Modelling Conservation Agriculture

ROLF SOMMER¹, WILLIAM D. BATECHLOR², JEFFREY W. WHITE³, JAMES W. JONES⁴, ARJAN J. GIJSMAN⁵, CHERYL H. PORTER⁴

¹International Maize and Wheat Improvement Center (CIMMYT), Tropical Ecosystems Program, Mexico
²Iowa State University, Agricultural and Biosystems Engineering, United States of America
³United States Department of Agriculture-Agricultural Research Service (USDA-ARS), US-Water Conservation Laboratory, United States of America
⁴University of Florida, Department of Agricultural & Biological Engineering, United States of America
⁵International Centre for Tropical Agriculture (CIAT), Colombia

Abstract

Conservation agriculture (CA) is a general term for a series of resource-conserving agricultural practices. Minimum or zero-tillage combined with crop residue retention and crop rotation are the fundamental components of CA. Additionally, alternative planting techniques such as permanent raised-bed systems are often applied in CA. These components add complexity to the cropping system, which challenges the applicability of commonly used crop-soil simulation model. But also the effects of conventional soil tillage, such as the temporal decrease in soil bulk density and increase in water infiltration capacity as well as mixing of soil layers, i.e. of texture, organic matter and nutrients, are often not accounted for in crop-soil simulation models or are represented in a limited way. In classical model applications this lack may be of little relevance. However, when models are used to explore the crucial differences between CA and conventional agriculture, changes in and effects on soil properties due to one or the other practice becomes highly relevant. This paper reviews how soil properties are affected by CA and conventional tillage. A modified version of the DSSAT (Decision Support System for Agrotechnology Transfer) model is described that includes several routines to account for the impact of tillage and surface residue retention.

Initial applications show that in the presence of a surface residue layer the classical SCS curve number approach fails to describe surface runoff adequately, because the residue layer increases surface roughness and retains water, which is not accounted for in the SCS approach. Also, in the presence of a residue layer soil evaporation is lower leading to comparably higher topsoil moisture content and consequently to a higher runoff according to the SCS curve number method. The one-dimensional cascade approach used by the model to simulate soil water infiltration and drainage does not adequately capture the soil water redistribution in raised-bed cropping systems. Modifications are needed to account for these two processes.

Keywords: Crop modelling, crop residues, soil water dynamics, tillage

Contact Address: Rolf Sommer, International Maize and Wheat Improvement Center (CIMMYT), Tropical Ecosystems Program, Km. 45, Carretera México-Veracruz, 56130 El Batán, Texcoco, Mexico, e-mail: r.sommer@cgiar.org