Virtual machines for real benefits

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The machines used to land apply solid and semi-solid manure are known to exhibit poor performances in terms of both transversal and longitudinal product distribution. As the environmental and agronomic requirements for manure land application become more prescriptive, the technical limitations of the equipment currently available to handle and land apply solid manure are becoming more apparent. Since solid and semi-solid manure present environmental, agronomic and societal advantages over liquid manure, there is a need to develop more suitable machines to accommodate these products.

The first step towards developing improved machines is to study the physical and flow properties of the products to be handled and land applied. The properties of manure products that were deemed to have the most influence on machine performance were: (a) total solids concentration, (b) density, (c) particle size distribution, (d) shear stress-shear strain relations and (e) friction characteristics. These selected properties were measured for different types of manure at different levels of total solids concentration in the solid and semi-solid ranges. Based on the measured properties, machine-product interactions are modeled using a numerical method allowing the simulation of the flow of granular materials. The numerical method called Distinct Element Method (DEM) has been selected in order to get some insights into the flow of manure products in handling and land application equipment. The challenge of modeling machine-product interactions using a particle flow approach is twofold: (1) a good representation of the manure products in the software environment must be obtained and (2) the dynamics of the flow of material and of the machines' functional units have to be implemented with sufficient realism.

Implications:
The ultimate objective of this research and development effort is to study the machine-product interactions taking place in manure handling and land application equipment in order to develop machines that will exhibit improved performances in the field in terms of uniformity of application and control of application rates for the benefit of both livestock operators and crop producers.