Title   QualiGrain expert system for stored grain quality maintenance: planning optimal storage technical
               routes.

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Abstract

The maintenance of cereal quality is a complex problem due to the interaction between biotic and abiotic factors in the stored grain ecosystem. The biotic factors (germination, insects, moulds and mites) provide information on the quality of the grain. The abiotic factors (time, temperature, moisture content, impurities and insecticides) influence the dynamics of biotic factors and provide information on grain storage conditions. The planning problem is to control the abiotic factors with a view to keeping storage conditions safe. The QualiGrain preventive approach includes four steps: assessment of the initial quality and condition of the grain; planning the optimal storage technical route; monitoring grain condition during storage; and re-planning the storage technical route if the grain condition drifts out of safe storage conditions. In the planning module, we use the biotic factors as state variables, the abiotic factors as control variables and the storage actions as actions of the plan. A storage action (drying, cooling, cleaning, treating with an insecticide or selecting a bin) is executable if the equipment and/or chemical(s) needed are available. 'Dry grain using the medium drier MD1 to reach 14.5% of moisture content' and 'Store grain in the vertical bin VB4', for example, are executable storage operations. The planning method is hierarchical, with two levels: (a) generation of generic storage plans, and (b) refining the generic storage plans taking into account time, the equipment available and the consumables allowed. An optimal storage technical route gives a plan of the storage actions to be executed during the storage period with the estimated safe storage interval after each action of the plan. A prototype of an expert system, QualiS, has been developed, running on Windows on a personal computer. The advice afforded by the decision support system has been validated by storage specialists before and after pilot-scale experiments in Denmark and the UK.