Decreasing Water Usage and Increasing Income for Vietnamese Small Farmers: Modeling Plant Stress with Handheld Infrared Thermometers

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The EPICS (Engineering Projects in Community Service) program at Arizona State University provides students the opportunity to partner with communities and create sustainable solutions to global issues. My team, Vietnam Smart Agriculture group, is designing a handheld infrared device to aid small farmers with their irrigation practices in order to reduce water waste and increase annual income. It has been estimated that more controlled irrigation techniques in Vietnam could lead to using thirty percent less water and provide about a forty percent increase in annual income for certain rural farming households. In order to operate this inexpensive system, the farmer measures the surface temperature of randomly selected plants around the farm, along with atmospheric temperature, using the handheld infrared sensor. The data would be used to suggest watering amounts displayed through a mobile app. As the research lead for this team, the goal of this research project was to provide the necessary background for the EPICS team to continue in creating a functional and accurate system.

The research question investigated was, “How can canopy temperature be used to determine plant stress and calculate watering amounts to optimize water usage in Vietnamese small farms?” The crop water stress index (CWSI) produces a value from 0 (a plant not stressed for water) to 1 (fully water-stressed), used as an indicator of a crop’s health and water needs. In order to accurately calculate CWSI, baselines must be obtained from each crop type when non-stressed and fully stressed. Baselines are calculated based on data taken from the specific climate and plant being indexed. This project investigated using both the Idso and Jackson method of determining CWSI.

This summer research project provided key insights into the development of the inexpensive system described above. For instance, the research found a lack of available baselines for the Vietnamese climate and many of the crops that small farmers would grow there. A large number of baselines would be required for the average Vietnamese small farm as they typically feature a variety of plants. Furthermore, since this technology is more often used for certain crops on large farms in locations such as the southwest USA, more data is necessary to determine baselines for calculating crop water stress indices for the small plots found on the farms and gardens in Vietnam.

Other key insights featured design improvements to increase functionality and accuracy. First, adding a level system to the handheld device could aid the accuracy of the human-performed measurements. Second, using human input would provide a better understanding of the accuracy of results. Third, connecting the app to weather station data would be required in order to gain access to the necessary variables for computing CWSI without overcomplicating the system. Future research will focus on finding suitable baselines to

be used in the EPICS team's product algorithm, along with creating a procedure for the farmers to use when taking plant canopy temperatures in order to minimize human error.