Publications

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Economically Optimum Irrigation Patternsfor Grain Sorghum Production: Texas High Plains

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- Full Text

Agricultural production and associated economic effects of irrigation on the Texas High Plains are seriously threatened by a rapidly declining groundwater supply and a swift upward trend in energy costs.

To optimize the amount of irrigation water to be applied during specified periods of the production process, a stochastic open-loop feedback control policy was built into a grain sorghum growth simulation model. The control policy operated under the basis of constant revision of the expectations generated at every starting point for each of the production periods. If discrepancies between the expected and the realized values existed, then, based on current conditions a reevaluation of the control variable, irrigation water, was made and the decision for the first period adopted. This process continued throughout each period of the growing season. Within the stochastic policy designed,

the values for the control variable were obtained by numerical search.

The model was applied to estimate optimal irrigation strategies and the impact of fuel curtailments on them. Initially, optimal irrigation strategies were developed under the assumption of perfect knowledge. Under this assumption, the results indicated there was not a unique strategy to be applied at all times. The quantities of irrigation water to apply at each period depended on the initial or starting conditions. Since one of the purposes of building the model was to make it perform under stochastic or real world conditions, the assumption of complete knowledge was relaxed to consider the case where the climatic environment was unknown. As in the deterministic case, the optimal amounts of irrigation water, by period. It was also observed, that with the open-loop feedback control, the results obtained for yields did not differ substantially from those obtained in the perfect knowledge case. The discrepancies among the two cases were primarily in the optimal amount of water applied and therefore in net returns. In the stochastic case, the use of irrigation water had a mean value approximately 25 percent more than in the case of perfect knowledge.

The effect of a fuel or irrigation curtailment was estimated for alternative time spans. When curtailments had a length of 10 days, there were no perceptible changes in the amount of net returns or yields, as compared to the no-curtailment case. The implication drawn was that by having frequent irrigation periods and applying optimal amounts of water, the adverse effects of 10-day curtailment periods were buffered.

The cases of twenty and thirty-day periods were found to have highly negative effects on the outcomes, especially net revenues, which decreased about 50 percent (from $99 to $50) in the curtailment case of 40 - 70 days after plant emergence compared to the no-curtailment value. The effects were not only on a decreased amount of returns perceived but also on an increased spectrum of relative fluctuation (from 18 percent to 68 percent for the same situations mentioned above).

It was also found that for the same time-span type of curtailments the effects were conditioned to the period in which they Occurred. However, the 20 or 30 day curtailment period might be applicable to much shorter actual fuel curtailment periods. Producers lose not only the time of fuel curtailments, but also, they must cover many acres with a limited number of wells. As a result, a 10-day fuel curtailment could easily result in a 20 to 30 day delayed irrigation.

To summarize, improved irrigation distribution technology could result in increased yields and less irrigation water by simply having very close control on timing and quantity of water applied.

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