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Using “Real-Time” Crop Simulation to Maximize Water Use Efficiency with a Limited Water Supply

Decreasing availability of irrigation water in the western Corn Belt and Great Plains has resulted in rationing of irrigation water. Some areas are limited to pumping only 50-80% of crop water requirements. In contrast, conventional irrigation scheduling methods rely on soil water thresholds that assume no restrictions on water supply, and such methods rarely take into account the fact that crop yield response to water stress differs greatly depending on growth stage. Currently there are no “real-time” decision-support tools available for irrigation scheduling decisions based on the differing sensitivity to yield loss from water stress at different crop growth stages—which is critical for optimizing use of a limited water supply. We propose such a framework using real-time crop growth simulation, historical climate data, and short-term weather forecasts. The core of the framework is real-time assessment of crop growth and yield response to an irrigation event when soil moisture falls below thresholds that support maximum growth rate. Fuzzy logic will be used to combine real-time crop growth simulation, short-term rain forecast, and grower’s tolerance for risk. Through this process the decision-support system will identify the times when water input is most critical for maximizing yield response, as well as the times when irrigation could be skipped to save water for more effective use at later growth stages—especially during silking and grainfilling phases. The system will also quantify the optimal amount of irrigation water for each irrigation event. Our goal is to develop a robust and user-friendly irrigation decision-support tool based on the existing Hybrid-Maize model framework (www.hybridmaize.unl.edu). Such a tool has the potential to substantially increase grain output per unit of applied irrigation water, which is crucial for both water conservation and the economic viability of irrigated crop production in water-limited regions.

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