

Design and Development of Onion Storage Shade for Better Ventilation and Longer Life

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Abstract

Onions are one of the most important cash crops for farmers in India and many other countries. However, most harvested onions are lost every year due to improper storage. Traditional storage methods, such as keeping onions in heaps under trees, in closed rooms, or in poorly ventilated sheds, do not provide sufficient airflow. As a result, moisture accumulates, leading to sprouting, fungal growth, rotting, and physical damage. These losses reduce farmers' income and create instability in market prices. To solve this problem, an improved onion storage shade has been designed with a focus on natural ventilation and cost-effectiveness. The structure is raised above ground level on a platform to prevent moisture from entering from the soil. This elevation also allows air to circulate from below. The side walls are made with perforated materials, such as bamboo slats, wooden battens, or wire mesh, which ensure continuous cross-ventilation. Proper airflow is essential because onions release moisture during storage, and removing this moisture helps maintain their quality. The roof is designed in a ridge shape, allowing hot air to rise and escape through the top. This reduces internal temperature and prevents condensation. The roofing material can be locally available sheets, tiles, or thatch, depending on regional climate conditions. The structure is simple, durable, and affordable, making it easy for small and medium farmers to adopt without heavy investment. Early field trials have shown a significant reduction in storage losses compared to traditional methods. By keeping onions dry, cool, and well-ventilated, the improved shade maintains firmness, reduces sprouting, and preserves weight. This allows farmers to store onions for longer periods and sell them when market prices are favorable. Overall, this improved storage shade supports better income stability, reduces post-harvest waste, strengthens the supply chain, and contributes to food security. It is a practical and sustainable solution that empowers farmers and promotes agricultural development.

Keywords: Agricultural engineering, natural airflow, onion storage, post-harvest losses, Shelf life, Storage shade, Ventilation

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INTRODUCTION

Onion cultivation is a significant contributor to global food security and economic development. As a staple ingredient in many cuisines, onions are in high demand, driving production in countries like India, China, and the US. However, the journey from farm to table is fraught with challenges, particularly in post-harvest handling and storage [1].

Onions are a perishable crop, and their storage requires careful consideration. After harvest, onions continue to respire, releasing heat and moisture that can lead to spoilage. Traditional storage methods often fail to address these issues, resulting in

significant losses. In India, for instance, post-harvest losses can range from 25–40%, translating to substantial economic losses for farmers and the country as a whole [2].

Improved onion storage sheds offer a practical solution to this problem. Designed to regulate airflow, temperature, and humidity, these sheds use natural ventilation to maintain a dry and cool environment. The key features of these sheds include raised platforms, slatted flooring, perforated walls, and ridge-type roofs. Locally available materials like bamboo, wood, and metal sheets make these sheds affordable and accessible to small farmers [3].

The design of these sheds is based on scientific principles, taking into account local climatic conditions, wind direction, and rainfall patterns. In dry regions, larger ventilation gaps may be sufficient, while in humid areas, higher elevation and wider airflow channels are necessary. In heavy rainfall zones, proper drainage systems must be included to prevent water accumulation around the shed.

Proper storage management practices, such as curing, sorting, and regular inspection, complement the shed design. Curing helps dry the outer skin, reducing moisture content and susceptibility to spoilage. Only healthy and undamaged bulbs should be stored, as damaged bulbs are more prone to spoilage. Regular inspection is crucial to identify and remove spoiled bulbs, preventing the spread of disease [4].

The benefits of improved onion storage are multifaceted. Farmers can increase their incomes by selling their produce during off-season periods, fetching better prices and enhancing profitability [5]. Market stability improves, and consumers benefit from consistent availability and stable prices. Additionally, reduced post-harvest losses mean more efficient use of resources like water, fertilizers, and land [6].

Community-level storage facilities can further enhance affordability and efficiency. Cooperatives and farmer producer organizations can develop shared storage systems, reducing costs and enabling collective marketing strategies. Government support and simple modern technologies like temperature and humidity monitoring devices can also enhance adoption.

In conclusion, improved onion storage sheds are a crucial innovation for farmers, offering a low-cost, effective solution to post-harvest losses. By promoting sustainable agriculture, reducing waste, and improving food security, these sheds can transform the lives of farmers and contribute to rural development [7].

LITERATURE REVIEW

Storing onions properly is very important to keep them fresh and prevent spoilage before they reach the market. In hot and humid areas, onions spoil very quickly. They may start sprouting, rotting, or drying up and shrinking. When this happens, farmers lose a large part of their harvest, which directly affects their income. Many farmers still use traditional storage methods, such as keeping onions in heaps on the floor, storing them in small rooms with very little ventilation, or covering them with tarpaulin sheets [8]. These methods do not control heat or moisture properly. As a result, onions heat up internally, release moisture, and begin to decay. According to the Indian Council of Agricultural Research (ICAR), farmers can lose around 25–40% of their onions within just 2–3 months if they use these traditional storage methods.

To solve this problem, improved storage systems have been developed by agricultural experts. For example, the National Horticultural Research and Development Foundation (NHRDF) designed a special onion storage structure with raised floors and side walls that allow proper airflow [9]. The raised platform prevents moisture from the ground from entering the storage area. The side walls are made

with gaps or perforations so that fresh air can circulate continuously. This design reduces onion losses to less than 15%, which is a major improvement. It also protects onions from direct sunlight and rain.

Natural ventilation plays a very important role in onion storage. When air flows freely through the stored onions, it removes excess heat and moisture. Scientific studies show that well-ventilated storage structures can maintain the inside temperature about 5–7°C lower than the outside temperature. This cooler environment prevents sprouting and reduces fungal growth. A sloped or ridge-type roof is also helpful because it allows hot air to escape from the top.

Another important step before storage is curing. After harvesting, onions should not be stored immediately. They need to be dried properly in the field for about 7–10 days. This process, called curing, dries the outer skin and neck of the onion, reducing moisture content and increasing storage life. Farmers should also sort the onions carefully and remove damaged, cut, or diseased bulbs. Even one rotten onion can spread infection to others if not removed in time.

The good news is that farmers do not need expensive materials to build better storage structures. Local materials, such as bamboo, wooden poles, thatch, wire mesh, or metal sheets can be used to build low-cost and effective storage sheds. These structures are affordable and suitable for small and marginal farmers. In rural Maharashtra, farmers who adopted improved storage sheds were able to store onions safely for three months and sell nearly 25% more produce later when market prices were higher. This helped them earn better profits [10].

Regular inspection is also very important. Farmers should check stored onions every 10–15 days and remove any spoiled bulbs. Proper stacking methods should be followed so that onions are not piled too high, as excessive pressure can cause damage. Maintaining cleanliness inside and around the storage shed also reduces the risk of pests and diseases.

Experts agree that well-designed onion storage units help farmers reduce losses, stabilize market supply, and increase income. When farmers can store onions for longer periods, they do not need to sell immediately at low prices during peak harvest season. Instead, they can wait for better market rates. This not only improves farmer income but also helps maintain price stability for consumers [11].

Proper onion storage also contributes to food security. When less produce is wasted, more food becomes available without increasing cultivation area. It means better use of water, fertilizers, labor, and land resources. Community-level storage systems built by farmer cooperatives or Farmer Producer Organizations (FPOs) can further reduce costs and allow collective marketing [12]. Government support in the form of subsidies, training programs, and simple monitoring tools like temperature and humidity meters can encourage more farmers to adopt improved storage systems.

In conclusion, proper onion storage is not just about keeping onions fresh — it is about protecting farmers' hard work, improving rural livelihoods, reducing food waste, and strengthening the agricultural economy. With simple improvements, local materials, and proper management practices, farmers can significantly reduce losses and increase their earnings. It is a practical and sustainable solution that can make a real difference in the lives of farmers and ensure a stable onion supply for the country.

PROBLEM STATEMENT

Onion is a very important vegetable that people use almost every day in cooking. It is used in homes, hotels, street food stalls, and food industries throughout the year. Because there is always demand for onions, farmers grow them in large quantities. But the real problem starts after harvesting. Many onions get spoiled because they are not stored properly. In villages, farmers often keep onions in heaps, small rooms, or temporary sheds that do not have enough airflow. These traditional methods do not control heat and moisture and do not fully protect the onions from rain or humidity. Due to this, onions begin

to sprout, rot, dry up, or get fungal infections. As a result, farmers may lose 30% to 40% of their total crop. This huge loss reduces their income and creates financial problems for their families [13].

To solve this problem, farmers need a simple and low-cost storage system that matches the local weather conditions. The storage shed should allow proper air movement so that the heat produced by the onions can escape easily. Good ventilation helps reduce moisture, which is one of the main reasons for rotting and fungus. The storage structure should also protect onions from direct sunlight, heavy rain, and high humidity. A raised platform is very important so that ground moisture does not damage the onions. The shed should also stay cooler inside, even during hot days. If farmers do not have proper storage, they are forced to sell their onions immediately after harvest when prices are usually low. Because of this, they cannot earn better profits during the off-season when prices increase.

The main aim of this project is to create a better onion storage shed that is affordable, easy to build, and effective in reducing losses. The improved design will focus on good airflow, keeping onions dry, and maintaining a cool environment inside the shed [14]. With better storage, onions can last longer without spoiling. This means farmers can store their produce safely and sell it later at better prices. As a result, they can earn more money and reduce financial stress. Proper storage will also ensure that good-quality onions are available in the market throughout the year. In the long term, improved onion storage will help reduce food waste, support farmers' livelihoods, and strengthen the overall agricultural system [15].

OBJECTIVES AND GOALS

The main aim of this project is to build a better onion storage shed that helps farmers keep their onions fresh for a longer time. Right now, many onions get spoiled after harvest because of poor storage. This new shed will improve airflow and protect onions from heat and moisture, so farmers lose less and earn more.

What we Want to Do

- *Learn from current methods:* First, we'll look at how farmers are storing onions now and find out what problems are making the onions go bad.
- *Build a simple, low-cost storage shed:* We'll design a storage shed that is easy to build, doesn't cost much, and uses local materials like bamboo or tin sheets.
- *Let air flow naturally:* The shed will be designed in a way that fresh air can move through easily. This helps stop onions from sprouting, rotting, or getting fungus.
- *Keep things cool and dry:* The shed will protect the onions from getting too hot or too wet, which is important for keeping them fresh.
- *Test it out:* We'll use the shed on real farms and compare the results with old storage methods to see how well it works.

What We Hope to Achieve

- Reduce onion spoilage from 30–40% down to less than 15%
- Make onions last 2–3 months longer in storage
- Keep onions in better condition so they sell for a good price
- Create a model that other farmers can also use
- Help promote farming practices that are cheap and good for the environment

METHODOLOGY

We developed the improved onion storage shed in a simple and practical way so that it would truly help farmers. First, we started by reading books, research papers, and agricultural guidelines about onion storage. This helped us understand what happens to onions after harvest. We learned that onions continue to release heat and moisture, and if this heat is trapped, it leads to rotting and sprouting. We also studied different storage methods used in various places and understood what worked well and what did not. This gave us a clear idea of the common mistakes to avoid.

After learning from books, we went to farms to see the real situation. We talked directly with farmers and observed how they were storing their onions. Many of them were using simple heaps, small rooms, or temporary sheds without proper airflow. Farmers told us about the problems they face, such as onions rotting during the rainy season, sprouting in hot weather, and getting damaged because of moisture. From these visits, we clearly understood that poor ventilation, excess humidity, and heat buildup were the main reasons for heavy losses. Farmers also said they needed a storage system that is affordable and easy to build.

Using both our research and the farmers' feedback, we designed a new type of storage shed as shown in Figures 1 and 2. The main focus was to improve natural airflow and protect onions from rain and direct sunlight. We added raised platforms so that ground moisture does not reach the onions. The walls were designed with gaps or slats to allow fresh air to pass through. We also included a sloped or ridge-type roof so that hot air can move out easily. We made sure the design could be built using local materials like bamboo, wood, metal sheets, and wire mesh so that farmers would not have to spend too much money as shown in Table 1.

Table 1. Components and costing (Estimated).

Component	Description	Estimated Cost (INR)
Frame structure	Bamboo or mild steel pipes for the frame	₹5,000 – ₹7,000
Roofing material	Tin/metal sheets or thatch for protection from rain and sun	₹3,000 – ₹5,000
Raised platform	Wooden planks or bamboo to keep onions off the ground	₹2,000 – ₹3,000
Side walls (Ventilation)	Slatted wood, bamboo, or mesh for airflow	₹1,500 – ₹2,500
Flooring (optional)	Concrete or bamboo mat flooring for hygiene	₹1,500 – ₹2,000
Fasteners & tools	Nails, bolts, tools for assembly	₹500 – ₹1,000
Labor cost	Local labor charges for construction	₹2,000 – ₹3,000

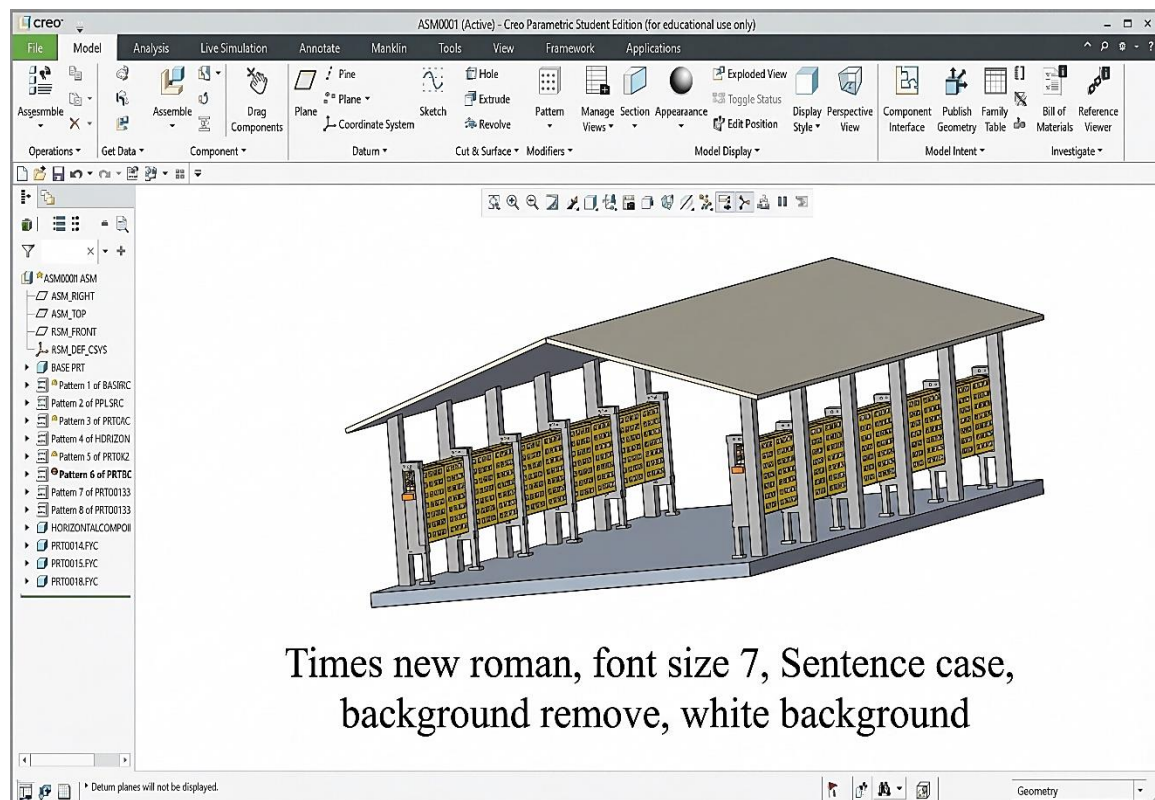


Figure 1. Solid work mode (Front view).

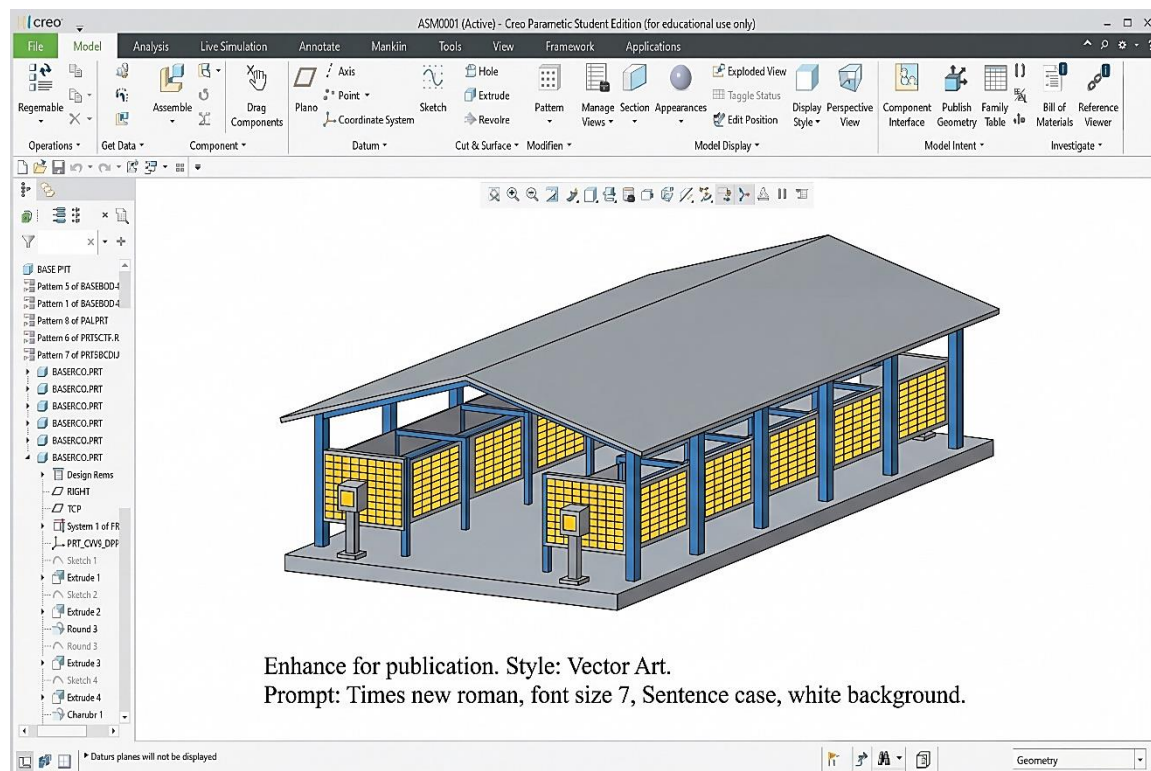


Figure 2. Solid work mode (Top view).

After finalizing the design, we built a full-size shed as a trial model. While building it, we made sure it was strong, stable, and simple to construct. We paid attention to proper spacing so that air could circulate between the onions. The shed was made durable enough to handle wind and rain, but still easy for farmers to copy without needing special skills or expensive tools.

Once the shed was ready, we tested it by storing freshly harvested onions inside for several weeks. We regularly checked the temperature, moisture levels, and condition of the onions. We observed how many onions spoiled, sprouted, or remained fresh. We also compared the results with onions stored in traditional ways. The improved shed performed much better. There was less moisture buildup, better air movement, and fewer spoiled onions.

After the testing phase, we made some small improvements to make the shed even better. We adjusted certain parts to improve airflow and made the structure stronger where needed. We also asked farmers for their opinions and suggestions. Their feedback helped us make the shed more practical and easier to use. Through this simple step-by-step process—learning, observing, designing, building, testing, and improving—we successfully created a storage shed that is useful, affordable, and farmer-friendly.

RESULTS AND DISCUSSION

We built a new and improved onion storage shed with better ventilation, and the results have been very positive. The main idea was simple — keep the onions cool and dry so they don't spoil quickly. After testing, we found that the shed stays about 2–3°C cooler than the outside temperature. This small temperature difference makes a big impact because onions naturally release heat and moisture after harvest. If that heat stays trapped, the onions start to rot or sprout. But in this improved shed, the heat escapes easily, and moisture does not build up inside.

Because of the better airflow and cooler environment, onions stored in the shed lose 5–7% less weight compared to traditional storage methods. Normally, onions shrink due to moisture loss, which reduces their market weight and price. In this new system, weight loss is lower, sprouting is delayed, and rotting

has reduced significantly. This means more onions remain fresh and suitable for sale, which directly benefits farmers.

For farmers, this improvement makes a real difference in income. When onions last longer and maintain good quality, farmers do not have to sell immediately after harvest when market prices are low. Instead, they can wait for a better time when demand increases and prices rise. Farmers who tested this shed shared that they were able to store onions for 2–3 weeks longer than before. Those extra weeks gave them the opportunity to sell during peak demand and earn better profits. This flexibility reduces financial pressure and improves overall stability for farming families.

One of the best parts of this shed is that it mainly uses natural ventilation. Fresh air enters through the open sides, and hot air moves out through the top. This continuous airflow keeps temperature and humidity under control without needing expensive cooling systems. In some cases, small low-power fans can be added, but even without them, the shed works efficiently. Because it uses natural airflow, electricity costs are very low. This makes the system affordable for small and medium farmers.

Another important benefit is better hygiene and disease control. When moisture collects in traditional storage, fungal infections spread quickly from one onion to another. In this improved shed, the dry environment reduces the risk of fungal growth. Since onions are stored in a well-organized and ventilated way, farmers can easily inspect them and remove any damaged bulbs early. This prevents further spoilage and keeps the overall stock healthy.

We are now working on improving the design further so it can be used in different climate conditions. In humid regions, we are planning to increase ventilation gaps and raise the platform height even more to avoid moisture problems. In dry or windy areas, slight design adjustments can help maintain the right airflow balance. We are also exploring larger shed models so that farmer groups, cooperatives, or communities can store onions together. This will reduce individual costs and increase collective profit.

Overall, the improved onion storage shed is a simple but powerful solution. It reduces post-harvest losses, increases storage life, maintains better quality, and improves farmer income. At the same time, it helps ensure a steady supply of onions in the market, which benefits consumers as well. With more awareness and wider adoption, this practical and low-cost innovation can bring long-term positive change to farmers and the entire onion industry.

FUTURE SCOPE

The onion storage shed we built is already working well and helping farmers reduce losses. But there are still many simple ways we can improve it in the future to make it even better and more useful.

First, we can improve the airflow even more. Right now, the shed allows fresh air to move in and out, but we can design it in a smarter way based on local wind direction and weather conditions. We can add adjustable openings or small movable vents so farmers can control the airflow depending on the season. Better airflow means the shed will stay cooler and drier, which will help onions last even longer.

Second, we can use stronger and longer-lasting materials. Instead of normal sheets, we can use rust-proof metal sheets or waterproof roofing that can handle heavy rain and strong sunlight. We can also treat bamboo or use coated steel so the structure does not get damaged easily. Even if these cost a little more at the beginning, it will save money later because the shed will need fewer repairs and will last many years.

We can also add simple technology to make the shed smarter. Small temperature and humidity sensors can be placed inside the shed. These can show farmers the current conditions on a small screen or even send updates to their mobile phones. In the future, we can connect these sensors to small fans

or automatic vents that open and close on their own when the temperature rises. Solar panels can also be added so the system works without increasing electricity costs.

Another good idea is to make the shed easy to expand. If we build it in small sections, farmers can start with a small storage space and later add more sections when their production increases. This is very helpful for small farmers. Farmer groups or cooperatives can also build bigger versions to store onions together and share the benefits.

We can also modify the shed slightly so it can store other crops like garlic or potatoes. This way, farmers can use the same structure for different crops throughout the year and get more value from it.

In the future, training programs can help farmers learn how to build and maintain these sheds properly. Government support or subsidies can also encourage more farmers to adopt this system.

In simple words, the storage shed is already helpful, but with small improvements in design, materials, technology, and size, it can become even better. It can last longer, work more efficiently, and help many more farmers reduce waste and earn better income.

CONCLUSION

The improved onion storage shed is a simple and practical solution made to help farmers reduce losses after harvest. When we built and tested the shed with better ventilation, the results were very encouraging. The biggest improvement was better airflow inside the shed. Fresh air can move in and out easily, which keeps the inside cooler and prevents moisture from building up. Since onions naturally release heat and moisture after they are harvested, it is very important to let that heat escape. If heat and moisture stay trapped, onions start to spoil. By keeping the environment cool and dry, the onions remain fresh for a longer time.

One of the most important benefits we saw was that onions lasted much longer in this shed. In traditional storage, onions often start sprouting or rotting quickly, especially in hot and humid weather. But in the improved shed, sprouting was delayed and rotting was reduced a lot. The storage life increased by about 2–3 months compared to old methods. This extra time is very valuable for farmers because they don't have to rush to sell their crop immediately after harvest. Instead, they can wait for market prices to improve and sell when demand is higher. This helps them earn better profits.

Another big advantage is reduced weight loss. Normally, onions lose moisture during storage, which makes them lighter and reduces their selling weight. In the improved shed, weight loss was reduced by around 5–7%. This may sound small, but when farmers store large quantities, it makes a big difference. More weight means more money, and less produce goes to waste.

The shed is also strong, simple, and affordable. It is built using locally available materials like bamboo, wooden poles, metal sheets, and natural roofing. This keeps the construction cost low. Farmers can build it themselves without needing expensive equipment or skilled workers. The structure is strong enough to handle rain and wind while still allowing proper airflow. The ventilation mainly works naturally, so there is little or no need for electricity. This keeps running costs very low.

Overall, this improved storage shed gives farmers many benefits. There is less spoilage, longer storage time, lower construction cost, and higher income. It helps farmers protect their hard work and reduces financial stress. In the future, the design can be adjusted for different climates, and simple tools like temperature or humidity sensors can be added to make it even better. Larger sheds can also be built for farmer groups or cooperatives.

In simple words, this onion storage shed is a smart and farmer-friendly solution. It saves onions from spoiling, helps farmers earn more money, and supports a steady supply of onions in the market. With more awareness and use, it can make a big positive difference for farmers across the country.

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