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Development and testing of a Cold Storage Prototype with an alternative Cooling Device

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Executive Summary

This thesis resp. project is part of the international research program RELOAD. The overall aim of RELOAD is the reduction of post-harvest losses (PHL) in East-Africanfood value chains. One participant of this program is the Dedo Peasant Association in Ethiopia. This group of farmers loses a major share of their produce after harvesting, due to a lack of appropriate storing facilities. Thus their income gets significantlyreduced. In order to reduce these losses and increase the farmer's income, RELOAD plans to construct a storage building in Dedo. Such a storage building has to be developed and tested before it can be built. For this reason the construction of a prototype is required. The objective of this project is to develop and test this prototype, in cooperation with the post-harvest department of the University of Jimma.

To achieve this aim, the project got divided into the following subtasks:

- Developing and designing of a cooling concept for the storage building
- Creating and analysing of a simulation model to predict the building's thermal behaviour and determine parameters for the cooling system
- Providing technical support for designing and constructing the prototype
- Testing of the prototype

The developed cooling concept for the storage building is based on low environmental temperatures, which are occurring at night. Based on this circumstance it has been planned to use two cooling systems for the storage building. The first system (night ventilation system) uses these low nighttemperatures directly. As soon as the environmental temperatures drop below the storage product temperatures, a fan is switched on and the room gets ventilated with cold ambient air. Thus room and storage

products get cooled down. The fan gets switched off in the morning, when the environmental temperature exceeds the storage product temperature.

The second cooling system is the day-ventilation system. It uses the low night temperatures only indirectly by cooling down a cold reservoir at night. This reservoir can for example consist of an insulated pile of stones. During the day, when the night-ventilation system is not working, the room air gets send through this cold mass and fed back into the room. Thus the room air and therefore the storage products can be cooled down resp. kept cool at day.

The storage products get harvested at day and stored in front of the building during the night to cool down. The storage room itself is kept closed most of the time and gets only opened for loading and unloading the products. Loading and unloading has to be done in the early morning when the temperatures are at their low point. Thus it is possible to minimize the heat loads for the room because not just the environmental but also the storage product temperatures are low.

Furthermore a numerical model has been developed with the simulation software TRNSYS. In this simulation two storage rooms, the storage products and the two cooling systems are modelled. Its purpose is to find an appropriate parameter setting for each cooling system and check their influence onto the thermal behaviour of the room resp. the storage products. By analysing the model and with regard to the high power consumption of the day-ventilation system it has been decided to use only the night-ventilation system for the storage building.

Also for the storage building a special concept has been developed. Instead of building just one, single large storage room, the required storage area gets distributed onto several smaller rooms. Furthermore each room has its own coolingand power supply system and therefore can be operated independently from the other rooms. The required electrical energy for the room gets provided by a photovoltaic-system. For the basic structure (outside walls and roof) of each storage room, the local building structure is supposed to get utilized. However, this way of constructing houses takes four to six months. This amount of time is not available for the prototype construction. Therefore clay-bricks have been chosen for the outer walls of the prototype. Thus the construction time can be decreased. As insulation material coffee husk and hulls get used. This loose material gets attached at the inside of the previously described building by using a special insulation structure developed at the department for Agricultural Engineering of the University of Kassel.

Due to time reasons it has not been possible to completely assist the prototype construction at the University of Jimma. Currently the construction works are still in progress. Consequently also the testing could not be executed.