Introduction to solar drying

Drying, in the context of agriculture, refers to the process of removing moisture from crops. After harvest, a crop will have inherent moisture that it accumulated during the growth phase. The moisture creates a favorable environment for microbial activity, which at the very least reduces the possible storage time, and at worst, leads to the spoilage of the crops rendering them unfit for consumption. Drying removes this moisture inherent in crops after harvesting, thereby increasing the crops' storage life. However, the process of drying varies, depending on a range of factors that include the crop, preferred technology, desired drying range, and even the budget. This write-up will focus on solar drying as this is the most widely adopted form of drying in Africa. To that end, there are two main practices of solar drying in Africa- Open sun drying and solar drying.

Open sun drying

This tactic is the most widely practiced approach to drying in Africa. It entails drying the harvested crops directly under the sun. Farmers using this method will find an open space with sufficient exposure to sunlight and place their crops directly on the surface. In some cases, indirectly through an appropriate drying maternal such as a mat or plastic bag. The crop will then dry as it absorbs heat from the sun, expelling moisture in the process. Despite its wide adoption, this approach to drying has serious limitations that include.

1. Contamination due to exposure to the immediate environment
2. Slow and uncontrolled drying rates, leading to uninform drying
3. Promotion of mould growth, leading to lower quality of the final product
4. Large expanse of space required, limiting the scope of application of the approach

5. High labor costs required to hire staff to transport crops to drying area, turn them as thy dry and remove them when conditions do not allow for drying
6. The method may not work in some cases such as during rainfall
7. The method sometimes affects the quality of the final product, making it inapplicable for some crops such as certain fruits and vegetables

Given the limitations, it follows then that open solar drying should be practiced in instances that allow. However, where possible, alternative means of drying that address the above challenges should be adopted. Solar drying is one such technology worth considering.

Solar drying

Unlike open sun drying, solar drying entails using well-designed structures to trap solar radiation to expel moisture from harvested crops. Adopting principles of design and applying scientific methodologies to develop the structures makes solar dryers more effective than open sun drying. In that regard, compared to open sun drying, solar dryers heat air to as much as 30 degrees above ambient temperatures, leading to faster drying rates. The speedier drying rates, in turn, reduce the level of microbial activity such as mold growth much faster, leading to increased storage life. Given that most solar dryers are enclosed, they prevent contamination from the external environment. Farmers can also use them in any weather, which is rarely the case with sun drying. The controlled environment of solar dryers further ensures the quality of the final product and the maximization of existing farm spaces. The costs of fabricating solar dryers are perhaps their only downside compared to sun drying. A keener look at the costs, however, shows that solar dryers are much cheaper in the long run when one considers the savings that come with effective drying.

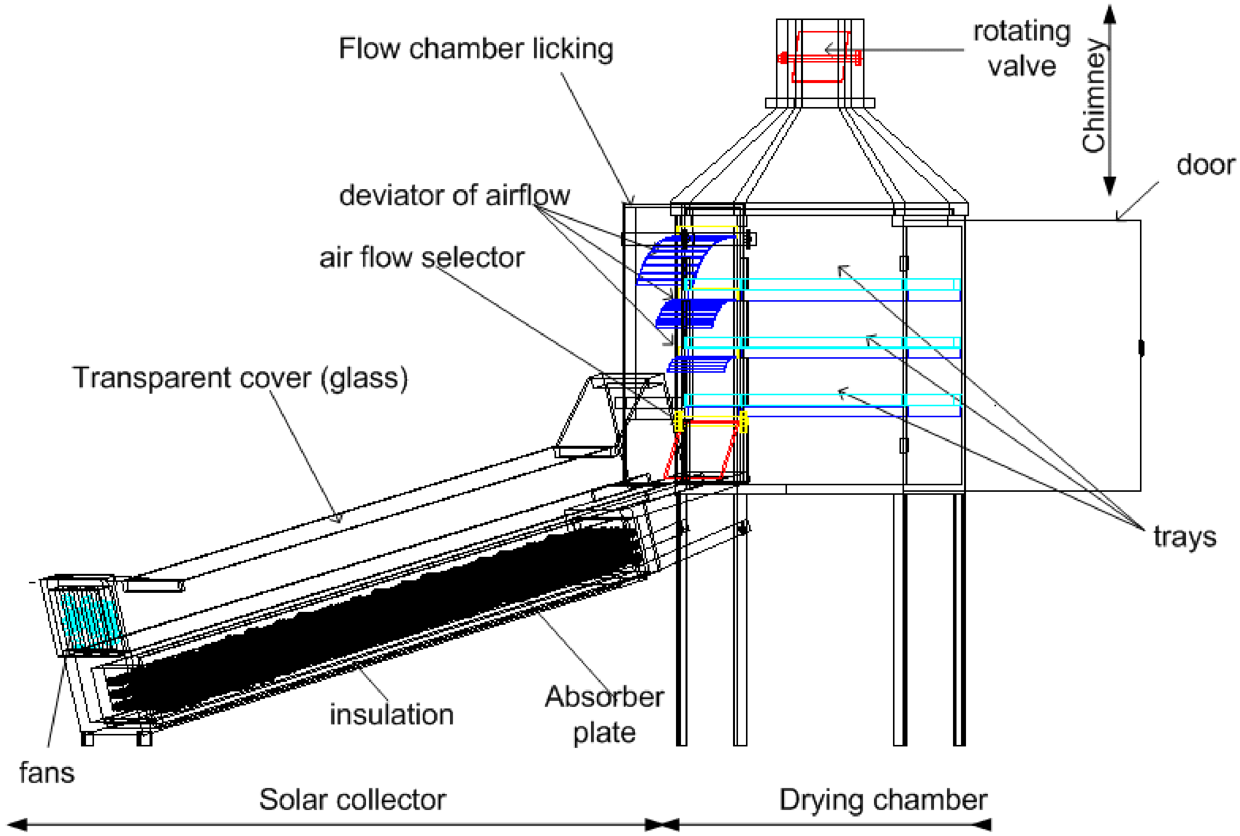
Types of solar drying structures

In academia, solar dryers are classified based on architecture, operating temperature, and heating mode. While adopting classification based on architecture, the dryers are grouped into direct dryers and indirect dryers (Prakash & Kumar, 2017). The former consists of box-type dryers that receive heat directly from the sun. The latter uses warm air for the drying process, while mixed-mode systems simultaneously use direct and indirect drying. As for classification based on operating temperature, this approach groups dryers into low-temperature systems and high-temperature systems. The former consists of slow dryers mainly used for bulk produce, while the latter is much faster and is used for smaller volumes of produce. Lastly, heating mode classification groups dryers into passive and active (Prakash & Kumar, 2017). Passive dryers rely on natural convection, while active dryers employ devices such as blowers to improve the natural convection process

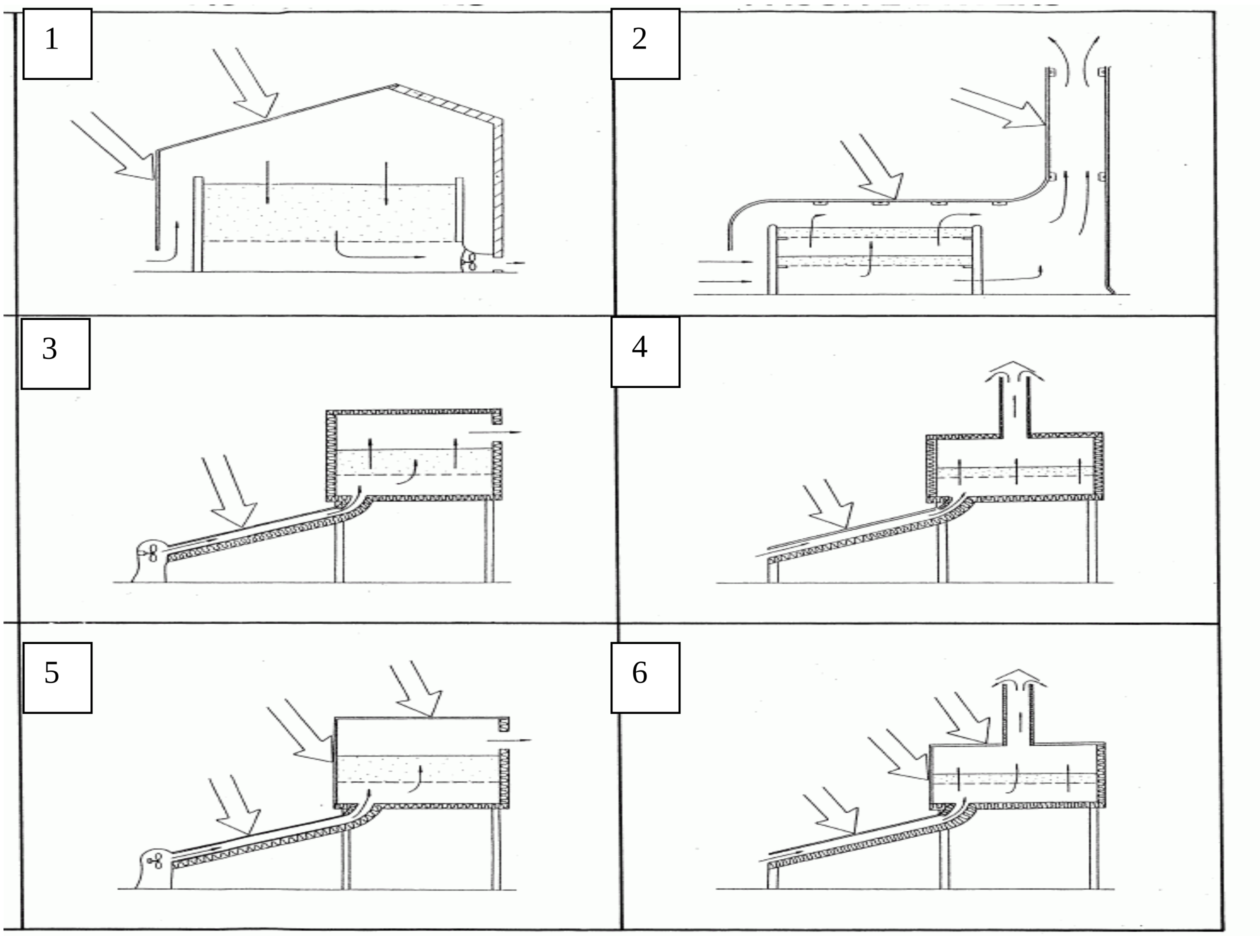
Solar dryers in Africa

Notably, these academic classification systems do not capture the realities of drying in Africa quite accurately. Thus, for our case, we will use our own classification system for solar dryers in Africa. We will classify them as either small dryers or tunnel dryers. Small dryers are mostly used when the volumes of produce being dried in small and the required rate of drying is faster.

A diagram of a typical small solar dryer is shown below.



While there are many variations to small dryers, their basic operations are captured in the image above. A typical small dryer will consist of a collector area, drying chamber and a chimney. Solar power is trapped in the collector, where it heats air that is released into the drying chamber. The hot air moves over the drying trays, expelling moisture from the crop and is released to the atmosphere via the chimney. Variations of this type of dry include the following:



(Buchinger & Weiss, n.d.)

The big arrows in the image show the solar radiation, while the smaller arrows indicate the air flow in and out of the dryer. Selecting the type of dryer to adopt from the above will depend on the unique circumstances of the farmer. A famer with a small budget and limited construction expertise should go for dryer type 1. Constructing the dryer entails, lining trays and covering them with an appropriate collector material. Spaces should be left at the bottom to allow air in and out of the dryer. Important to note is that the air flow in this design is poor since it does not follow the natural conventional air movement, where hot air is allowed to rise and be released at the top. For famers, with good construction experience, dryer type 2 is most appropriate. Constructing this dryer is much the same as type 1; only that, a chimney is incorporated to facilitate natural air convection. Notably, the chimney addresses the weakness of dryer type 1, by allowing the air to flow by natural convection. For farmers with a slightly higher budget and in need of faster drying rates, dryer type 3 is a good option. Incorporating a rotating chimney into dryer type 3 to become type 4 will lead to faster drying rates. The limitation of these two dryers (3 & 4) is that the drying chamber is not made from material that allow it to collect solar energy. Thus, adding an absorbent material leads to the improved versions show in image 5 & 6.

Tunnel dryers

Tunnel dryers are used for much larger volumes of crop. They usually consist of drying trays, arranged in a collector tunnel. Air flows into the dryer through the bottom and is heated by solar radiation in the tunnel. The heated air removes moisture from the crop and is released at the top of the tunnel via chimneys or open spaces designed for the same.