



# 2023 International Conference on Integrative Precision Agriculture – Local Solutions Through Global Advances

USDA Pecan Postharvest – Imaging  
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## Abstract

Pecans (*Carya illinoensis*) are a valuable agricultural commodity, with the United States being one of the largest producers in the world. One of the challenges in the industry is finding ways to crack pecans efficiently and effectively. To improve cracking procedures, researchers need to be able to quantify the quality of the pecan cracking process, which requires accurately measuring the number and type of cracks on the pecan shells. Image analysis can be used to determine various crack metrics on pecan shells, such as crack arclength, orientation, number of cracks, branched cracks, and thickness of cracks. With this information, researchers can make informed decisions on cracking procedures and evaluate the efficacy of different cracking techniques. Ultimately, the goal is to identify the relationship between post-crack statistics and post-shell statistics to improve overall pecan processing.

To conduct image analysis on pecan shells, a prototype imaging system was designed and fabricated to rotate pecans and test software capabilities. Video footage was taken of cracked pecans as they are passed through the system. A software was developed in MATLAB that uses raw video footage of rotating pecans as an input. It then tracks and indexes pecans while detecting cracks. The software then provides a comprehensive description of the crack profile of each indexed pecan in the form of a matrix that can be further processed to determine crack statistics. To validate the detected cracks, false positives were filtered out through a series of rules. All cracks that had centroids within 25% of the edge of the frame or were only present in two frames or less were discarded. For circumferential cracks, if the averaged crack width over all frames was at least 75% of the frame width in every frame, then it was marked as a full circumferential crack. For longitudinal cracks, if the centroid of the crack doesn't pass within 10% of the midpoint of the frame, it is discarded.

Using the described image analysis techniques, researchers can accurately quantify the number and type of cracks on pecan shells, allowing for better decisions on pecan cracking procedures. The results of this research can potentially lead to more efficient pecan processing and improved product quality.

**Keywords:** Food process engineering, crack detection, pecans, image analysis, cracking and shelling.