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CROP SELECTIONS AND WATER ALLOCATIONS FOR LIMITED IRRIGATION

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INTRODUCTION

Irrigators are facing challenges with declining well yields or reduced allocations from water districts. To make reductions in water use, irrigators are considering shifts in cropping patterns that earn better net economic returns. A decision planning tool, the Crop Water Allocator (CWA), available at **www.mobileirrigationlab.com**, has been developed to find optimum net returns from combinations of crops, irrigation amounts, and land allocations (crop rotations) that program users choose to examine. The model uses yield-irrigation relationships for 11-21 in. of rainfall in western Kansas as a basis to estimate yields for particular rainfall zones. The user can customize the program with crop localized crop production costs or rely on default values from typical western Kansas farming operations. Irrigators are able to plan for the optimum economic use of their limited water supply by testing options with CWA.

Irrigators choose crops on the basis of production capabilities, economic returns, and crop adaptability to the area, government programs, crop water use, and their preferences. When full crop evapotranspiration demand cannot be met, yield-irrigation relationships and production costs become even more important inputs for management decisions. Under full irrigation, crop selection often is driven by the prevailing economics and production patterns of the region. Crops that respond well to water, return profitably in the marketplace and/or receive favorable government subsidies are usually selected. These crops still can perform in limited irrigation systems, but management decisions arise as water is limited: should fully watered cops continue to be used; should other crops be considered; what proportions of land should be devoted to each crop; and finally, how much water should be apportioned to each crop? The outcome of these questions is finding optimal economic return for the available inputs.

Determining the relative importance of the factors that influence the outcome of limited-irrigation management decisions can become complex. Commodity prices and government programs can fluctuate and change advantages for one crop relative to another. Water availability, determined by governmental policy or by irrigation system capacity, may also change with time. Precipitation probabilities influence the level of risk the producer is willing to assume. Production costs give competitive advantage or disadvantage to the crops under consideration.

The objective of this project has been to create a decision tool with user interaction to examine crop mixes and limited water allocations within land allocation constraints to find optimum net economic returns from these combinations. This decision aid is for intended producers with limited water supplies to allocate their seasonal water resource among a mix of crops. But, it may be used by others interested in crop rotations and water allocation choices.

BACKGROUND

CWA (Klocke et al., 2006) calculates net economic return for all combinations of crops selected for a rotation and water allocated to each crop. Subsequent model executions of land-split (crop rotation) scenarios can lead to more comparisons. Individual fields or groups of fields can be divided into in the following ways: 100%; 50%-50%; 25%-75%; 33%-33%-33%; 25%-25%-%50; 25%-25%-25%-25%. The number of crops eligible for consideration in the crop rotation could be more than the number of land splits under consideration. Optimum outcomes may recommend fewer crops than selected land splits. Fallowing part of the field is a valid option. Irrigation system parameters, production costs, commodity prices, yield maximums, annual rainfall, and water supplied to the field were held constant for each model execution, but can be changed by the user in subsequent executions.

The model examines each possible combination of crops selected for every possible combination of water allocation by 10% increments of the water supply. The model has an option for larger water iteration increments to save computing time. For all iterations, net return to land, management, and irrigation equipment is calculated:

Net return = (commodity price X yield) – (irrigation cost + production cost)

where:

commodity prices were determined from user inputs; crop yields were calculated from yield-irrigation relationships derived from a simulation model based on field research; irrigation costs were calculated from lift, water flow, water pressure, fuel cost, pumping hours, repair, maintenance, and labor for irrigation; and production costs were calculated from user inputs or default values derived from Kansas State University projected crop budgets (**www.agmanager.info/crops/**). All of the resulting calculations of net return are sorted from maximum to minimum and several of the top scenarios are summarized and presented to the user.

Field research results have been used to find relationships between crop yields and amounts of irrigation (figure 1). Yields from given irrigation amounts multiplied by commodity prices are used to calculate gross income. Grain yields for corn, grain sorghum, sunflower, and winter wheat were estimated by using the "Kansas Water Budget" software. Software development and use are described in Stone et al. (1995). Yield for each crop was estimated from irrigation amount for annual rainfall and silt loam soils.

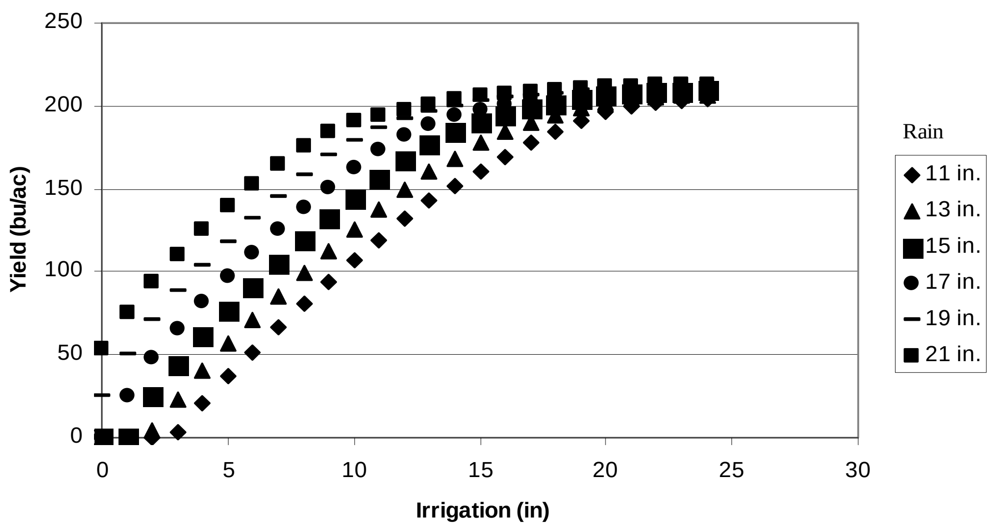

Figure 1. Yield-irrigation relationship for corn with annual rainfall from 11-21 in.

The resulting yield-irrigation relationship for corn (fig. 1) shows a convergence to a maximum yield of 220 bu/ac from the various combinations of rainfall and irrigation. A diminishing-return relationship of yield with irrigation applied was typical for all crops. Each broken line represents normal annual rainfall for an area.

The crop production budgets are the foundation for default production costs used in CWA. Program users can input their own costs or bring up default costs to make comparisons. For western Kansas, cost-return budgets for center-pivot irrigation of crops (**www.agmanager.info/crops/**) provided the basis for default production-cost values for CWA. Results can be sensitive to production costs, which require realistic production inputs.

CROP SELECTION WITH RESTRICTED IRRIGTION

In 2012 irrigators need to tailor their water management to have the expectation of producing at least their irrigated proven yield to qualify for crop insurance as an irrigated practice. If they do not have enough water to produce their proven yield on the whole field, they may need to reduce irrigated acreage to fully irrigate the planted area. They need to know how much water it will take to produce their proven yield.

Predicted corn and sorghum yields for 2012 (tables 1-4) were based on a crop simulation model developed by Kansas State University (Crop Yield Predictor available at www.mobileirrigationlab.com. The stored soil water available for plant use at the beginning of the growing season is one of the sources of water to produce the crop. The other sources are growing season precipitation and irrigation.

Each row in the yield table is for the available soil water on October 1, 2011 and April 1, 2012. The change in soil water from October 1 through April 1 is based on the average annual precipitation expected during the dormant season. Water accumulates if there is room enough to store it, depending on how much evaporation occurs at the soil surface, and how much water drains below the expected root zone. KSU researches (Lamm and Rogers) measured available soil water (ASW) after the 2011 harvest in producer irrigated fields in southwest Kansas. They found a minimum of 17% ASW and a maximum of 95% ASW among the sampled fields. This demonstrates that producers need to determine ASW in their own fields. Within each row in the table, there are columns for the amount of irrigation it will take to produce the predicted yield. An irrigator can find his/her proven yield on the table for each value of ASW (rows) and applied irrigation (columns). The volume of irrigation, available for that field in 2012, needs to be determined in units of acre-inches, This volume divided by the inches of irrigation required to produce the proven yield (from the table) is the acreage that can be planted (see example.

These tables are provided by Kansas State University for producers as information for determining possible strategies for 2012. They were not derived by the Risk Management Agency. Crop insurance underwriters should be contacted for additional information.

Table 1. Predicted corn yields for annual precipitation of 17 inches.

Available Soil Water 1-Oct	Available Soil Water 1-Apr	Applied Irrigation 5" Yield	8" Yield	11" Yield	14" Yield	17" Yield	20" Yield	23" Yield	26" Yield
%	%	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac
10	20	92	124	149	**168**	184	198	210	220
30	35	120	148	169	186	200	213	220	220
50	50	148	171	189	203	215	220	220	220
70	60	164	184	200	213	220	220	220	220

Example:
Corn from table1; annual precipitation = 17 inches; available water on April 1= 20%;
proven yield = 168 bu/ac; irrigation needed = 14 inches;
irrigation volume available = 1200 ac-inches (12 inches for 100 acres);
Irrigated acres to produce proven yield = (1200 ac-inches)/14 inches) = 88 acres

Table 2. Predicted corn yields for annual precipitation of 21 inches.

Available Soil Water 1-Oct	Available Soil Water 1-Apr	Applied Irrigation 5" Yield	8" Yield	11" Yield	14" Yield	17" Yield	20" Yield	23" Yield	26" Yield
%	%	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac
10	25	135	165	183	193	205	217	220	220
30	45	156	182	197	206	216	220	220	220
50	60	172	194	207	214	220	220	220	220
70	70	178	197	210	217	220	220	220	220

Table 3. Predicted sorghum yields for annual precipitation of 17 inches.

Available Soil Water 1-Oct	Available Soil Water 1-Apr	Applied Irrigation 5" Yield	8" Yield	11" Yield	14" Yield	17" Yield	20" Yield	23" Yield	26" Yield
%	%	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac
10	20	108	125	139	149	158	160	160	160
30	35	123	137	149	158	160	160	160	160
50	50	136	148	158	160	160	160	160	160
70	60	144	154	160	160	160	160	160	160

Table 4. Predicted sorghum yields for annual precipitation of 21 inches.

Available Soil Water	Available Soil Water	-------------------------Applied Irrigation---------------------------------							
		5"	8"	11"	14"	17"	20"	23"	26"
1-Oct	1-Apr	Yield	Yield	Yield	Yield	Yield	Yield	Yield	Yield
%	%	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac
10	25	123	139	147	155	160	160	160	160
30	45	139	148	155	160	160	160	160	160
50	60	146	154	160	160	160	160	160	160
70	70	148	156	160	160	160	160	160	160

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