IRRIGATION SCHEDULING FOR EFFICIENT ALFALFA PRODUCTION

Joseph M. Lord, Jr.
Civil Engineer
JMLord, inc.-Agricultural Scientists

This is a statement on scheduling irrigations for good water management practices and crop production. First it should be noted that scheduling irrigations is not just the accurate and exact timing of one single irrigation, but is the collective strategy for making all the needed irrigations on a particular crop in a particular growing season. It is important when discussing irrigation scheduling that it be brought out that irrigation scheduling is really a water management service.

The ultimate objective in any irrigation scheduling strategy is to obtain the optimum yield per unit of water applied. An example would be the number of pounds of crop per acre inch of water or tons of alfalfa per acre inch of water applied. These numbers relate to basically all crops and all production evaluation procedures.

Proper irrigation scheduling must consider the things that have happened prior to determining an irrigation event as well as what will happen after that irrigation event. In providing a comprehensive complete water management strategy, the water manager should be able to sit down and define when and what amounts should be applied to any particular crop before it's planted. When that crop is planted he will adjust, modify, and fine-tune that water management strategy until completion of the crop.

The Bureau of Reclamation, who has done a lot of work in developing a water management service, calls their program IMS or Irrigation Management Services. We are private consultants, selling a professional service for a consulting fee. Our company in the San Joaquin Valley of California has been providing an irrigation scheduling service to growers for the past six years. These services have been provided to over forty different crops on over five hundred thousand acres.

The effectiveness of this irrigation scheduling service is very dependent upon the field man's ability to evaluate the plant/water relationship and communicate an independent recommendation to the irrigation decision maker. The field man's role in the servicing of a scheduling is paramount to the program's success. The recommendation he will make can be done either verbally or as a written report. The written report is the most effective presentation to minimize chances for misunderstanding and assure that accurate records are kept of all recommendations. The computer is a tool that facilitates analyzing many of the complexities of irrigation scheduling and at the same time develops a very professional appearing report in a timely manner.

The major consideration in scheduling irrigation is to maintain an optimum soil moisture condition for vegetative growth. This moisture condition varies from location to location in the field, from field to field, and farm to farm. It also varies relative to the chemical/physical properties of the soil and to the time of year that the crop is being grown. To even further compound the issue, a complete irrigation scheduling service has to integrate with the cultural operations of growing that crop. This is particularly relative to hay production or the cutting and baling or harvesting of the crop.

There are several other water management services available in the valley and there are also as many techniques by which people can develop an effective water management program. One of the more common practices in irrigation scheduling is to use soil moisture measuring devices. These might be tensiometers, gypsum blocks, or neutron probes. A recent product to enter the irrigation scheduling field is a leaf psycrometer or pressure bomb which is used for evaluating plant moisture. All of these devices can be effective in developing a water management program.

We would be remiss not to consider the irrigation scheduling practice that has probably been used on more acreage than any other. This of course is the traditional method of looking at the crop and making the decision when to irrigate on its visual appearance. This method can be supplemented with some minor soil evaluation, using a soil probe or irrigator shovel. The visual appearance method has been effective and will continue to be a very commonly used technique for the timing of irrigations. This method can be supported with the refinement of keeping good operational records of when the crop was irrigated and how much was put on. These accounting practices are essential for developing an effective seasonal strategy.

We will not attempt to evaluate some of the methods mentioned here. Nor would we suggest that we could quantify the benefits or shortcomings of these methods. This paper is directed toward how we provide a water management strategy in the San Joaquin Valley.

These irrigation scheduling services are based on a computer model. We refer to this model as a Soil-Water-Atmosphere-Plant model and we call it the SWAP-ET model, recognizing that ET represents evapotranspiration or consumptive use of crops. A flow chart showing the input/output aspects of this water management model is shown by figure I.

Very briefly, the soil is defined by its physical and chemical properties considering water-holding capabilities, salinity, and other minor aspects. These soils data define our rootzone reservoir which is the operational objective of our irrigation scheduling service.

The water, or W of the model's name is also defined by its chemical properties, but more specifically we are interested in how the water is applied, what is the method of irrigation, and what are the operational limitations and capabilities of the irrigation method being used.

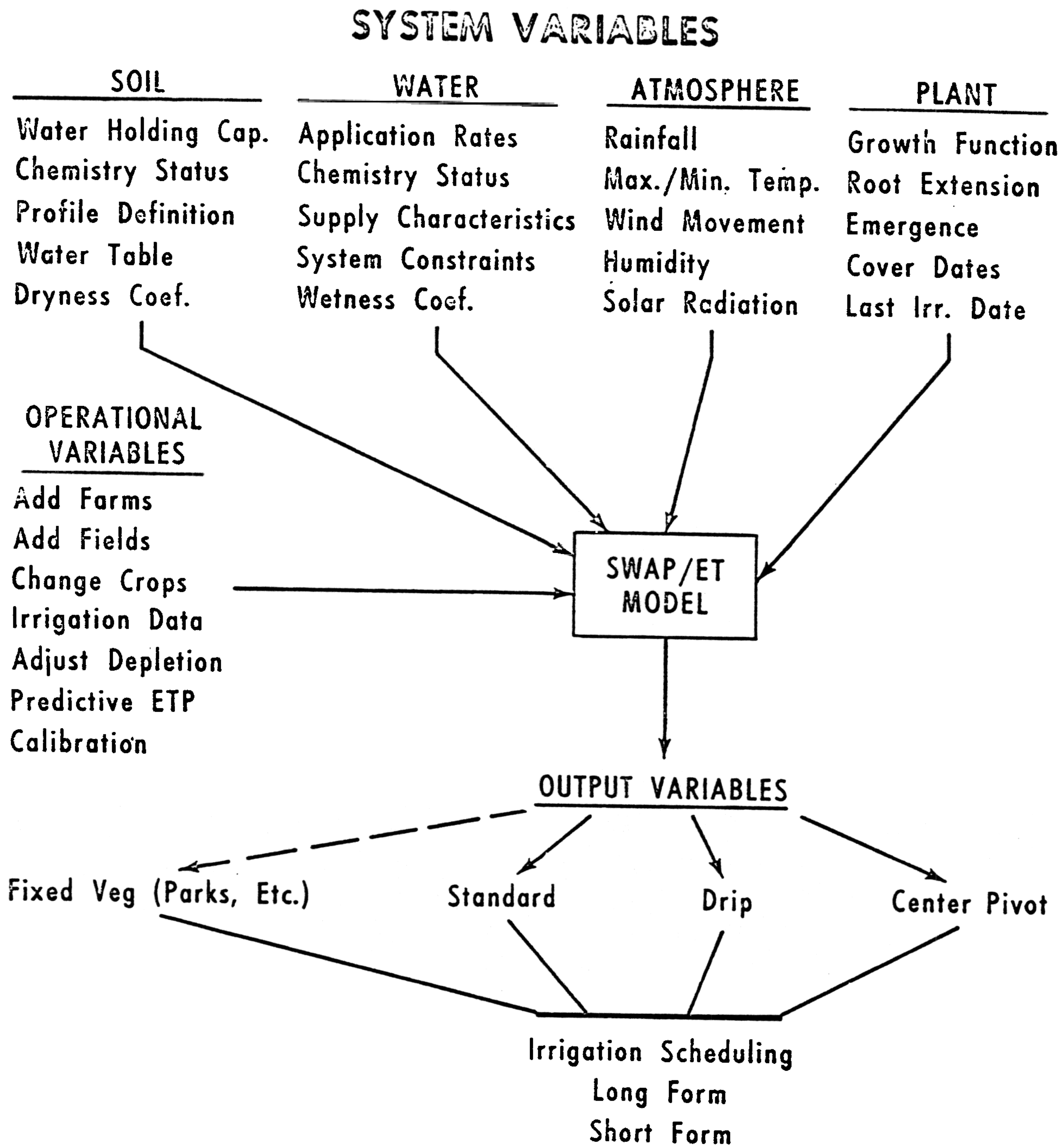
The atmosphere is nothing other than measurement of the climatic conditions that effect plant/water use. These are maximum and minimum temperatures, relative humidity or dew-point temperature, and wind movement (specifically we are interested in wind travel and not wind velocity or wind direction-just how many miles of wind have moved by a fixed point). Solar radiation is the fifth component of our climatic considerations. We own, maintain, and calibrate nine weather stations in the San Joaquin Valley in support of our water management services.

The plant of course is represented in our computer by a growth function which reflects its stage of growth from emergence to maturation. It is represented digitally by a mathematical relationship that considers its critical stages of growth, such as flowering, root sizing, etc.

Taking these five components and putting them on a computer, we are able to timely consider a lot of different variables associated with each component and come out with an over-all soil moisture status and a recommended irrigation date, considering again what has happened in the past and what we are projecting to happen in the future. An example of a typical report is included and shown as Figure II. Figure III gives a brief explanation of this report.

Scheduling irrigations with an ET Model or any other effective method of determining soil moisture and predicting crop water use, will produce economic benefits. These benefits can come from increased crop production or just maintaining good crop production during critical periods. They can be realized by avoiding some of the disease and insect problems that are associated with too much and/or not enough water. Good water management gives the land owner effective control of his resources, both his water and soil. For example, he can maintain salinity balance, recognizing his irrigation inputs and the need for salt balance in a long-term soil management objective. Conversely, he may minimize his irrigation inputs to give due consideration to a perched or localized water table condition. Water management can mean benefits to an irrigation water user in reduced labor or better management of his labor or equipment supplies. However, I would be the first one to assure all water users that irrigation scheduling does not guarantee profits, but only assures an agricultural water user the opportunity of having some numbers and data to consider in what he is doing, what he has done, or what he will be doing in his irrigation practices.

FIGURE


SYSTEM VARIABLES
SOIL
Water Holding Cap.
Chemistry Status
Profile Definition
Water Table
Dryness Coef.
WATER
Application Rates
Chemistry Status
Supply Characteristics
System Constraints
Wetness Coef.
ATMOSPHERE
Rainfall
Max./Min. Temp.
Wind Movement
Humidity
Solar Radiation
PLANT
Growth Function
Root Extension
Emergence
Cover Dates
Last Irr. Date
OPERATIONAL VARIABLES
Add Farms
Add Fields
Change Crops
Irrigation Data
Adjust Depletion
Predictive ETP
Calibration
SWAP/ET MODEL
OUTPUT VARIABLES
Fixed Veg (Parks, Etc.)
Standard
Drip
Center Pivot
Irrigation Scheduling
Long Form
Short Form

JMLord incorporated agricultural scientists

engineering & agronomy studies • irrigation & drainage designs • soil & water evaluations • laboratory services

ACME FARMING COMPANY
SOIL MOISTURE REPORT
-6/01/77-

Daily Climatic Data:

-DATE- Mo/Day	----TEMPERATURES---- Max	Min	Dew Pt	SOLAR RADIATION	WIND RUN Miles	RAIN In	POTENTIAL EVAPOTRANSPIRATION ******************
5/16	69	42	42	522	96	0.00	0.20
5/17	73	39	42	638	119	0.00	0.25
5/18	74	41	38	480	142	0.00	0.26
5/19	77	52	53	630	108	0.00	0.22
5/20	88	50	51	630	77	0.00	0.24
5/21	87	51	50	485	114	0.00	0.26
5/22	70	48	49	273	159	0.00	0.19
5/23	72	50	46	431	109	0.00	0.21
5/24	77	48	55	592	119	0.00	0.22
5/25	79	49	49	581	120	0.00	0.25
5/26	80	52	51	572	129	0.00	0.26
5/27	79	47	48	653	112	0.00	0.27
5/28	82	44	41	651	130	0.00	0.32
5/29	87	47	41	659	115	0.00	0.33
5/30	94	50	46	641	75	0.00	0.29

Potential Evapotranspiration (ETP):

This Period (past 15 days)
Total ETP - 3.75 Inches
Average ETP - 0.25 In./Day

Forecast
Next Seven Days 0.29 In./Day
Next Two Weeks 0.30 In./Day

-FIELD- Name	-CROP- Name	ROOT ZONE Feet	------DEPLETIONS---- Allowable Inches	Current Inches *******	IRRIGATIONS As of - 5/30 No.	Total	----IRRIGATION SCHEDULE----- Latest Date	Amt	******Next***** Date	Amt
35-1	BARLEY	5.0	6.8	6.3	3	16.8	4/28	5.5	None	****
35-4	BARLEY	5.0	6.6	6.8	3	17.1	5/5	5.5	None	****
4-1	TOMATO	2.5	2.8	1.3	5	12.6	5/24	3.5	6/4	3.7
4-3	TOMATO	2.5	2.8	0.7	5	11.0	5/26	3.2	6/7	3.9
2-1	S ALF	5.0	7.9	3.9	2	10.1	5/13	5.5	6/24	10.5
3-1	COTTON	2.0	2.9	2.7	1	12.0	12/21	12.0	6/2	3.9
3-2	COTTON	2.0	2.8	2.5	1	12.0	12/18	12.0	6/6	3.7
34-1	COTTON	2.0	2.8	2.9	1	12.0	12/20	12.0	5/31	3.9
34-2	COTTON	2.0	2.6	2.7	1	12.0	12/17	12.0	5/31	3.5
15-E	PEACH	5.0	1.7	1.5	4	8.5	5/20	2.0	5/31	2.7
15-W	NECT	5.0	2.8	2.1	2	2.9	5/9	1.8	6/3	4.1
17	PLUMS	5.0	3.1	2.6	3	7.9	5/28	1.5	6/2	4.6
18	ALMON	4.0	1.4	1.6	5	8.4	5/21	1.4	6/1	2.3

(FOR EXPLANATION, SEE REVERSE)

SOIL MOISTURE REPORT
TERMINOLOGY AND DEFINITIONS

FIGURE III

TEMPERATURES

Max.: The maximum air temperature recorded during the 24-hour period indicated by the date.

Min.: The minimum air temperature recorded during the same time period.

Dew Pt.: The dew point temperature of the air as recorded at 8:00 a.m. on the date shown which indicates the relative moisture content of the air.

SOLAR RADIATION: A measurement of the sun's energy in Landleys or Gram-Calories/ Square Centimeter.

WINDRUN MILES/DAY: A measurement of the relative wind movement past a fixed point in twenty-four hours.

RAINFALL: The measured rainfall in inches at a location that best represents the fields under the program.

(ETP) POTENTIAL EVAPOTRANSPIRATION: The daily amount of moisture that could be removed by evaporation and by transpiration of the plant. It can be approximated by the daily water use of an 18-inch stand of well-watered alfalfa.

FIELD NAME: The grower's identifying name of the field.

CROP NAME: Crop being grown.

ROOT ZONE: The depth of root zone in feet that is being considered for the next irrigation. It represents the soil profile that the crop is using water from as judged by Harza's field representative.

DEPLETION ALLOWABLE: The amount of water in inches that should be used or depleted from the root zone reservoir before making an irrigation. This represents the optimum moisture level as defined by the soil's water-holding capacity and moisture response of the crop being grown.

DEPLETION CURRENT: The status of the soil moisture and the date of this report. This is the amount of water that has been used and should be less than allowable depletion.

IRRIGATIONS - NUMBER & AMOUNT: This is the total number of irrigations made on the field at the date of the report and the total amount of water that has been applied during these irrigations.

IRRIGATION SCHEDULE--DATE & AMOUNT OF LAST: The date the last irrigation was started and the net amount of water in inches applied to the field. This would represent an average value of what was effective across the field.

IRRIGATION SCHEDULE--DATE & AMOUNT OF NEXT: The date that Harza recommends the next irrigation should be started and the amount of water to apply. This amount takes into consideration the irrigation efficiency of each field and is considered a gross amount of water to apply.

fresno: 1685 'e' street, suite 109 • fresno, ca 93706
209/268-9755

merced: 3191 'm' street, p.o. box 2264 • merced, ca 95340
209/722-7640