Title: Enhancement of peanut grading with a prototype microwave sensor deployable in static and dynamic applications in the presence of foreign material.

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Project Report:

The main objective of this research was to develop real-time peanut grading techniques for nondestructive determination of physical properties, such as kernel moisture content and bulk density, in unshelled peanuts (pods), using a portable microwave sensor developed by the Agricultural Research Service, U. S. Department of Agriculture. We were successful in demonstrating the feasibility of using the microwave sensor to determine moisture content of shelled and unshelled peanuts. Measurements were performed with five different types of peanuts: Georgia Runner, Texas Runner with high oleic acid, Valencia, Virginia, and Spanish. Figure 1 illustrates the fact that there is minimal effect of peanut type on the correlation between the calibration function ψ and moisture content. Therefore, a single calibration can be utilized in moisture sensing for different types of peanuts that vary in composition and structure using this microwave technology. We were also successful in demonstrating the feasibility of determining kernel moisture content from measurements on pods. This eliminates the need of having to shell peanuts in order to determine their kernel moisture content.

The deployment from the 2008 peanut harvest season was greatly expanded in that five portable microwave sensors were deployed to buying stations within the southeast peanut belt for the 2009 peanuts harvest season. Approximately 4,000 samples of "clean" and "unclean" unshelled peanuts were measured with the five microwave sensors. The data from these measurements was used to evaluate the performance of the microwave sensors in comparison to the performance of the GAC 2100. Figure 2 illustrates the comparison of the performance of both sensors at Peanut Producers LLC in Bartow, GA. This graph shows that the performance of the microwave sensor is comparable to that of the GAC 2100.

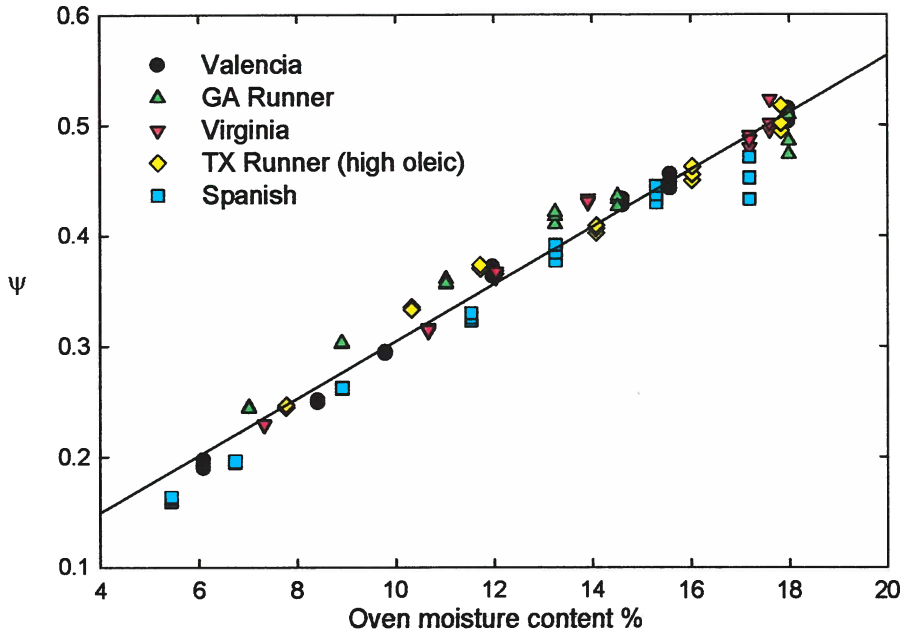

Figure 1: Variation of ψ with moisture content for shelled peanuts of indicated types at 6 GHz and 23°C

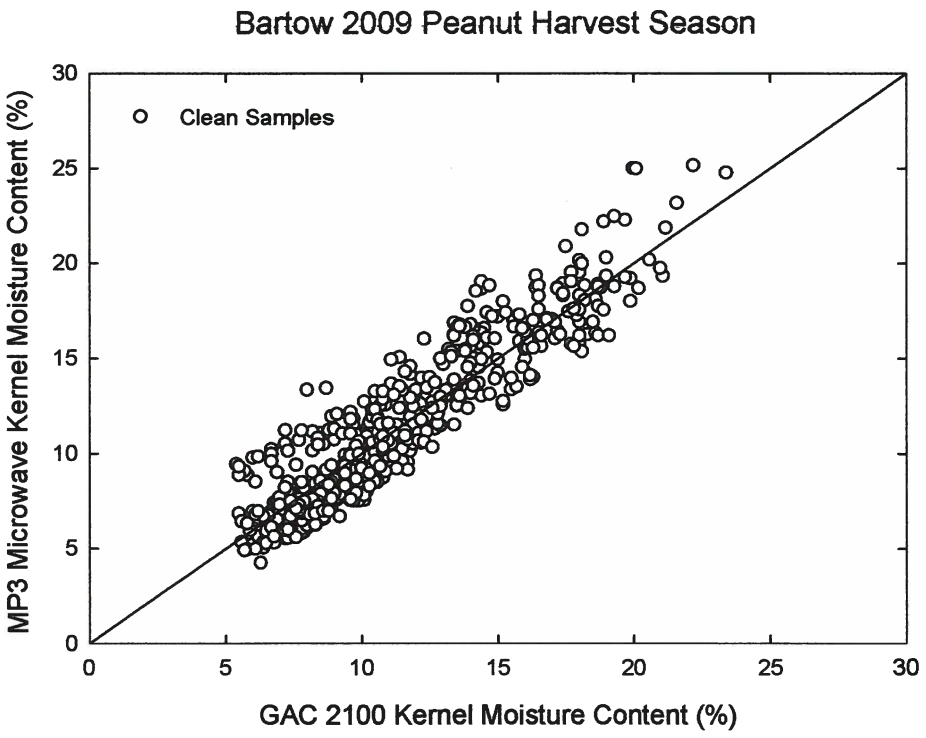

Figure 2: Kernel moisture content predicted with microwave prototype sensor versus kernel moisture content predicted with GAC 2100

Analysis will continue to determine the effect of foreign material on kernel moisture content determination. Through interaction with buying point officials, it was noted that types of foreign material in peanuts vary with the growing region. Therefore, we will further investigate to see if effects are specific to type of foreign material or universal.

Results from measurements show that the implementation of a feedback controller using the portable microwave sensor to further automate and optimize peanut drying is feasible. There are decision support systems used presently to estimate the drying time based on initial atmospheric conditions and the initial moisture content of the bed of peanuts. However, these systems demand heavy user interaction such as sampling for kernel moisture content and observing current atmospheric conditions, and they are susceptible to permitting underdrying or overdrying if not updated appropriately. Other control systems have the capability of monitoring atmospheric conditions and adjusting the heat of the blower accordingly. However, they rely on sampling to determine kernel moisture content and therefore determine the duration of drying. Nevertheless, there is still a risk of overdrying or underdrying. The microwave sensor provides the capability of determining the kernel moisture content of the pods in real-time. Knowledge of the kernel moisture content in real-time will allow for more efficient drying control.

In conclusion, the plan of investigation was quite successful. We remain excited about the project and are hopeful for the adoption of this technology within the peanut grading process.

Figure 3: Portable Prototype Microwave Moisture Sensor (shown with detachable funnel)