

Home

Journals

Abstract Databases

Reference Works

My Alerts

My Profile

Help

WELCOME GUEST USER [info](#)

6 of 16 results list ◀ previous next ▶

European Journal of Agronomy[Volume 18, Issues 3-4](#), January 2003, Pages 289-307

DOI: 10.1016/S1161-0301(02)00109-0

PII: S1161-0301(02)00109-0

Copyright © 2002 Elsevier Science B.V. All rights reserved.

This Document

▶ **SummaryPlus**

- [Full Text + Links](#)
- [PDF \(255 K\)](#)

Actions

- [E-mail Article](#)

CropSyst, a cropping systems simulation model

Claudio O. Stöckle^a,  ^a, Marcello Donatelli^b and Roger Nelson^a^a Department of Biological Systems Engineering, Washington State University, Pullman, WA 99164-6120, USA^b ISCI (Research Institute for Industrial Crops), Via di Corticella 133, 40128, Bologna, Italy

Available online 14 December 2002.

Abstract

CropSyst is a multi-year, multi-crop, daily time step cropping systems simulation model developed to serve as an analytical tool to study the effect of climate, soils, and management on cropping systems productivity and the environment. CropSyst simulates the soil water and nitrogen budgets, crop growth and development, crop yield, residue production and decomposition, soil erosion by water, and salinity. The development of CropSyst started in the early 1990s, evolving to a suite of programs including a cropping systems simulator (CropSyst), a weather generator (ClimGen), GIS-CropSyst cooperater program (ArcCS), a watershed model (CropSyst Watershed), and several miscellaneous utility programs. CropSyst and associated programs can be downloaded free of charge over the Internet. One key feature of CropSyst is the implementation of a generic crop simulator that enables the simulation of both yearly and multi-year crops and crop rotations via a single set of parameters. Simulations can last a fraction of a year to hundreds of years. The model has been evaluated in many world locations by comparing model estimates to data collected in field experiments. CropSyst has been applied to perform risk and economic analyses of scenarios involving different cropping systems, management options, and soil and climatic conditions. An extensive list of references related to model development, evaluation, and application is provided.

Author Keywords: Farming systems; Agricultural modeling; Simulation models; Cropping systems; Watershed simulation; CropSyst; ClimGen

Article Outline

1. Introduction
2. CropSyst components and modeling approach
 - 2.1. CropSyst parameter editor
 - 2.2. CropSyst
 - 2.3. ClimGen
 - 2.4. ArcCS
 - 2.5. CropSyst watershed
 - 2.6. Miscellaneous utility programs
3. Model description
 - 3.1. Water budget
 - 3.2. Nitrogen budget

- 3.3. Crop phenology
- 3.4. Biomass accumulation
- 3.5. Leaf area development
- 3.6. Root growth
- 3.7. Yield
- 3.8. Crop growth response to elevated atmospheric CO₂
- 3.9. Crop rotations
- 4. Data requirements
- 5. Software implementation and distribution policy
 - 5.1. Programming framework
 - 5.2. User interface
 - 5.3. Input file formats
 - 5.4. Event driven modeling
- 6. Model testing and examples of applications
 - 6.1. Evaluation of models and its limitations
 - 6.2. Evaluation of CropSyst
 - 6.3. Model application
- 7. Closing the loop between development and application
- References



Fig. 1. Flowchart of biomass growth calculations in CropSyst.

Table 1. Statistical comparisons of observed and simulated responses to water treatments for four crops and four locations (**St** and **St**) (<1K)
N, number of data point; Obs, observed value; Sim, simulated value; RMSE, root mean square error; *d*, index of agreement.

Table 2. Statistical comparisons of observed and simulated responses to water and nitrogen treatments for wheat at two locations (**St** and **Pala**) (<1K)
N, number of data point; Obs, observed value; Sim, simulated value; RMSE, root mean square error; *d*, index of agreement.

Table 3. Statistical comparisons of observed and simulated seasonal evapotranspiration for four crops and two locations (**St** and **Pala**) (14K)
N, number of data point; Obs, observed value; Sim, simulated value; RMSE, root mean square error; *d*, index of agreement.

References

Acutis and Donatelli, 2003. Acutis, M., Donatelli, M., 2003. SOILPAR 2.00: software to estimate soil hydrological parameters and functions. *Eur. J. Agron.* 18, 373–377.

Acutis et al., 1998. Acutis, M., Donatelli, M., Stöckle, C.O., 1998. Comparing the performance of three weather generators. *Proceedings of the Fifth European Society for Agronomy Congress, Nitra, Slovak Republic, 28 June–2 July*, vol. II, pp. 117–118.

Acutis et al., 1999. Acutis, M., Donatelli, M., Stöckle, C.O., 1999. Performance of two weather generators as a function of the number of available years of measured climatic data. *Proceedings First International Symposium Modelling Cropping Systems, Lleida, Spain, 21–23 June*, pp. 129–130.

Allen et al., 1998. Allen, R.G., Pereira, L.S., Raes, D., Smith, M., 1998. Crop evapotranspiration: Guidelines for computing crop water requirements. Irr. Drain. Paper 56. UN-FAO, Rome.

Arkin et al., 1976. Arkin, G.F., Vanderlip, R.L., Ritchie, J.T., 1976. A dynamic grain sorghum growth model. Trans. ASAE 19, 622–626, 630.

Badini et al., 1997. O. Badini, C.O. Stöckle and E.H. Franz, Application of crop simulation modeling and GIS to agroclimatic assessment in Burkina Faso. *Agric. Ecosyst. Environ.* **64** (1997), pp. 233–244. [Abstract](#) | [PDF \(825 K\)](#)

Bechini et al., 1999. Bechini, L., Bocchi S., Maggiore, T., 1999. Spatial interpolation of soil properties for irrigation planning. A case study in Northern Italy. Proceedings First International Symposium Modelling Cropping Systems, Lleida, Spain, 21–23 June, pp. 143–144.

Belhouchette et al., 2001. Belhouchette, H., Donatelli, M., Braudeau, E., Wery, J., 2001. Test of the cropping systems model CropSyst in Tunisian conditions. Proceedings Second International Symposium Modelling Cropping Systems, 16–18 July, Florence, Italy, pp. 47–48.

Berti et al., 2001. Berti, A., Morari, F., Borin, M., Giardini, L., 2001. Use of CropSyst to simulate a four year rotation with different fertilization levels. Proceedings Second International Symposium Modelling Cropping Systems, Florence, Italy, 16–18 July, pp. 105–106.

Bindi et al., 1999. Bindi, M., Donatelli, M., Fibbi, L., Stöckle, C.O., 1999. Estimating the effect of climate change on cropping systems at four European sites. Proceedings First International Symposium Modelling Cropping Systems, Lleida, Spain, 21–23 June, pp. 147–148.

Bocchi et al., 2001. Bocchi, S., Confalonieri, R., Bechini, L., 2001. CropSyst for rice in Northern Italy. Proceedings Second Modelling Cropping Systems International Symposium, Florence, Italy, 16–18 July 2001, pp. 51–52.

Boote et al., 1998. K.J. Boote, J.W. Jones, G. Hoogenboom and N.B. Pickering, The CROPGRO model for grain legumes. In: G.Y. Tsuji, G. Hoogenboom and P.K. Thornton, Editors, *Understanding Options for Agricultural Production*, Kluwer Academic Publishers, Dordrecht, The Netherlands (1998), pp. 99–128.

Bouman et al., 1996. B.A.M. Bouman, H. van Keulen, H.H. van Laar and R. Rabbinge, The 'School of de Wit' crop growth simulation models: a pedigree and historical overview. *Agric. Syst.* **52** (1996), pp. 171–198. [Abstract](#) | [PDF \(1534 K\)](#)

Bouniols et al., 1991. A. Bouniols, M. Cabelguenne, C.A. Jones, A. Chalamet, J.L. Charpentreau and J.R. Marty, Simulation of soybean nitrogen nutrition for a silty clay soil in southern France. *Field Crop Res.* **26** (1991), pp. 19–34.

Campbell, 1985. G.S. Campbell *Soil Physics with Basic*, Elsevier, Amsterdam (1985).

Castellvi and Stöckle, 2002. F. Castellvi and C.O. Stöckle, Comparing the performance of WGEN and ClimGen in the generation of temperature and solar radiation. *Trans. ASAE* **44** (2002), pp. 1683–1687.

Castellvi et al., 2002. F. Castellvi, C.O. Stöckle and M. Ibañez, Comparing a locally calibrated versus a generalized temperature generation process. *Trans. ASAE* **44** (2002), pp. 1143–1148.

Chen et al., 2002. Chen, S., Zhao, B., Stockle, C.O., Harrison, J., Nelson, R. 2002. Use of models as decision support tools in dairy nutrient management. ASAE Paper No. 02-4094, St. Joseph, MI.

Confalonieri et al., 2001. Confalonieri, R., Maggiore, T., Bechini, L., 2001. Application of the simulation model CropSyst to an intensive forage system in Northern Italy. In: Proceedings Second International Symposium Modelling Cropping Systems, Florence, Italy, 16–18 July, pp. 59–60.

Crisci et al., 2001. Crisci, A., Moonen, C., Ercoli, L., Bindi, M., 2001. Study of the impact of climate change on wheat and sunflower yields using an historical weather data-set and a crop simulation model. Proceedings Second International Symposium Modelling Cropping Systems, Florence, Italy, 16–18 July, pp. 119–120.

de Wit et al., 1970. de Wit, C.T., Brouwer, R., Penning de Vries, F.W.T., 1970. The simulation of photosynthetic systems. In: Setlik, I. (Ed.), Prediction and measurement of photosynthetic productivity. Proceeding IBP/PP Technical Meeting Trebon 1969. Pudoc, Wageningen, The Netherlands, pp. 47–50.

Diaz-Ambrona et al., 2001. Diaz-Ambrona, C.G.H., O'Leary, G.J., O'Connell, M.G., Connor, D.J., 2001. Application of CropSyst to a new location and crops: advantages and limitations. Proceedings Second International Symposium Modelling Cropping Systems, Florence, Italy, 16–18 July, pp. 127–128.

Donatelli et al., 1996a. M. Donatelli, C.O. Stöckle, E. Ceotto and M. Rinaldi, CropSyst validation for cropping systems at two locations of Northern and Southern Italy. *Eur. J. Agron.* **6** (1996), pp. 35–45.

Donatelli et al., 1996b. Donatelli, M., Spallacci, P., Marchetti, R., Papini, R., 1996b. Evaluation of CropSyst simulations of growth of maize and of water balance and soil nitrate content following organic and mineral fertilization applied to maize. Proceedings Fourth European Society for Agronomy Congress, Veldhoven-Wageningen, The Netherlands, 7–11 July, vol. I, pp. 342–343.

Donatelli et al., 1999a. Donatelli, M., Stöckle, C.O., Nelson, R.L., Francaviglia, R., 1999a. Evaluating cropping systems in lowland areas of Italy using the cropping system simulation model CropSyst and the GIS software **ARCVIEW**. Proceedings Seventh ICCTA Conference, Firenze, Italy, 16–17 November 1998, pp. 114–121.

Donatelli et al., 1999b. M. Donatelli, C.O. Stöckle, R.L. Nelson, C. Gardi, M. Bittelli and G.S. Campbell, Using the software CropSyst and **ARCVIEW** in evaluating the effect of management in cropping systems in two areas of the low Po valley, Italy. *Rev. de Cien. Agric.* **22** (1999), pp. 87–108.

Donatelli et al., 2002a. Donatelli, M., Stöckle, C.O., Nelson, R.L., Bellocchi, G., 2002a. ET_CSDLL: a DLL for the computation of reference and crop evapotranspiration. *Agron. J.*, (submitted for publication).

Donatelli et al., 2002b. Donatelli, M., Acutis, M., Fila, G., Bellocchi, G., 2002b. A method to quantify time mismatch of model estimates. Seventh Congress of the European Society for Agronomy, Cordoba, Spain, July 15–18, 269–270.

Donatelli et al., 2002c. Donatelli, M., Tubiello, F., Peruch, U., Rosenzweig, C., 2002c. Scenarios of climate change effects on sugar beet in Northern and Central Italy. *Ital. J. Agron.*, in press.

Donatelli et al., 2003. Donatelli, M., Bellocchi, G., Fontana, F., 2003. RadEst3.00: Software to estimate daily radiation data from commonly available meteorological variables. *Eur. J. Agron.*, **18**, 363–367.

Eruygur, 2000. Eruygur, O.H., 2000. Use of bio-physical models in agricultural economics: an application of Cropsyst. MS thesis, Dept. Agr. Economics, Middle East Technical University of Ankara, Turkey, pp. 139.

Ferrer-Alegre and Stöckle, 1999. F. Ferrer-Alegre and C.O. Stöckle, A model for assessing crop response to salinity. *Irrig. Sci.* **19** (1999), pp. 15–23.

Ferrer-Alegre et al., 1999a. Ferrer-Alegre, F., Villar, J.M., Carrasco, I., Stöckle, C.O., 1999. Developing management decision tools from yield experiments with the aid of a simulation model: an example with N fertilization in corn. Proceedings of the First International Symposium Modelling Cropping Systems, Lleida, Spain, 21–23 June, pp. 175–176.

Ferrer-Alegre et al., 1999b. Ferrer-Alegre, F., Villar, J.M., Castellví, F., Ballesta, A., Stöckle, C.O., 1999. Contribution of simulation techniques to the evaluation of alternative cropping systems in Andorra. Proceedings First International Symposium Modelling Cropping Systems, Lleida, Spain, 21–23 June, pp. 177–178.

Fila et al., 2003. Fila, G., Bellocchi, G., Acutis, M., Donatelli, M., 2003. IRENE: a software to evaluate model performance. *Eur. J. Agron.*, **18**, 369–372.

García de Cortázar et al., 2002. García de Cortázar, V., Silva, P., Acevedo, E., 2002. Validation of a predictive model of the effect of temperature and humidity on wheat straw decomposition. *Agricultura Técnica (Chile)*, (in press).

Godwin and Jones, 1991. Godwin, D.C., Jones, C.A., 1991. Nitrogen dynamics in soil plant systems. In: Hanks, J., Ritchie, J.T. (Eds.), *Modeling plant and soil systems*, Amer. Soc. of Agronomy, No. 31, pp. 297–302.

Greenwood et al., 1990. D.J. Greenwood, G. Lemaire, G. Gosse, P. Cruz, A. Draycott and J.J. Neeteson, Decline in percentage *N* of C_3 and C_4 crops with increasing plant mass. *Ann. Bot.* **66** (1990), pp. 425–436.

Jackson, 1982. R.D. Jackson, Canopy temperature and crop water stress. *Adv. Irrig.* **1** (1982), pp. 43–85.

- Jara and Stöckle, 1999. J. Jara and C.O. Stöckle, Simulation of corn water uptake using models with different levels of process detail. *Agron. J.* **91** (1999), pp. 256–265.
- Keating et al., 2003. Keating, B.A., Carberry, P.S., Hammer, G.L., Probert, M.E., Robertson, M.J., Holzworth, D., Huth, N.I., Hargreaves, J.N.G., Meinke, H., Hochman, Z., McLean, G., Verburg, K., Snow, V., Dimes, J.P., Silburn, M., Wang, E., Brown, S., Bristow, K.L., Asseng, S., Chapman, S., McCown, R.L., Freebairn, D.M., Smith, C.J., 2003. An overview of APSIM, a model designed for farming systems simulation. *Eur. J. Agron.*, **18**, 267–288.
- Jones et al., 1998. J.W. Jones, G.Y. Tsuji, G. Hoogenboom, L.A. Hunt, P.K. Thornton, P.W. Wilkens, D.T. Imamura, W.T. Bowen and U. Singh, Decision support system for agrotechnology transfer DSSAT v3. In: G.Y. Tsuji, G. Hoogenboom and P.K. Thornton, Editors, *Understanding Options for Agricultural Production*, Kluwer Academic Publishers, Dordrecht, The Netherlands (1998), pp. 157–177.
- Jones et al., 2001. J.W. Jones, B.A. Keating and C.H. Porter, Approaches to modular model development. *Agric. Syst.* **70** (2001), pp. 421–443. [Abstract](#) | [Full Text + Links](#) | [PDF \(271 K\)](#)
- Kiniry et al., 1989. J.R. Kiniry, C.A. Jones, J.C. O'Toole, R. Blanchet, M. Cabelguenne and D.A. Spanel, Radiation-use efficiency in biomass accumulation prior to grain filling for five grain crop species. *Field Crop Res.* **20** (1989), pp. 51–64.
- Lindemann et al., 1987. Lindemann, E.R., Stöckle, C.O., Redell, D., 1987. Field testing a computer-assisted on-farm irrigation scheduling program. ASAE Paper No. 87–2560, St. Joseph, MI.
- Loomis and Connors, 1992. R. Loomis and D. Connors *Crop Ecology: Productivity and Management in Agricultural Systems*, Cambridge University Press, Cambridge, UK (1992).
- Marchetti et al., 1997. R. Marchetti, M. Donatelli and P. Spallacci, Testing denitrification functions of dynamic crop models. *J. Envir. Qual.* **26** 2 (1997).
- Marchetti et al., 1998. Marchetti, R., Spallacci P., Ceotto E., Papini R., 1998. Predicting yield variability for corn grown in a silty-clay soil in Northern Italy. In: Proceedings Fourth International ASA-CSSA-SSSA Conference on Precision Agriculture, St. Paul, MN, 19–22 July, pp. 467–478.
- Marcos, 2000. Marcos, J., 2000. Simulation-based assessment of alternative crops in the dryland Pacific Northwest. Ph. D. dissertation, Washington State University, Pullman, Washington.
- Marcos et al., 1999. Marcos, J., Fiez, T., Stöckle, C.O., Huggins, D., 1999. Model-based assessment of alternative crop adaptation to the dryland cropping areas of the Pacific Northwest. Agronomy Abstracts, ASA Annual Meeting, Salt Lake City, UT, American Society of Agronomy, Madison, WI.
- Mazzetto et al., 2001. Mazzetto, F., Ceccon P., Bonera R., Sacco D., Acutis M., 2001. A model of multicriteria analysis aimed at evaluating different cropping systems. Proceedings Second Modelling Cropping Systems International Symposium, Florence, Italy, 16–18 July 2001, pp. 150–151.
- McCown et al., 1996. R.L. McCown, G.L. Hammer, J.N.G. Hargreaves, D.P. Holtzworth and D.M. Freebairn, APSIM: a novel software system for model development, model testing and simulation in agricultural systems research. *Agric. Syst.* **50** (1996), pp. 255–271. [Abstract](#) | [PDF \(886 K\)](#)
- McKinion et al., 1988. McKinion, J.M., Baker, D.N., Whisler, F.D., Lambert, J.R., 1988. Application of the GOSSYM/COMAX system to cotton crop management. ASAE Paper No. 88–7532, St. Joseph, MI.
- Meinke et al., 2001. H. Meinke, W.E. Baethgen, P.S. Carberry, M. Donatelli, G.L. Hammer, R. Selvaraju and C.O. Stöckle, Increasing profits and reducing risks in crop production using participatory systems simulation approaches. *Agric. Syst.* **70** (2001), pp. 493–513. [Abstract](#) | [Full Text + Links](#) | [PDF \(179 K\)](#)
- Monteith, 1965. J.L. Monteith In: *Evaporation and environment. 19th Symposia of the Society for Experimental Biology* **19**, University Press, Cambridge (1965), pp. 205–234.
- Monteith, 1977. J.L. Monteith, Climate and crop efficiency of crop production in Britain. *Phil. Trans. Res. Soc. Lond. Ser. B* **281** (1977), pp. 277–329.

- Morari et al., 2000. Morari, F., Berti, A., Borin, M., Giardini, L., 2000. CropSyst model in simulating cropping systems with different input levels. Proceedings Ninth International Conference on the UN-FAO ESCORENA network, Gargnano del Garda (BS), Italy, 6–9 September, pp. 257–262.
- Pala et al., 1996. M. Pala, C.O. Stöckle and H.C. Harris, Simulation of durum wheat (*Triticum durum*) growth under differential water and nitrogen regimes in a mediterranean type of environment using CropSyst. *Agric. Syst.* **51** (1996), pp. 147–163. [Abstract](#) | [PDF \(666 K\)](#)
- Pannkuk et al., 1998. C.D. Pannkuk, C.O. Stöckle and R.I. Papendick, Validation of CropSyst for winter and spring wheat under different tillage and residue management practices in a wheat-fallow region. *Agric. Syst.* **57** (1998), pp. 121–134. [Abstract](#) | [PDF \(563 K\)](#)
- Peralta and Stöckle, 2001. J.M. Peralta and C.O. Stöckle, Nitrate from an irrigated crop rotation at the Pasco-Quincy area (Washington, USA) available for groundwater contamination: a long-term simulation study. *Agric. Ecosyst. Environ.* **88** (2001), pp. 23–34.
- Priestley and Taylor, 1972. C.H.B. Priestley and R.J. Taylor, On the assessment of surface heat flux and evaporation using large scale parameters. *Mon. Weath. Rev.* **100** (1972), pp. 81–92.
- Renard et al., 1997. Renard, K.G., Foster, G.R., Weesies, G.A., McCool, D.K., Yoder, D.C., 1997. Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE). US Dept Agric., Agriculture Research Service. Agriculture Handbook No. 703, pp. 384.
- Richardson and Wright, 1984. Richardson, C.W., Wright, D.A., 1984. WGEN: A model for generating daily weather variables. U.S. Department of Agriculture, Agricultural Research Service, ARS-8, pp. 83.
- Richter et al., 1999. Richter, G.M., Agostini, F., Donatelli, M., Smith, P., Smith, J., 1999. Modelling the N-dynamics of a wheat-sugar beet rotation at different complexity. Proceedings First International Symposium Modelling Cropping Systems, Lleida, Spain, 21–23 June, pp. 239–240.
- Ritchie and NeSmith, 1991. Ritchie, J.T., NeSmith, D.S., 1991. Temperature and crop development. In: Hanks J., Ritchie J.T., (Eds.), Modeling Plant and Soil Systems, Agronomy Monograph No.31, ASA, CSSA, and SSSA, Madison, WI, pp. 5–29.
- Ritchie et al., 1998. J.T. Ritchie, U. Singh, D.C. Godwin and W.T. Bowen, Cereal growth, development and yield. In: G.Y. Tsuji, G. Hoogenboom and P.K. Thornton, Editors, *Understanding Options for Agricultural Production*, Kluwer Academic Publishers, Dordrecht, The Netherlands (1998), pp. 79–98.
- Rivington et al., 2001. Rivington, M., Matthews, K.B., Sibbald, A.R., Stöckle, C.O., 2001. Integrating CropSyst with a multiple-objective land use planning tool (LADSS). Proceedings Second International Symposium Modelling Cropping Systems, Florence, Italy, 16–18 July, pp. 171–172.
- Ross and Bristow, 1990. P.J. Ross and K.L. Bristow, Simulating water movement in layered and gradational soils using the Kirchhoff transform. *Soil Sci. Soc. Am. J.* **54** (1990), pp. 1519–1524.
- Sadras, 2002. Sadras, V.O., 2002. Interaction between rainfall and nitrogen fertilisation of wheat in environments prone to terminal drought: economic and environmental risk analysis. *Field Crops Res.*, **77**, 201–215.
- Saxton et al., 1986. K.E. Saxton, W.J. Rawls, J.S. Romberger and R.I. Papendick, Estimating generalized soil–water characteristics from texture. *Soil Sci. Soc. Amer. J.* **50** (1986), pp. 1031–1036.
- Scott et al., 2001. Scott, M., L.W. Vail, J.A. Jaksch, Anderson K.K., Stockle, C.O., 2001. Early warning of ENSO events for regional agriculture. Report for the Office of Global Programs, U.S. NOAA, Contract 28340A. Battelle Pacific Northwest Division, Richland, Washington.
- Silvestri et al., 1999. Silvestri, N., Bellocchi, G., Mazzoncini, M., Menini, S., 1999. Evaluation of the CropSyst model for simulating soil water, soil nitrate, green area index and above-ground biomass of maize under different management. Proceedings First International Symposium Modelling Cropping Systems, Lleida, Spain, 21–23 June, pp. 253–254.
- Stöckle et al., 1998. Stöckle, C.O., Bellocchi, G., Nelson, R.L., 1998. Evaluation of the weather generator ClimGen for several world locations. Proceedings Seventh International Congress for Computer Technology in Agriculture, Florence,

Italy, 15–18 November 1998, pp. 34–41.

Stöckle et al., 1997. C.O. Stöckle, M. Cabelguenne and P. Debaeke , Comparison of CropSyst performance for water management in Southwestern France using submodels of different levels of complexity. *Eur. J. Agron.* **7** (1997), pp. 89–98. [Abstract](#) | [PDF \(622 K\)](#)

Stöckle and Campbell, 1989. C.O. Stöckle and G.S. Campbell , Simulation of crop response to water and nitrogen: an application example using spring wheat. *Trans. ASAE* **32** (1989), pp. 66–74.

Stöckle and Debaeke, 1997. C.O. Stöckle and P. Debaeke , Modelling crop nitrogen requirements: a critical analysis. *Eur. J. Agron.* **7** (1997), pp. 161–169. [Abstract](#) | [PDF \(508 K\)](#)

Stöckle and Jara, 1998. C.O. Stöckle and J. Jara , Modeling transpiration and soil water content from from a corn field: 20 min vs. daytime integration step. *Agric. For. Meteorol.* **92** (1998), pp. 119–130. [Abstract](#) | [PDF \(360 K\)](#)

Stöckle et al., 1994. C.O. Stöckle, S. Martin and G.S. Campbell , CropSyst, a cropping systems model: water/nitrogen budgets and crop yield. *Agric. Syst.* **46** (1994), pp. 335–359.

Stöckle and Nelson, 2000. C.O. Stöckle and R.L. Nelson *Cropsyst User's manual (Version 3.0)*, Biological Systems Engineering Dept., Washington State University, Pullman, WA (2000).

Stöckle et al., 1992. C.O. Stöckle, J.R. Williams, N.J. Rosenberg and C.A. Jones , A method for estimating the direct and climatic effects of rising atmospheric carbon dioxide on growth and yield of crops: Part I—modification of the EPIC model for climate change analysis. *Agric. Syst.* **38** (1992), pp. 225–238.

Swaney et al., 1983. D.P. Swaney, J.W. Jones, W.G. Boggess, C.G. Wilkerson and J.W. Mishoe , Real-time irrigation decision analysis using simulation. *Trans. ASAE* **26** (1983), pp. 562–568.

Tanner and Sinclair, 1983. C.B. Tanner and T.R. Sinclair , Efficient water use in crop production: research or re-search?. In: H.M. Taylor, W.R. Jordan and T.R. Sinclair, Editors, *Limitations to efficient water use in crop production*, Amer. Soc. Agron, Madison, WI (1983).

Tubiello et al., 2000. F. Tubiello, M. Donatelli, C. Rozenweig and C.O. Stöckle , Effects of climate change and elevated CO₂ on cropping systems: model predictions at two Italian locations. *Eur. J. Agron.* **2–3** (2000), pp. 179–189. [Abstract](#) | [Full Text + Links](#) | [PDF \(231 K\)](#)

US Soil Conservation Service, 1972. US Department of Agriculture, Soil Conservation Service. 1972. National Engineering Handbook, 4. Hydrology. Washington, DC, pp. 548.

Van Keulen and Seligman, 1987. Van Keulen, H., Seligman, N.G., 1987. Simulation of water use, nitrogen nutrition and growth of a spring wheat crop, Pudoc, Wageningen.

Ventrella and Rinaldi, 1999. D. Ventrella and M. Rinaldi , Comparison between two simulation models to evaluate cropping systems in Southern Italy. Yield response and soil water dynamics. *Agric. Med.* **129** (1999), pp. 99–110.

Wilkerson et al., 1983. Wilkerson, G.G., Mishoe, J.W., Jones, J.W., Boggess, W.G., Swaney, D.P., 1983. Within-season decision making for pest control in soybeans. ASAE Paper No. 83–4044, St. Joseph, MI.

Williams et al., 1984. J.R. Williams, C.A. Jones and P.T. Dyke , A modeling approach to determining the relationship between erosion and soil productivity. *Trans. ASAE* **27** (1984), pp. 129–144.

Willmott, 1982. C.J. Willmott , Some comments on the evaluation of model performance. *Bull. Amer. Meteorol. Soc.* **63** (1982), pp. 1309–1313.

[European Journal of Agronomy](#)
[Volume 18, Issues 3-4](#), January 2003, Pages 289-307

This Document
▶ **SummaryPlus**
▪ [Full Text + Links](#)
▪ [PDF \(255 K\)](#)

Actions
▪ [E-mail Article](#)

6 of 16 results list ◀ previous next ▶

[Home](#) [Journals](#) [Abstract Databases](#) [Reference Works](#) [My Alerts](#) [My Profile](#) [? Help](#)

Send [feedback](#) to ScienceDirect

Software and compilation © 2003 ScienceDirect. All rights reserved.

ScienceDirect® is an Elsevier Science B.V. registered trademark.

Your use of this service is governed by [Terms and Conditions](#). Please review our [Privacy Policy](#) for details on how we protect information that you supply.