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Simulation of Air Movement in a Low-Cost Storehouse Using Computational Fluid Dynamics: Application for Bulk Sweet Potato Roots Ventilation

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Abstract

The main cause of postharvest losses during storage of sweet potato roots under tropical climates is lack of suitably designed storage systems. In rural areas for instance, harvested sweet potato roots are often stored in bulk using various forms of storage technologies. Hot spots and mold damage may occur during storage especially if the roots are not ventilated. In this research, we demonstrated how commercially available engineering tools can be utilise to design a simple and low-cost African mud storehouse for storage of perishable crops such as sweet potato under tropical climates. The research contributes to an ongoing Global Food Supply (GlobE) project-Reduction of Post-Harvest Losses and Value Addition in East African Food Value Chains. The low-cost African mud storehouse was envisaged to have a rectangular air plenum built inside for bulk sweet potato storage. Aerodynamically, unfavourable designs often cause non-uniform air distribution. The arrangement of a ventilation fan, the geometric designs of the air inlet, plenum chamber and outlet decisively influence the uniformity of air distribution. To achieve this, different geometries of the storehouse were studied theoretically using computational fluid dynamics (CFD) technique. The most appropriate geometrical sketch with acceptable uniform air distribution in the storehouse was selected and constructed. The constructed storehouse has inside dimensions of about $3.10 \times 2.40 \times 2.20\,\mathrm{m}$. Experiments were conducted using potatoes to validate the selected design geometry. The potatoes were modelled as a porous media. Results of experimental measurements as well as the CFD simulations of air velocities and pressure profiles on the selected design are presented and discussed.

Keywords: Air distribution, bulk storage, computational fluid dynamics, design, mud storehouse, sweet potato roots, ventilation

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