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Water Optimizer: A Tool for Decision Support and Policy Analysis

Developed by Derrel L. Martin and Raymond J. Supalla[1]

Water Optimizer is a tool for analyzing alternative water management strategies when the available water supply is limited. It can be used by producers to determine the profit maximizing crops to produce and the optimum amount of water to apply to each crop, given a particular water supply. It can also be used to evaluate the economic consequences of public policies which expand or reduce the amount of irrigation.

The Water Optimizer model can compute the profit maximizing strategy for producers located in any county in Nebraska where there is significant irrigation. This can be done for three different soil types (fine, medium and coarse textured), for two types of irrigation systems (gravity and pivot) and for any water cost. The model does this by simultaneously considering seven crops (corn, soybeans, wheat, grain sorghum, alfalfa, edible beans and sunflowers) at all irrigation levels ranging from dryland to fully-watered.

Water Optimizer has been widely used to evaluate management strategies in the Republican and Central Platte basins. In most cases we find that the optimum strategy when water becomes limiting is to continue to irrigate the same acreage and the same crops at less than full irrigation (called deficit irrigation), as long as the water supply for the field is at least 80 percent of the full requirement. When the water supply is less than 80 percent of the full requirement it usually becomes advantageous to plant some acres to a lower water using crop, often soybeans, and/or to reduce the number of acres irrigated. The profit maximizing crop when water is not limited is usually continuous corn, although an irrigated corn and soybeans rotation is sometimes competitive.

Water Optimizer results also reveal that the costs of water allocation policies which reduce the amount of irrigation water applied to a crop are small for the first units of reduction, but increase rapidly as allocation levels are reduced. For example, an allocation level of 15 inches in Red Willow County, which is about 90 percent of the full requirement for pivot irrigated corn, would reduce the net income of irrigators by only $8.11 per acre, or $57.24 per acre-foot of reduced water application. If the allocation was reduced another 10 percent to 13.5 inches, however, the cost in the form of reduced net income would more than double to $22.39 per acre, or $80.00 per acre-foot. This result occurs because the effect of irrigation water on crop yields diminishes as more and more water is applied to the crop. [2]

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[1] Derrel L. Martin is Professor of Soil and Water Engineering in the Department of Biological Systems Engineering and Raymond J. Supalla is Professor of Agricultural and Natural Resource Economics, Department of Agricultural Economics, University of Nebraska – Lincoln.

[2] It is important not to confuse cost estimates expressed in terms of water applied, with costs expressed in terms of consumptive use. Costs per unit of water consumed or saved are always higher than costs per unit of water applied for the same policy choice, because not all of the water applied is lost to the basin. Although Water Optimizer can be used to compute costs per unit change in consumptive use, it is cumbersome to do so with the current version and some supplementary calculations are required.

Water Optimizer can also be used to calculate the cost of retiring irrigated acres. For our Red Willow County example the cost or retiring relatively good quality irrigated land was estimated at $143 per acre per year, or $102 per acre-foot of applied water.

All of these cost estimates correspond, of course, to a particular situation and set of input costs and crop prices. One of the strengths of Water Optimizer is that it can be easily used to evaluate management strategies or water policy consequences for alternative circumstances, such as $3.00 diesel fuel or $4.00 corn.

Public officials interested in using Water Optimizer to conduct their own analyses of water issues should contact Brain McMullen, Water Resources Research Associate, at 472-1781, or e-mail bmcmullen2@unl.edu, for a copy of the model and a users manual. The model is built in a Microsoft Excel spreadsheet and is usable by anyone with a working knowledge of Excel, although interpreting results in a policy framework can be cumbersome and confusing. Hence, we welcome legislative requests for particular analyses to be conducted by UNL staff, subject, of course, to time and budget constraints.