Veheragama

The farmer stored 1000 Kg onion in a model ventilated storage structure for 1 month and sold onions in the last week of October @ Rs 22/Kg. Onion loss recorded was 6% which was mainly due to driage.

At harvest

Production cost for 1000 Kg of onion @ Rs 4.33/Kg (Rs) 4330.00
Sale price of onion at harvest @ Rs 8/Kg 8000.00
Net profit (at harvest) 3670.00

Cost benefit ratio 1:0.848
After 1 month storage

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production cost plus storage cost</td>
<td>4,870.00</td>
</tr>
<tr>
<td>Value realized after sale of 940 Kg of onion (with 6% loss) @ Rs 22/Kg</td>
<td>20,680.00</td>
</tr>
<tr>
<td>Net profit after 1 month storage</td>
<td>15,810.00</td>
</tr>
</tbody>
</table>

**Cost benefit ratio**

1:3.246

6.4.2 Bakamuna (Siyambalawe)

The farmer stored 4000 Kg of onion during September. Mudalali approached him for purchase of his onion @ Rs 8.00/Kg. He refused to sell and kept his stock in a ventilated model structure which was modified in his own hut at a storage cost of Rs 0.34/Kg. During the last week of October, Mudalali offered Rs 25/Kg but the farmer did not sell the stock as he expected higher rates.

The analysis of cost benefit ratio based on the above facts will be:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total quantity produced/stored</td>
<td>4000 Kg</td>
</tr>
<tr>
<td>Production cost @ Rs 4.33</td>
<td>Rs 17,320.00</td>
</tr>
<tr>
<td>Price offered by Mudalali at harvest</td>
<td>Rs 32,000.00</td>
</tr>
<tr>
<td>Net profit at harvest (if sold)</td>
<td>Rs 14,680.00</td>
</tr>
<tr>
<td><strong>Cost benefit ratio at harvest</strong></td>
<td>1:0.847</td>
</tr>
<tr>
<td>Cost of storage @ 0.34/Kg plus cost of production</td>
<td>Rs 18,680.00</td>
</tr>
<tr>
<td>Quantity of stored bulbs in October (minus 6% loss)</td>
<td>3760 Kg</td>
</tr>
<tr>
<td>Sale price @ 25/kg</td>
<td>Rs 94,000.00</td>
</tr>
<tr>
<td>Net profit after 1 month storage</td>
<td>Rs 75,320.00</td>
</tr>
</tbody>
</table>

**Cost benefit ratio**

1:4.032

The above facts and figures are self explanatory, showing how farmers benefit by the storage of Big Onion.
6.5 EFFECT OF ENVIRONMENTAL CONDITIONS ON ONION DURING STORAGE - PREVAILING PREDICTIONS

Most farmers store onion in late September or early October, therefore the increased humidity and low temperature following the October - December rains will be a concern to onion health and its keeping quality.

A perusal of the temperature, rainfall and humidity data presented in (Figure 5) shows that normal average temperatures (26.68 - 28.71°C) during October, November and December are just above the lowest limit (25°C) suitable for dormant stage of onion bulbs. Further the relative humidity is within the permissible limit, i.e. 75% during October. In November and December, the range of relative humidity (81.84 - 84.37%) may increase black mould, fungal rot, rooting and sprouting. However, the farmers have stored onions in ventilated storage structures after proper curing, sorting and grading. Therefore, humid pockets between the bulbs will break up faster due to continuous air flow which will help in maintaining the optimum storage conditions.
Fig. 5. Avg. Temperature, Rainfall & Relative Humidity (1984 - 1993)

Source: RARC, Aralaganwila (Avg. for Oct., Nov., & Dec of 9 years only)
7. **PRESERVATION OF BIG ONION**

During peak harvests, the increased volume of onion creates a decline in prices. Under such circumstances processing of onions by the producer may be one solution instead of selling at low prices or incurring heavy losses due to lack of storage facilities.

Consumers however, can also take advantage of low prices by purchasing the onions in bulk quantity and preserving them for future use. Onion can be preserved through following ways:

a. **By the preparation of pickles**

b. **By dehydration:**

Onions can be dehydrated in slices, rings or shreds and packed in moisture proof polythene bags. A solar drier can be used for dehydration. The process of dehydration is simple, and can be followed by any farmer or housewife and can be promoted through food preservation extension media. First cut the onions into 1/10 inch thick slices after removal of tops, then immerse in a 5% solution of common salt for about 10 minutes and drain off the salt solution. Dry at 140-150°F for 11-13 hours. Temperatures higher than 50°F may lead to browning of slices. The drying ratio depends upon the variety and varies from 1:7 to 1:9. The dried product can be powdered for use in several ways.
## Appendix I

### COMPARATIVE COST OF PRODUCTION OF BIG ONION/ACRE IN SRI LANKA (SYSTEM B) AND INDIA

<table>
<thead>
<tr>
<th>OPERATION</th>
<th>SYSTEM B (SL Rs)</th>
<th>INDIA (SL Rs)</th>
<th>RAINY (SL Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Rent</td>
<td>936.00</td>
<td>936.00</td>
<td>936.00</td>
</tr>
<tr>
<td>Seed</td>
<td>3850.00</td>
<td>936.00</td>
<td>624.00</td>
</tr>
<tr>
<td>Land preparation</td>
<td>1500.00</td>
<td>530.40</td>
<td>530.40</td>
</tr>
<tr>
<td>Nursery raising</td>
<td>1500.00</td>
<td>499.20</td>
<td>312.00</td>
</tr>
<tr>
<td>Manures &amp; fertilizers</td>
<td>2820.00</td>
<td>1934.40</td>
<td>2059.20</td>
</tr>
<tr>
<td>Transplanting</td>
<td>2000.00</td>
<td>936.00</td>
<td>936.00</td>
</tr>
<tr>
<td>Irrigation</td>
<td>1200.00</td>
<td>1123.20</td>
<td>499.20</td>
</tr>
<tr>
<td>Weeding &amp; Hoeing</td>
<td>4500.00</td>
<td>936.00</td>
<td>936.00</td>
</tr>
<tr>
<td>Plant protection</td>
<td>1875.00</td>
<td>1092.00</td>
<td>780.00</td>
</tr>
<tr>
<td>Harvesting, curing</td>
<td>2000.00</td>
<td>936.00</td>
<td>967.20</td>
</tr>
<tr>
<td>sorting, grading &amp; packing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation</td>
<td>400.00</td>
<td>1872.00</td>
<td>1248.00</td>
</tr>
<tr>
<td>Overhead charges</td>
<td></td>
<td>187.20</td>
<td>187.20</td>
</tr>
<tr>
<td>Supervision charges</td>
<td></td>
<td>124.80</td>
<td>124.80</td>
</tr>
<tr>
<td>Total cost of production</td>
<td>21645.00</td>
<td>12043.20</td>
<td>10140.00</td>
</tr>
<tr>
<td>Average yield (MT/Acre)</td>
<td>5.0</td>
<td>12.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Cost/MT (Rs)</td>
<td>4329.00</td>
<td>1003.60</td>
<td>1267.50</td>
</tr>
<tr>
<td>Cost/Kg (Rs)</td>
<td>4.329.00</td>
<td>1.003</td>
<td>1.268</td>
</tr>
</tbody>
</table>

* Conversion rates: 1.56 SL Rs = 1.0 Indian Rs

**Source:**
- India - "Onions in India" (compiled by Dr. U.B. Pandey, AADF bulletin no 5, 1993)
- Sri Lanka - "Let Us Grow Big Onion" (compiled by Mr. Y.P. de Silva, MARD, 1992) System B.
Appendix II

TERMS OF REFERENCE OF CONSULTANCY

a. Background and objectives

During the past few years onion production increased significantly in Sri Lanka. This resulted in seasonal gluts and off season shortage. Due to poor storage and other related problems. The end result of large harvests was severe loss to both producers and wholesale buyers.

It is timely and important to improve onion storage to minimize loss thereby providing a market during the off season. This is one area which can be strengthened to increase profits in onion production.

The objective of this consultancy is to provide technical assistance on onion storage to both settler-farmers and the cooperative wholesale establishment (CWE).

b. Purpose

(i) To reduce the losses incurred by the CWE due to lack of storage.

(ii) To stabilize onion prices by eliminating to some extent the harvest period gluts and off season shortages.

(iii) To provide farmers with the opportunity to take advantage of high, off season prices for onion.

c. Specific works undertaken by the consultant

(i) To review the present status of onion production and storage in the Mahaweli areas of Sri Lanka especially in Systems B and G. To work closely with CWE and with both large and small scale farmers to understand the present problems associated with onion storage and related production problems.

(ii) To discuss finding with Sri Lankan onion storage experts recommended by the MEA Senior Agronomist and by MARD.

(iii) To recommend a suitable, low-cost storage model for small-holder farmers and farmer organizations.

(iv) To recommend a suitable storage model, or suitable modifications to existing structures available to CWE for large volume storage as appropriate to CWE or to large private wholesalers.
(v) To submit draft reports with concrete recommendations.

(vi) To conduct a final seminar for MEA, DOA, and CWE specialists and decision makers.

The specific works assigned in connection with CWE were not undertaken. Details are available from Dy. C.O.P. MARD, Pimburattewa.
Appendix III

BRIEF RESUME OF THE WORKS UNDERTAKEN (June 9 - July 10, 1993)

a. Conducted a survey of onion growing areas of Systems B and G, i.e. Wijayabapura, Veheragama, Kalingawila, Bakamuna, Siyambalawa and Minneriya, Ebbankatuwa, Porongwewa, Pelwehera, Velihena Colony, Palutawewa of Dambulla and Kimbissa. During the visit I met with 28 farmers and 6 traders of Big Onion.

b. Worked with farmers and extended postharvest technology of Big Onion.

c. Prepared economic, scientific storage godowns at Veheragama (two), Kalingawila (four units in one shed) and Siyambalawewa (one).

d. Performed preharvest spray of carbendazim in the field for reduction of storage losses.

e. Delivered talks on postharvest technology of onions to the agriculture officers and field assistants of Mahaweli System B (MRTC), Welikanda and Mahaweli System C.

f. Surveyed storage structures and storage practices being followed by the farmers and extended the right procedure of storage for Big Onions to the farmers and traders.

g. Delivered a talk on postharvest technology of onion at Peradeniya for the Agricultural Authorities of different states of Sri Lanka in the presence of Hon. Agriculture Minister, Agriculture Secretary and Directors of Agriculture and Research of Govt. of Sri Lanka.

h. Visited RARC Aralaganwila, and Ma:ailuppallama and discussed present status of Big Onion research and storage.

i. Collected data required for the preparation of a draft report from ARTI, Colombo, and other institutions.
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Mr. Bruce Spake, Chief of Party
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Ministry of Agriculture Development and Research - Sri Lanka

Hon. R.H. Dharmadasa Banda, Minister
Mr. Dixon Nilaweera, Sec’y. Minister

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Mr. E.N.R. Fernando, ARTI, Colombo
Mr. Joe Fernando, TESS Agro Pvt. Ltd.