

## BRAINSTORMING INSTRUCTIONS FOR GREENHOUSE GRID DESIGN TASK



Photos provided by HESE (2014).

Over the last 4 years, Penn State's HESE (Humanitarian Engineering and Social Entrepreneurship) program has been refining the design for a low-cost greenhouse for small-scale farmers which enables them to move from subsistence to sustainability. Greenhouses can allow farmers to grow vegetables and fruits year-round, increase their yields and improve their livelihoods while reducing spoilage and providing food security. A Penn State greenhouse team has collaborated with Kenyan, Rwandan and Tanzanian entities to design, prototype, and field-test affordable greenhouses designed for small agro-enterprises and sustenance farmers. Last year, the Penn State team contractually licensed our greenhouse design solution to a for-profit company called Mavuuno Greenhouses Limited -

<http://www.mavuunogreenhouses.com>. Mavuuno manufactures Greenhouse Kits for the East African market, which are sold through a network of distributors and construction agents who assemble the Greenhouse Kits on farms and train the farmers on startup and maintenance regimens. In addition, HESE has a licensing agreement with The Greenhouse Center, another for-profit company based in Cameroon for the West African Market. Finally, with USAID support, HESE is working with World Hope International to jumpstart GRO Greenhouses in Mozambique and Sierra Leone over the next year.

The Mavuuno greenhouse design has been well researched and the selection of materials optimized for location, minimal cost, and durability. To set up the greenhouse, the carpenter (construction agent) goes to a site with the Greenhouse Kit and hires 1-2 local laborers at about \$3 - \$6 per day (8 hours). These local laborers are typically young men and readily available because of the high unemployment rates: youth unemployment is about 70% in Sierra Leone.

Some critical steps that must be done before construction of the frame:

1. Clear and level a 7 meter x 7 meter area for the 6 meter x 6 meter greenhouse.
2. Locate one corner of the greenhouse, and lay out the 6 meter x 6 meter grid for the frame posts in a square pattern.
3. Dig the post holes, construct the frame and attach the glazing material to the frame.

Parts of Step 1 and 2 form this DEM project challenge. With only simple tools such as rope or wire, a level, and a measuring tape, 1) define an efficient method for measuring how level the ground is, and 2) define the process so a 6 meter x 6 meter square area can be marked with 49 frame post locations which are square. Any one post can be no more than 1 centimeter off. The goal is to completely mark the grid (start to finish) in 10 minutes or less. Other factors: assume the person laying out the grid cannot read or write, and the wood for the greenhouse frame will be warped.

Design of very simple tool(s) to help with measuring ground "levelness" and do the grid layout process is encouraged. However, any new device must not be too heavy and should be ruggedized for harsh environments. The budget for any new device is \$10. Available materials are nylon string, wood and metal bars.