Title A two-dimensional model of grain storage with dynamic visualisation: predictions for temperature, moisture content, germination and respiration - a case study for rapeseed.

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Abstract

The development of a two-dimensional (r-z plane) simulation model of a cylindrical silo is described. The model assumes the presence of axi-symmetric conditions. The heat and mass transfer equations are solved for the case of uniform vertical flow using the "up-wind" difference technique employed in computational fluid dynamics. This describes the ventilated case and the unventilated case, when the velocity is set to zero, and the heat and mass transfer is assumed to be driven purely by diffusion. For the ventilated case, aerodynamic dispersion terms are incorporated, describing the enhancement of heat and moisture diffusion by mixing of air in its tortuous path through the grains. The programme can simulate the storage of wheat, barley and rapeseed using subroutines for each set of properties. The solution of the energy and moisture balance equations provides the temperature and moisture fields over a vertical section through the silo axis. Subroutines to predict germination (viability) and respiration (mould growth) are then used to calculate the percentage viability and cumulative dry matter loss. Using contour-mapping software, the temperature, moisture content, viability and cumulative dry matter loss are displayed in two dimensions. The programme was used to investigate the holding of high-moisture rapeseed before drying, with air flows of 0, 5, 10 and 15 m3 h-1 t-1. With no ventilation, the grain temperature increased rapidly to 50 deg C in approximately 12 days. On the other hand, even the lowest ventilation rate was sufficient to maintain the grain temperature to approximately 20 deg C. During ventilation, the mean moisture content dropped to 12.8% at approximately 30 days regardless of the flow rate. The cumulative dry matter loss was significantly reduced by ventilation.