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Assessment of new in-bin drying and storage technology for soybean seed

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On-farm, in-bin drying and storage of soybean in environments with unconditioned air often result in repeated drying and rewetting of the grains which may have adverse effects on quality metrics. If done using natural air, as recommended for soybean destined to the seed market, the in-bin drying and storage method requires operation at well-defined local weather dependent strategies to maintain the seed quality. This study simulated in-bin drying and storage of soybeans. Different fan control options and drying strategies were used to assess performance in terms of drying duration to target final moisture content (MC), percent over drying, energy expenditure and drying cost. Fan operation included running the fan continuously (CNA), only at night (NANO), only during the day (NADO), at a set window of equilibrium MC of natural air (EMC-NA) and set EMC window with supplemental heating of ambient air as an option (EMC-H). Drying and storage performance was tested for soybean at initial moisture content (IMC) (16% to 22%, wet basis), air flow rate (1.04 to 5.0 $m^3 min^{-1}$ [air] t^{-1} [soybean]) and harvesting start dates (August 15 to November 15). Simulation model was validated using a bench scale pressure drop system filled with soybeans with IMC of 22%, wet basis. The result shows that fan control strategies, air flow rates, harvest date and initial MC of the soybeans significantly ($P < 0.05$) impact the drying duration, percent over drying and final MC of the grain. The simulation predicted well the overall profile of the experimental data. Layer by layer statistical comparison revealed that the overall mean relative deviation (MRD) was less than 10%, low values of Root mean square error (RMSE) (ranged between 2.4 and 2.5), Mallows' criteria (ranged between 2.4 and 7.0) and overall Chi-square was 0.88.