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# Review the Design of the Solar Dryer for the Dryer of Fruit and Vegetable Dryers

**Tariku Workineh Daksa[1, *], Getachew Neme Tolesa[2]**

[1]Department of Food Technology and Process Engineering, Haramaya Institute of Technology, Haramaya University, Haramaya, Ethiopia
[2]Department of Food Science and Postharvest Technology, Haramaya Institute of Technology, Haramaya University, Haramaya, Ethiopia

### Email address:
tariku1workineh2@gmail.com (Tariku Workineh Daksa), geneto65@gmail.com (Getachew Neme Tolesa)
[*]Corresponding author

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**Abstract:** Fruits and vegetables are very seasonal and are particularly abundant year-on-year. Preserving these fruits and vegetables can prevent high accusations and can be achieved during the exit period at the cost of pay. Drying out fruits and vegetables is essential for the preservation of food. The technique is done using artificially fossil fuels or placing the fruit and vegetables under the sun. The first method has an expensive and environmentally negative impact, and the second method is entirely dependent on the weather. By contrast, the use of solar dryers is relatively cheap and efficient. Some solar dryers run without electricity or fossil fuels. This paper looks at a variety of solar panels that are widely used today. Active and useless design solar dryers are an environmental influence on solar power (Harness). This plays a crucial role in the solar dryer. They are often easy and relatively cheap to make, often showing efficient and active designs based on low-quality products or the use of compulsory convection. The indirect and direct, design dryers that have shown potential in drying food products in tropical and subtropical countries are reviewed. Such low-cost food drying technologies can be easily introduced in rural areas of developing and developed countries. This technology aims to reduce the quality of production, improve product quality and promote overall sanitation. Therefore, this review should be used to adequately guide individuals by selecting appropriate drying designs for the conditions given to them and later assessing the execution of the system for developing countries such as Ethiopia.

**Keywords:** Design of Solar Dryer, Fruit, Vegetable, Drying

## 1. Introduction

Fruit and vegetable production is crucial to economic activity in Ethiopia. N. and Gebre found gardening on commercial government and private farms at 541 Thousand Ha, and about 2,710 million tons of vegetables and roots, and tubes were produced [1]. This will create a means of living for more than 1 million families in 2010/11.

Fruits and vegetables are major sources of carbohydrates, minerals, and vitamins, especially vitamins A and C, which can be digested [2]. At peak times, prices are usually lower, which can lead to profits and even losses for the arcades. In addition, a large supply at the time could lead to significant production damage in the market. Preserving these fruits and vegetables can prevent high accusations and be priced over time [3]. Sun drying is still the most common method of preserving food products in most tropical and semi-tropical countries.

But because it is contaminated with rain, wind-bearing dust and dust, insects, rats, and other animals, the lack of food quality in the sometimes edible and dried products can have a devastating economic impact on domestic and international markets.

The development of the drying process still represents a major scientific challenge in the food sector. One of the biggest limitations of drying is high energy consumption. Drying is to blame for 10 to 20% of industrial energy consumption in the developed world [4]. Furthermore, drying fruits and vegetables is a complex operation to study mainly because the changing couch and temperature during the drying process are transmitted internally [5]. Not only is it about food drying, costs, and the final attributes of the dried product must be considered because they are very sensitive to work conditions heat, humidity, and gradients.

Solar drying technology is "a good alternative to food conservation that establishes clean, sanitary and hygiene conditions that meet national and international standards [6]. The benefits of these dryers on solar thermal heat are year-round use and light machinery, so there is less money to buy. In principle, the air is heated by solar radiation, and when created, it is caused by pressures that allow vertical air to flow. As a result, these dryers don't require any electrical or mechanical components because the energy generated by natural convection is based solely on temperature differences or changes in air density.

Solar dryers are thought to have been designed based on the way it operates under coercion. Although passive systems are often easier and relatively cheaper to build, they are commonly reduced in low-quality products or efficiency. The way it is exposed to solar radiation can be taken into account. Direct dryer design often leads to weakening production quality because direct radiation exposure can damage production in a variety of ways. The rotating dryer design is often low but significantly increases its quality. There should be a stop here to ensure adequate product quality and drying efficiency while reducing the complexity and investment in the dryer. The capacity of the solar dryer depends largely on the fruit and vegetables and the shape. On the one hand, the product needs to be small to ensure there is plenty of time for events such as washing and cutting. At the same time, it has to be big enough for the user to earn an income.

It is common in sub-Saharan Africa to dry materials by directly exposing them to the sun. The food is distributed on the soil and is usually covered to make the food contaminated. The system often causes the product to malfunction. For example, Tröger *et al* found that dried onions and tomatoes are commonly contaminated with microbes and sand bees [7]. What's more, the drought's long and final production humidity content is high. To prevent these problems, indirect drying is increasingly being done by placing the product in a neutral room, protecting it from infection. Solar panels are entirely dependent on solar energy, which is a widely available resource in tropical communities. For these reasons, solar dryers are often seen as more efficient than sun dryers, which are typically lower than mechanical dryers [6]. By setting these up, packaging, storage, and transportation costs are effective [8]. The environment controlled by solar dryers also prevents food from affecting the growth of fungi and microbes due to underwater stress, heat loss, and foreign particle pollution. Therefore, improving the quality of production can be achieved by reducing wasted production and reducing the use of traditional fuels. Solar panels also affect market capacity and generating capacity as higher prices for better quality products are achieved. Therefore, the opportunities offered through low-cost and locally produced solar panels offer a valuable alternative to significantly reducing the losses associated with the post-harvest downturn. The objective of this review is to review the fruit and vegetable dryer and to review different designs of Solar dryers.

## 2. Overview of the Importance of Fruits and Vegetables

Fruits and vegetables play a vital role in human health. Antioxidants such as vitamins A, C, and E are given to cancer, cataracts, heart disease, hypertension, stroke, and diabetes [9]. Vegetable production is a major economic activity in Ethiopia. From small gardening to commercial government and private farms in 2010/11 B. C. E. The 2,710 million tons of vegetables and roots and tubes on 541 Thousand Ha, created a living system for over 1 million families [1, 2]. Commercial production of farms, including vegetables, has also increased in recent years as government farms, such as the Ethiopian Horticulture Development Corporation, have expanded and private investment in national and international assets has increased [10]. The commercial product is concentrated in Ethiopia's Rift Valley because of its proximity to irrigation, accessible, and agro-processing industries.

The Development Corporation has been carrying out crop production and marketing operations since its inception in 1980 [11]. Recent crops such as green peanuts, okra, cereals, and eggs have also become important to the foreign market for private companies. Ethiopia has the ideal climate and Edac conditions for producing tropical, tropical, land, and highland vegetables. [10]. Warmer seasons are produced in tropical regions such as tomatoes, onions, capsicums, and beans in rainfall and irrigation (especially in the Rift Valley), while the highlands are ideal for producing cool-season vegetables such as Calais, cabbage, garlic, war cemetery, carrots, beetroot vegetables are used in both rainy food and roots [12]. The increase in irrigation vegetable production is attributable to increased commercial farms and a smaller irrigation scheme [13]. Ethiopia has a relative advantage over many horticulture brands because of its favorable climate, prone to European and Middle Eastern markets, and the presence of land, irrigation, and labor water. Thus, Ethiopia's rural development strategy focuses on market-driven agricultural development, and the government pledged to support market mergers and Agro Enterprise Development. In Ethiopia, vegetable production and consumption are on the rise as the spread of markets and cities to Djibouti, Somalia, South Sudan, Sudan, the Middle East, and European markets and cities continue to grow [14]. The wealth and health benefits of Ethiopia's economics are also well-known. Vegetables play an important role in human health by neutrally presenting antioxidants such as vitamins A, C, and E for cancer, cataracts, heart disease, blood pressure, blood pressure, and diabetes contact. [15, 14]. A Garden is also a source of financial income for families and an opportunity for smaller farmers to increase their participation in the market [16]. Vegetables also serve as a source of raw materials for the local manufacturing industry. Products such as tomato additives, tomato juice, oleoresin, and capsicum land spices make a significant contribution to the national economy [13]. The growing horticulture industry and the development of high yields of horticulture crops are creating employment opportunities, especially for women and young people. It is a source of financial income for families and an opportunity for small farmers to increase their participation in the market [16]. It has the highest domestic market in Ethiopia, with fruits and vegetables used for both fresh and work. This market is much bigger than the size of exports [17].

### *2.1. Post-Harvest Loses of Fruits and Vegetables*

In developing countries, post-harvest losses are generally estimated at 40 percent, but in some areas, these losses could exceed 50% [18]. High humidity content such as fruit and vegetables, has disappeared rapidly due to microbial degradation in these developing communities. The degradation starts shortly after harvest and increases significantly in high humidity areas. To mitigate these losses, the work of utilities near the harvest areas is critical. But the limitations and lack of electricity in many rural areas mean farmers have little choice but to preserve their crops.

According to Gewali *et al*, the main requirement for food producers is to ensure that leftover fresh produce is not wasted in the long term [19]. This would allow the market for the harvest, which is used to drink preserved products at seasonal rates, and boost the local economy. This stimulation of food production is also a catalyst for national growth. While there are big losses in developing countries post-harvest, the main difference between developed and developing communities, more production disappears before reaching the retailers.

A general understanding of the biological mechanisms leading to destruction is essential for the testing, development, and implementation of appropriate conservation systems that reduce and damage the quality of production. In addition to the losses in post-harvest grain volumes, it should be noted that it contributes to the overall loss of agricultural commodities.

It is also known to be due to a variety of biological mechanisms, such as mechanical damage, physiological disorders, pathological degradation, respiratory speed, ethylene production and activity, enrichment and rooting water stress, and structure changes (Cader, 2005). The exact rate of deterioration depends on environmental factors such as airspeed, sanitation, temperature, atmospheric structure, and relative humidity [20]. It is recommended by Kothar *et al* that this harvested product be preserved, sold, or carried out as soon as possible to prevent the risk of deterioration from escalating [8]. To overcome this problem, the process of drying out food products as a precondition for stockpiling them was widespread. Drying will improve shelf life and significantly reduce production volume and weight by reducing packaging, storage, and transportation costs [8].

### *2.2. Drying*

Effective drying of agricultural commodities causes moisture from the crop to disperse, reducing the amount of moisture in production so that it does not deteriorate [21]. Drying is commonly cited as a solid product to remove water content from heat. According to Visavale the moisture in the liquid chemical compound is trapped in the tiny structure of the material, which is found in the material matrix and even exerts less pressure than pure liquid [22]. The humidity above the humidity is called unlimited moisture. When a solid heat dries up, two processes take place simultaneously. Energy transmission (usually like heat) evaporates moisture from the atmosphere upwards. Internal humidity to the solid surface and the subsequent energy evading due to the appliance.

They guide the dry pace at the speed at which the two processes are carried out. Transferring heat from the environment to wet energy varies depending on the effects of convection, conduction, or radiation, and in some cases different dryers vary in type and design as a result of these combinations, depending on the main temperature transmission method [23]. But with a dielectric heater, radio repetitive (RAF), or microwave dryer power, it generates heat in the solid and leaks into the exterior. Process, removing moisture like vapor from the material, such as heat, air moisture and flow, the area of the exposed surface, and pressure [24]. It depends on external conditions. Performing the humidity in the solid is a function of strength and circulation and humidity.

Sun drying is a common method in the developing world and refers to foods spread across the sun in suitable places such as carpeting, roofing, or floor drying [25]. According to Visavale, the way the sun dries up is generated by the movement of the surrounding air [26]. To succeed, along with production maturity, it takes a season without more than 98 °F of bright sunshine and warm showers. Dust, rain, and cloudy weather are the main problems with sun drying [27]. When the weather is very windy, dusty, or rainy, it needs constant monitoring during the dry season to protect the product from pets and remove the product. The dry harvest is often contaminated with waste and microbes and the quality of insects such as flies [28]. Although it is a very cheap method, the quality of the dried products is poor because they are contaminated with insects, birds, and dust. Furthermore, direct exposure to sunlight or ultraviolet light can significantly reduce the number of vitamins in the dry substance [29].

Drying wet matter through a hot air drying system is primarily done by connecting the warm air directly to get into the wet stuff. The wholesale transfer of water from the inside to the production and the removal of water vapor from the surface are the two main processes that facilitate the drying process. The type and quality required for drying costs must be considered in the economy of dried production, raw materials, size, and dry efficiency.

The design of a hot air dryer is generally used to dry fruits and vegetables. These dryers include cabinet or delivery, transmitters, pneumatic conveyor dryers, conveyor dryers, belts, liquid, spray, and drum dryers.

Overall, Cabinet dryers are designed to dry small amounts

(100-2000 kg/day dried product). It is commonly used for laboratory or pilot-sized drying experiments [30]. It has a razor blade and tube to control the air moving around a dry room or in a dry room. The source of the heat can be a heating system, an electric heater, a biomass oven, or a heat exchange. The power is supplied from the air stream to provide the heat needed to disperse the water from the production floor and cover the dryer room [31].

The improvement in solar drying weakens solar drying technology [32]. Sun drying is said to be good for sun drying and is an effective way to use solar energy [33]. While the sun's drying refers to the methods used to dry out solar energy in the same way as sun drying, it does not include "sun drying" open air [28].

Solar drying technology is a drying system that produces better quality products and is considered an alternative to drying agricultural products in developing countries. It is often separated from the 'sun dryer' by designing it designed to harvest and enhance solar radiation so that it can be used in a way that allows it to dry out the energy it moves to dry out the sun's rays [25]. Sun drying has more to do with the sun dying. Higher air temperatures and the resulting relative moisture in the solar dryer are conducive to reducing dry crops, energy and labor savings, and environmental protection. Chen *et al*, also improve the quality of production because they keep products produced due to solar heat from degrading and contaminating them from living things [29].

### *2.3. Drying Fruits and Vegetables in the Solar*

Sun drying is the most common method of preserving agricultural products in tropical and tropical countries. But because they are insolvent from rain, wind-transmitted waste and dust, insects, rats, and other animals, a lack of food quality in products that are sometimes unfit for consumption and dry can have a devastating economic impact on domestic and international markets. Therefore, the process of drying agricultural products should be carried out with a closed tool (solar or industrial dryer) to improve the quality of the final product. [34].

According to Othieno *et al,* the solar drying system is described as a basic source of energy, the drying technology that has been discovered by improving the sun's rays [35]. But sun drying is one of the old and widespread methods of crop drying. The drying technique involves drying the material on the ground or platforms with a slender layer and exposing it directly to the sun and wind. However, is a process in which agricultural materials dry through solar thermal air in a more protected environment, rather than through direct exposure to the sun. The dry fruit industry has often been recommended to speed up the economic pace by both reducing energy consumption and drying dried fruits, helping to harness dried grapes, Ocra, tomatoes, and onions with solar energy. The dry time would lead to higher quality products in terms of color and the constitution. And when compared to oil or shale dryers, solar dryers charge a lot of money to small investors, especially under favorable meteorological conditions. Drying fruits and vegetables with solar power developed in Egypt [36]. Lambert *et al*, noted that the use of solar energy technology in the industrialized world in the developing world is largely economically viable compared to the industrialized world [37]. Norton *et al*, Reported that solar energy was considered a useful source of energy to dry out a variety of crops [38].

## 3. Solar Dryer Types

Various printed publications have examined and analyzed sun dryers in various categories [39]. Development in the fields and technicians have been depleted of fruit and vegetables [40].

In general, solar panels produced for agricultural food products can be classified directly, indirectly, and in a variety of hyenas. It can also be classified as motion or movement. The definition of a direct sun dryer is that the product in a clear hole dries up when exposed directly to solar radiation. Indirectly, drying can be done with organic or compulsory convection, while the product is stored in a dryer room, while solar energy is separated from the dryer room and swallowed by solar energy. The mixed solar dryer combines the properties of direct and inhibitor eyes and also represents a solar dryer that is used in conjunction with solar energy by another source of heat.

### *3.1. Design of Passive Solar Dryers*

Passive solar dryers are called natural circulation or natural convection systems (39]] Their performance depends entirely on solar power. The air in these devices is heated and naturally distributed through the pressure generated by wind and heat waves. In this consultation, these dryers don't require electrical or mechanical components such as fans or spirits because the power of natural convection drive is based on temperature differences or changes in air depth. The difference in a certain amount of weight between air and dry air causes vertical air to flow free of electricity supply.

Direct dryers are best at drying out small fruits and vegetables such as bananas, pineapples, mangoes, potatoes, carrots, and French beans. This type of dryer is a dryer that is covered in a layer made of glass or plastic. The dryer room is usually a box with a shallow, internal air hole that allows air to enter and exit the box. The food samples are placed in a lavish jar that allows air to flow inside and into the food. The sun's rays pass through the membrane of light and convert it into low temperatures when it hits a wall. This low-level heat is trapped in a box called the "greenhouse effect." Simply put, the shortest wavelength of solar panels can penetrate the membrane of light. Once converted into low-level temperatures, the intensity shines as a long wavelength that can't pass back through the cover

### *3.2. Design of Active Solar Dryers*

To move solar energy from the collector's environment to dry beds in the form of warmer air, with active solar dryers including external pathways such as fans or pumps [6]. The collectors should be positioned in the ideal direction to make solar energy collectors better. A tool system can be used to manually adjust the angle it collects. Melting collectors are more effective than horizontally placing them for two reasons. First, more solar energy can be collected as the assembly page approaches solar panels. Second, the warm, less dense air rises into the dryer room, raining down on the collectors. In a moving dryer, the heated air in the sun's heat flows through the solar dryer to find the food environment as much as possible. Sliced foods are placed on dryer doors, made from screens or other materials that allow dry air to flow into all parts of the food. Once inside the dry room, the warm air flows through the enclosed food. Poorly assembled trays create gaps around the edges, causing large amounts of warm air to pass through the food and preventing the dryer from increasing its capacity to remove moisture from the food. The warm air loads moisture as several layers of food flow through a pipe. This wet air rises through the port. Fresh air is then taken to replace exhausted air. Active solar dryers are known to be ideal for drying out high-humid food containers such as papaya, kiwi fruit, cabbage, and flowers. [41].

Their main concern about the capacity of solar dryers is that the air in these devices cannot penetrate large amounts of crops [42]. Furthermore, the airflow will stop at night and in the weather. These limitations increase the risk of product deterioration and an increase in enzyme responses due to mold attacks. Thus, it concluded: "The efficient use of natural dryers is limited to drying small loads in areas with high levels of insulation." [43].

On the other hand, compelling solar dryers have been developed to allow continuous air and airflow. Because they are used in solar power as well as motorized devices or aerial systems, these dryers generally have reliable and efficient advantages. On the other hand, the standard of electricity for fans or fungi restricts the implementation of these devices because electricity is not available in many rural areas. Even when there is electricity, it is practical because the incomes of those who can afford it are so low. In this case, the cost of electricity should be balanced against improved system performance, such as greater drying capacity, reduced dry time, and improved product quality. According to Wereko-Brobby natural convection dryers typically show about 10-15% overall dryer efficiency, while compelling-convection dryers are 20-30% in total [44]. High-humidity products such as fruits and vegetables are often distributed in mobile dryers.

### *3.3. Designs of Direct Solar Dryers*

Straight dryers are part of a dryer. The solar collector usually creates a roof or wall of the room. Along with the direct design, the product itself acts as an absorber. The temperature affects not only convection but also radiation on the product [42]. Direct sun dryers usually place it in a hole with a thin layer of plastic or glass. The drying room itself is a rectangular box that allows air to flow through small holes at the top and bottom. When air flows through both the containers and the product, trays are used to capture the product.

The heat generated by these direct dryers is generated not only by solar radiation on dryers but also on the product. Direct dryers have been shown to successfully dry out small moisturizers such as bananas, carrots, fruit, mangoes, pineapples, and potatoes. However, it is important to note that when using a direct dry design, sunlight can affect some of the essential ingredients in the product. Direct exposure to sunlight often leads to color loss, vitamin loss, and undesirable temperatures [45] higher on the product. These dryers are so deep that they need to circle crops more frequently to reach the same dry spaceship. So, if there is a shortage of land, the type of drying indirectly is preferred to dry out a significant amount. The moisture emanating from the menu can also blur the inside of the inner layer, reducing time play. Normal direct-type, solar dryer Figure 1.

#### *3.3.1. Design of Tent Solar Dryers*

The tent sun dryer rooms are the plastic sheet that covers a sheet of wooden poles. Black plastic sheets are chosen to absorb extra heat on the opposite side of sunlight exposure. The regular room contains a hanger to hold on to the food. But W Weiss & Buchinger, suggests that dry time does not improve compared to when drying out in the air [46]. Instead, tent dryers serve little more than to protect them from predators as dust, rain, or tin-sized as the main purpose. Tent dryers can also be stored if they are not used, often used to dry crops at low density and humidity. A typical tent dryer can be seen in Figure 2.

#### *3.3.2. Designs of Traditional Seesaw Solar Dryer*

The traditional dryer is a solid, rectangular system that supports Zambia [42]. The support is designed so the frame can track sunlight throughout the day. The product was surrounded by several nets that allowed air to spread downhill and then vaporize. They often use wooden metal sheets to swallow heat. These are painted black for better temperatures. It can also be used in a heating detector along with wood fiber, polystyrene, cardboard, or other insole devices. The product is stored on portable jars that sit regularly or in the middle of the sliced metal, allowing for improved air temperature. A common water dryer is seen in Figure 3.

The greenhouse effect has been seen adding more than plastic paper. Air fish are powered by the natural principle of convection, while clean air enters the lower end of the dry room and escapes at the top end. Airflow improves by opening a vast air network compared to the air intestines. This will allow for a gradual extension of the fruit's intersection, which will improve Convection.

#### *3.3.3. Designs of Box-Type Solar Dryer*

A box-like solar dryer is widely used in small amounts of food drying processes. The overall design is made of wooden boxes and has a glittering lid of sparkling materials. Inside, the wall he collected was painted black to absorb incoming radiation, and the product was attached to Mesh Tree. Holes in the bottom and front of the dryer allow air to enter the dryer while heating air is drained from gaps at the end of the back wall. Picture 4 shows the feature and design of a standard sandbox dryer. These types of dryers can get more heat and dryer time than tent dryers. But the number of people who are still dry is still relatively low, and our products often reduce colour. These dryers have minimal drying capacity and are generally used only indoors [19].

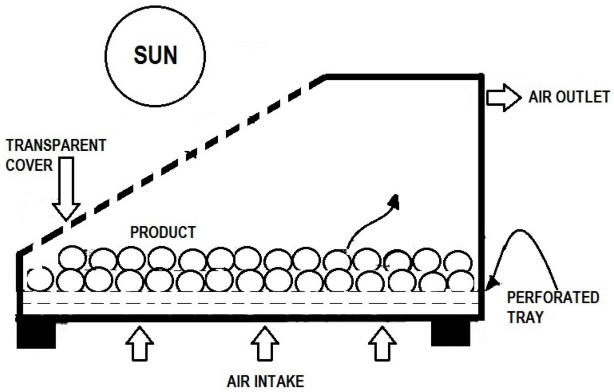


***Figure 1.*** *Direct-type, solar dryer work principle*

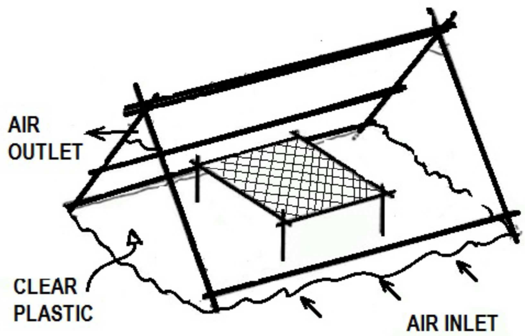


***Figure 2.*** *A direct-type, tent sun dryer.*

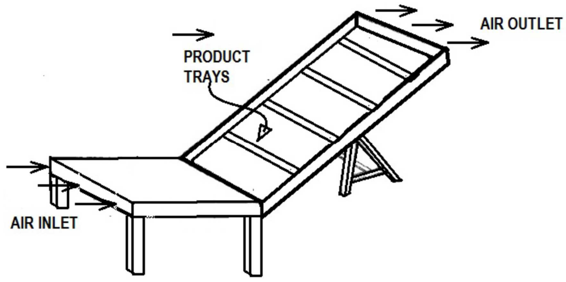


***Figure 3.*** *Direct-type, seesaw dryer.*

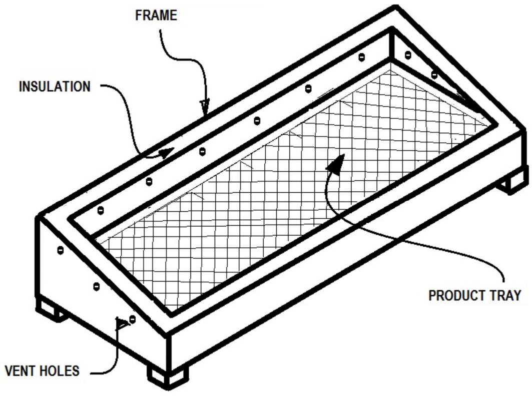


***Figure 4.*** *Direct-type, box dryer.*

### *3.3.4. Designs of Indirect Solar Dryers*

Sun dryers that are usually indirectly dried are smaller than direct dryers, but they usually have better efficiency [6] and can dry higher amounts of food production [46]. The main difference with trafficking dryers, unlike direct dryers, is that the product is not directly exposed to sunscreen. This reduces corrosion risk, such as decay, upper layer fractures, and sufficient internal drying, which are caused by direct radiation exposure. Solar energy collectors in these distributed versions must find the right location to improve solar energy concentrations. This requires a suitable attitude when large amounts of solar energy are collected into the sunlight. The solar collector's orientation also helps air flow through the natural convection principle, where the heat in the system releases less and thicker air.

### *3.3.5. Designs of Solar Cabinet Dryer*

The solar box dryer is generally considered more sophisticated compared to box dryers, which are the collector heating the air in the sunshine, and a dryer room with shelves or shelves. The principle of surgery is the type of box dryer that rises in the air at the height of the dryer. A formal sun cabinet dryer is displayed in Figure 5. The complexity of the design is a relatively expensive option, but these dryers are still considered suitable for small-scale and income-generating communities [19]. These dryers are designed to be made with solar panels that serve as a major source of energy. Although back-up boilers are used to ensure radiation is inadequate due to weather conditions and can be dried continuously during the night. The radiation passes first in the interior of the sun's heat-gathering, where the cover of these dryers passes. The heat causes the air in the area to warm up. Natural fusion triggers the heated air, forcing it into damp dryer jars. The wet air is then released through places at the top of the dryer, reducing the pressure of the internal cabinet.

The air heated by the sun will be lighter or thicker than the air. Therefore, the depth of pressure is minimal, attracting air through the assembly, drying, and crops. The effect increases because it has higher altitudes between the bed and bed and bed. But because the air cools as it passes through the bed, the effect on the height of the bed is less than the height of the bed [46]. The wet air is then released through the air above the drying chamber or through a sling shall. Irtwange and Adebayo explain the height of the thighs to dry sun dryers [47].

The cabinet of these dryers is a large wooden or metal box that is well-made to reduce heat. To make these dryers, water-resistant fabric is often used. The runners in the interior will be installed in the tape to support the foods they are eating. The dryers slide on these runners. Easy to load, unload, and clean. The general rule of thumb requires an m 2 tray area to produce 10 kilograms of new produce [46].

The basic components of the solar air collection are cover, absorber, airway, and insulation. When the sun's rays are transmitted through the cover, they heat the air in the air. While the air is relatively low in temperature compared to water, these sunny air collectors don't deteriorate because they get fewer technical tools than water-based collection systems and when less liquid is flowing [46]. This compromise implies that air collectors have to get a significant amount of flow.

Keener, *et al* evaluated collectors of the flat plate used in the farming dryer process [48]. The basic type of collection is an empty bowl between radiation and the surface is used as a water tank plate. Empty board collectors are easily incorporated into the roofs of storage facilities. At the same time, collectors of covered plates show the efficiency of collecting, but they also bring high costs and complexity. This extremely naked and high cost comes when glittering covers are added and used above the plates.

More sophisticated designs have also been developed, including liquidity on both sides, where the airline forms between two metal plates [46]. The top sides of the plates are black-plated and a glass cover is installed on top. Collectors of hanging plates are likely to show more efficiency than those collecting empty, covered plates, but they need a more complex invention because the air is allowed to flow on either side.

Attention has also been paid to the integration of side wall collectors into dryer walls. But these designs are often expensive and only useful for two or three seasons [6]. Plastic film solar collectors have also been presented [48] and [8]. A solar panel index increases the amount of energy in the dryer, causing airwaves to rise significantly. This increases the rate of moisture removal. But it turns out that it is beneficial to have an ankle function only when the incoming air is heated above 10-30°C [46]. Otherwise, the head will make no progress unless it effectively displays air temperature by collecting solar heat. It is important to note that even when dryers reach high-density differences they still emit less pressure on the height of the thigh per unit [46]. By contrast, the coercive convection devices cause significant pressure differences.

The effect of the thigh pushes air into and out of the ankle index and is activated due to differences in temperature and hut. The thermal variation and high altitude of the heads are powerful and increase the size of the heads. Therefore, the amount of flow caused by the effects of the head leads to significant temperature differences between the warmer air and the air around it. This term is the flow of Equation 1, where Q is the chimney effect, C is the flow coefficient, A is the cross-flow area, g is the height of the ankle, and T is the average internal temperature and the ambient air temperature.

$$Q = CA\sqrt{2gh\frac{Ti-To}{Ti}} \quad (1)$$

Although the way natural convection dryers are handled is acceptable, there are many natural problems. The main limitation of these systems is not enough air fish to slow the pace of drying and remove moist air, which causes fruit to deteriorate. These occur when the air flows about the same as the temperature in the surrounding air. As a result, it reduces airflow levels [49]. At the same time, extreme internal heating can keep production warm. Temperatures of up to 70-100°C can be reached by these dryers, which have a maximum concentration for most products [46].

Various design improvements have been made to respond to these limitations. One of these designs would have wind-powered vehicle wheels installed at the top of the thighs [46]. They use exhaustion to control the temperature and airflow of these dryers. But the devices are inactive when nostalgia is blowing with nostalgia that has no effect between the wind peaks. Therefore, this drying pattern is limited to areas with relatively high and sustained winds.

There has also been a strong emphasis on the inclusion of compulsory convention elements in monitoring the temperature and flow levels of solar cabinet dryers. In these hybrid solar cabinet dryers, contact and moisture control can be provided with the best airflow throughout the drying process. Moreover, the depth is less restricted. Therefore, the capacity and reliability of these dryers will increase significantly compared to natural dryers. For these reasons, well-thought-out and executed dryers are considered more efficient and have higher controls than natural circulation types. It has been shown to reduce drying time by up to three times, while the space needed for the collection can be reduced by up to 50% using forced convection [46]. Next, Convection dryers will be able to produce the same amount as natural dryers, which include six times the size of assembly sites [46].

Given these factors, the speed of airflow is critical to overall system performance. Airflow is very high and the speed of the spirit is very low, causing thermal capacity to weaken. It also increases the effects of airflow [46]. In general, pressure reductions must also be low to keep the necessary electricity as low as possible for fans.

To improve circulation, the dryer design requires a small overhaul, as infant extraction may not be necessary when fans are implemented [44]. It has been shown that forced circulation cabinet dryers significantly improve the rate at which they dry without a socket, thus reducing the risk of crop damage due to a lack of formal drying [49]. Still, the establishment of fixed-speed air flow significantly reduces the dryer's capacity compared to more sophisticated and controlled air speed systems that use electronics [49]. But these sources of electricity are either unavailable or affordable for small-scale farmers in developing countries.

As a result, photovoltaic (PV) cells have received a lot of attention as an energy supplier to fans. The performance of PV-driven systems in some developing communities is a demonstration of the reliability of some developing communities on the grid [46]. In these PV power systems, fans are directly integrated into solar panels, resulting in simpler and safer systems that operate without the combination of advanced clusters or cargo controls. Therefore, changes in solar radiation change the speed or speed of the bird, so the airflow changes.

While this system has the advantage of light temperature control, airflow control has disappeared. Therefore, there needs to be a compromise on design complexity and control of airflow.

But when PV cells merge, the price of solar dryers rises significantly. This has severely restricted the implementation of PV-powered devices in developing communities as the drying investment capital becomes too high. Thus, it is widely accepted that when grid power is available, it provides a cheap source of electricity [46]. But the most damaging effect on solar dryers was the limited use of fruits during pure weather and therefore the length of drying. In addition to limited production volumes, solar panels can lead to lower production quality. Attention has been focused on adjusting the low temperature between conventional air collectors and the flowing air stream. Improvements have been made by Weiss and Buchinger adding layers to the interior, making the inside v-crotch, or cutting the surface of the interior [46]. The water section also has thermal storage rooms such as rock beds, water, desiccants, or concrete. These storage components collect and store heat while solar panels are running on the system. Then, if the weather is bad, this heat is posted to the dryer.

Another way to ensure adequate heat absorption is to combine back heating components. Additional heat is useful because warmer air can absorb more moisture and help raise the temperature that migrates water to the production floor. Agricultural waste such as tin, phrases, and shells can be used in the burn process. Yet Weiss and Buchinger as it is stated, that biomass, especially oil timber, is the most common source of energy in rural areas of the developing world [46]. But in many current operations, the oil trail is effectively burned. Therefore, it is important to develop lighter, more affordable incinerators to meet solar drying technologies when radiation exposure is very low.

But improvements to solar dryers will increase the cost and complexity of the design. As a result, these more sophisticated solar dryers are used in the developing world and are increasingly dependent on imported parts and materials [50]. Only small amounts of operations are compromised by these limits and subsequently maintaining the minimum capacity of the dryers.

### *3.3.6. Designs of Tunnel Solar Dryer*

The solar tunnel dryer is a medium-sized dryer when it comes to drying the interior. With the combination of forced convection processes, the tunnel dryer is dependent on electricity; Therefore, it is only suitable for medium-sized farms or small-scale operators where electricity is available or where investment capital allows alternative energy to be implemented. The compulsory convection controls in the tunnel dryer increase the drying rate and provide a higher quality product than those achieved by traditional and open airways. Some studies have shown that high-humidity fruits can dry out at half-time in 46 cases compared to normal methods.

Key components of the tunnel dryer are solar collectors and dryers. Tunnel dryers also have air flow sensors that are transmitted through the PV Panel, generator, or centralized equipment by fans. The basic design of these dryers is similar to the design of cabinet dryers. Tunnel dryers use insects or admirers to force sunscreen into the sun's rays used to raise the temperature. The air will continue to flow through the food dryer, where moisture is removed. Some tunnel dryers use gas-powered boilers to keep them dry even in extreme weather. Although some designs are fitted with a handcuff, the dryer rooms can often be accessed by hand covering them. The product is distributed on a net suspended over the length of the dryer room. Pictured 6 is a typical tunnel dryer. Tunnel dryers can be fitted permanently at the top of the foundation, or they can be made of a motion design that allows them to move depending on the needs and conditions of the target community [6]. The benefits of the compulsory tunnel dryers can be altered at the fan speed, depending on the amount of solar radiation. Uniform drying is also resistant without having to turn the fruit around [46]. These dryers can easily adapt to the climate and manufacturing needs of specific countries. But advocates of compulsory convention and gas-powered heating will attract significant investment.

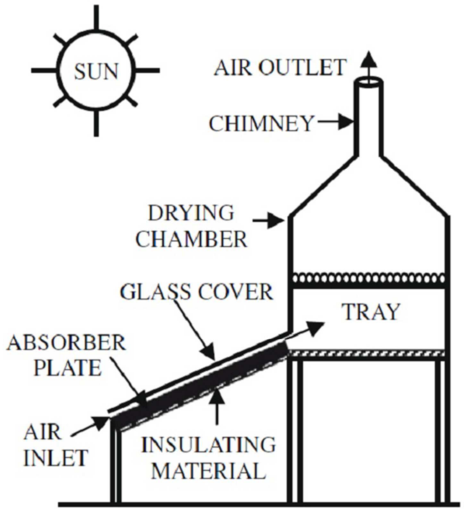


***Figure 5.*** *A synthetic-type Cabinet dryer.*

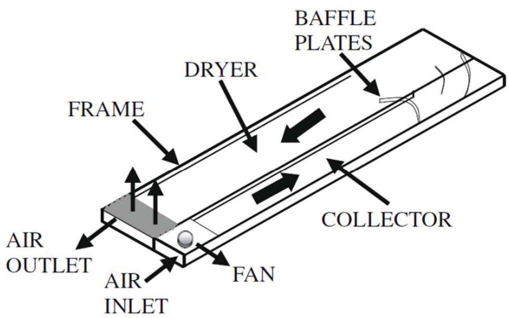


***Figure 6.*** *The type of trafficker is the tunnel dryer.*

### *3.4. Solar Dryer Design Mixed*

A Suffolk dryer [51] was presented with a mixed natural convection foundation for drying Cassava and other crops in an enclosed structure. The dryers were made and used for experimentation. One mathematical model- the air heating process, Drying, and technical fulfillment standards- Uses a two-pass double-duct solar air heater in a mixed-natural-convection solar crop dryer [51]. Dry air temperature and humidity are the results of dry air temperature and humidity, and standards of composition. The model has been shown to act as a design tool for prototype development because it can accurately predict the function of the prototype.

Ahmed, Q. R., et a l (2001) proposed a simple solar-air heater covered in cheap plastic film with air bubbles [52]. There was a huge increase in the inner temperature (10°C) of the arrest.

Pérez-Luna, et al, the invention of solar heating stoves have been developed in recent decades as a variety of modifications have been made to better manage dryer and temperature efficiency, demonstrating the focus of a variety of dryers and components in solar heating ovens on changing the industry system [53]. Based on this analysis, some changes have been recommended in the future.

With a mathematical model, an air heating process model, a drying model, and a scientific fulfillment model, a single-pass solar air heater was approached to dry agricultural products to dry in a mixed natural-convection solar crop dryer [51]. The hair dryer's temperature, humidity levels, crop temperature, humidity content, and performance criteria are derived. Simulation results performed using the model have been presented, and compared to the experimental data, the model has been shown to accurately predict the model's performance.

# 4. Summary and Conclusion

Fruit and vegetable degradation in developing countries is known to be particularly high in wet, tropical regions. Various factors associated with product decommissioning are evaluated in this report and various solutions are outlined. Traditional drying processes such as open sun drying and smoke drying lead to lower quality products due to microbial and fungal infections, while in developing countries sophisticated dryers are difficult to implement because they are limited in cash and resources. Solar panels use sunlight in a besieged environment, allowing us to protect production and keep traditional energy sources from being used.

A systematic mix-up system was developed to ensure a clear difference in the design of solar dryers. See sun dryers such as natural convection and compelling convection dryers, direct and indirect types of dryers, critical dryers, greenhouse dryers, Cabinet dryers, tunnel dryers, and mixed dryers. Solar dryers are often seen as based or operated on the coercive route. They are often easier and relatively cheap to make, often with lower quality production or efficiency. The way it is exposed to solar radiation can be considered. Direct radiation exposure can damage the product in a variety of ways, with direct dryers often causing a weakening of production quality. Indirect dryers are usually slowly cooled but greatly increase the quality. There should be a stop here to ensure adequate product quality and drying efficiency while reducing the complexity and investment in the dryer. Such low-cost food drying technologies can be easily introduced in rural areas of developing countries. This technology aims to enhance the quality of production, improve product quality and promote overall sanitation. Therefore, this review should be used to provide adequate guidance on selecting sunscreen designs that are suitable for certain conditions for individuals.

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