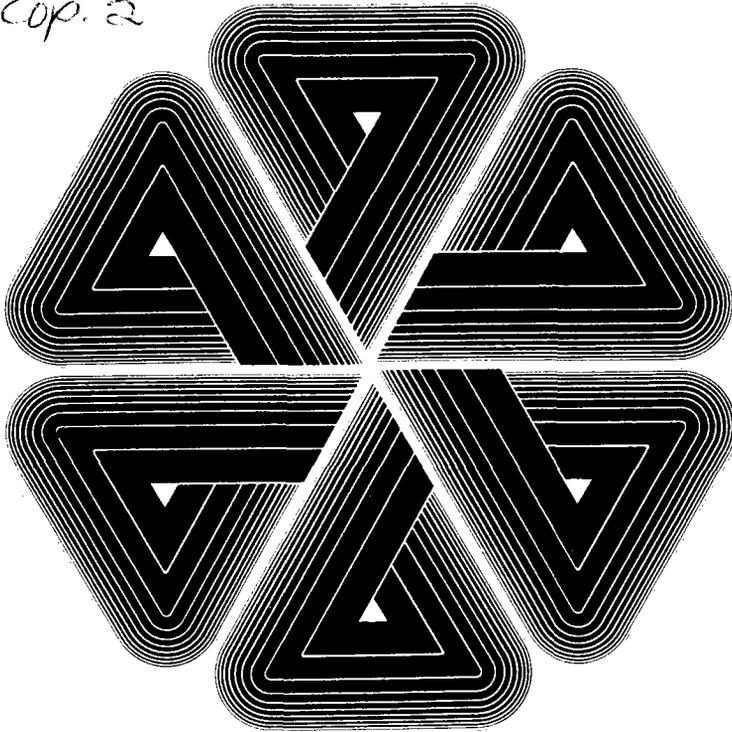


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Oregon State University Extension Service Computer Software

WHEATPLAN

- DESCRIPTION:** WHEATPLAN is designed to assist farmers improve their nitrogen fertilizer decision making for dryland winter wheat production in North Central Oregon.
- USERS:** For farmers, Extension agents, agricultural service company and agency personnel.
- COMPATIBILITY:** Requires IBM PC or compatible clone, DOS 2.x, and 256K RAM.
- AUTHORS:** Floyd Bolton, associate professor of crop science; Stanley Miller, professor of agricultural and resource economics; Mike Taylor, research assistant in agricultural and resource economics, Oregon State University; and D. Michael Glenn, research soil scientist, USDA-ARS, Kearneysville, West Virginia.
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- VERSION:** Pilot
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OREGON STATE UNIVERSITY EXTENSION SERVICE

A CLIMATE-YIELD-NITROGEN COMPUTER PROGRAM
TO EVALUATE
WHEAT FERTILIZER STRATEGIES
FOR
OPTIMAL NITROGEN APPLICATION
FOR
WINTER WHEAT PRODUCTION IN NORTH CENTRAL OREGON

by

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I. INTRODUCTION

The dryland cereal producer in the lower Columbia Basin makes many critical soil and crop management decisions each season. These decisions are made more difficult because of the highly variable climatic conditions that exist in the region. A particularly difficult crop management decision facing the cereal grower is the determination of the amount and the timing of nitrogen application given the uncertain climatic future.

In the following, a user-friendly computer program entitled "Wheat Fertilizer Strategies for Optimal Nitrogen Application" (WFSONA) is described. Its purpose is to assist farmers improve their nitrogen fertilizer decision making for dryland winter wheat production in North Central Oregon. Field research trials and long-term climatic data from the Sherman Experiment Station and wheat growers in and around Moro, Oregon were utilized to develop the program. The program accurately predicts yield and fertilizer requirements for farms in the 10-15 inch precipitation zones of the lower Columbia Basin.

The program description is presented in three major sections. The first section after the Introduction, Section II, contains an explanation of the field research and climatic data upon which the computer model is based. Section III describes the determination of the individual farmers productivity index. The user is instructed in how to use the computer program in Section IV.

II. CLIMATIC DATA ANALYSIS AND FIELD RESEARCH TRIALS

Long-Term Climate-Grain Yield Analysis

Current dryland cereal fertilizer recommendations are based on the average results of long-term experiments conducted at many locations. Experimental yields vary from year to year and location to location because of climatic and topographic differences. Fertilizer application recommendations are based on average conditions. Soil samples for moisture and soil nitrogen analysis can be helpful in determining fertilizer needs. This method of determining nitrogen fertilizer requirements has worked well in the past and is quite accurate for "average" or normal growing conditions. However, an extensive analysis of long-term precipitation and grain yield records at the Moro Experiment Station has revealed that average or normal precipitation patterns, which include both the fallow and crop periods, occur about one out of three crop seasons. This means that nitrogen fertilizer application rates would be reasonably accurate in about one-third of the crop cycles (Table 1).

A method was developed for determining the amount of precipitation in both the fallow and crop periods that differs from the long-term average. For example, precipitation during the fallow ranging from 10.30 to 14.55 inches is considered to be a normal fallow (NF) period (Table 1). Any fallow period with precipitation above 14.5 inches is a wet fallow (WF) and below 10.30 inches is a dry fallow (DF) season. The same technique is used to determine normal crop (NC), wet crop (WC) and dry crop (DC) periods.

Table 1. Fallow-crop patterns at the Sherman Agricultural Experiment Station (Moro, OR) based on 65 years of monthly precipitation data

Fallow (14 month, Aug-Sept) Cumulative precipitation (in)	Probability (%)	Crop (10 month, Oct-July) Cumulative precipitation (in)	Probability based on previous fallow (%)	Fallow-crop cumulative precipitation (in)	Probability for the fallow-crop sequence (%)	Mean grain yield (bu/A)
8.12 - 10.29 dry fallow (DF)	21.5	Dry crop (DC) 7.03 - 8.58	14.4	DFDC 15.15 - 18.87	3.1	26.0
		Normal crop (NC) 8.59 - 12.61	64.3	DFNC 16.70 - 22.9	13.9	23.6
		Wet crop (WC) 12.62 - 15.85	<u>21.3</u>	DFWC 20.73 - 26.14	4.6	39.0
			100.0			
10.30 - 14.55 normal fallow (NF)	60.0	Dry crop (DC) 7.03 - 8.58	28.2	NFDC 17.32 - 23.13	16.9	26.6
		Normal crop (NC) 8.59 - 12.61	56.5	NFNC 18.87 - 27.16	33.9	30.2
		Wet crop (WC) 12.62 - 15.85	<u>15.3</u>	NFWC 22.90 - 30.40	9.2	33.7
			100.0			
14.56 - 16.89 wet fallow (WF)	18.5	Dry crop (DC) 7.03 - 8.58	16.8	WFDC 21.58 - 25.77	3.1	34.6
		Normal crop (NC) 8.59 - 12.61	75.1	WFNC 23.13 - 29.50	13.9	37.8
		Wet crop (WC) 12.62 - 15.85	<u>8.1</u>	WFWC 27.16 - 32.74	<u>1.5</u>	38.0
			100.0	100.0		

The probability of NF or NC precipitation is about 60% if the periods are considered independently. However, cereal crops produced in dryland regions are dependent on precipitation from both the fallow and crop periods. The probability of a NFNC season is about 33.9%. This means that the cereal grower faces average or "normal" precipitation conditions only once in every three crops. The data in Table 1 also show that the extreme combinations, DFDC, DFWC, WFDC, and WFWC occur only rarely with a combined probability of 12.3%. The remaining five fallow-crop sequences (DFNC-13.9%, NFDC-16.9%, NFNC-33.9%, NFWC-9.2%, and WFNC-13.9%) account for 90% of the occurrences or 9 out of 10 times.

Climate-Nitrogen-Grain Yield Field Experiments

The long-term precipitation analysis showed that grain yields were dependent on the sequence of dry, normal, or wet fallow and crop periods (Table 1). A series of field experiments were conducted to determine the effect of these precipitation patterns on soil nitrogen, moisture storage, evaporation rates, temperature, and stand establishment on the potential grain yield.

The amount of nitrogen mineralized in the fallow period was significantly affected by the different amounts of precipitation received (Table 2). The data also shows that early September sampling more accurately reflects the amount of soil nitrogen available to the crop than May or June sampling.

Table 2. Fallow nitrate mineralization

	Pounds/acre		
	Dry	Normal	Wet
May	20.5	13.1	9.7
Sept.	56.8	44.0	65.6

There were also significant differences in the amount of soil nitrogen mineralized during the crop period as a result of the different combinations of fallow and crop periods (Table 3).

Table 3. Crop season nitrogen mineralization

Precipitation pattern	Amount mineralized pounds/acre
DFNC	38.5
NFDC	34.4
NFNC	32.0
NFWC	26.5
WFNC	21.0
Average	30.5

A field trial was conducted to simulate the five (5) fallow-crop precipitation patterns that had occurred most frequently in the past

historical records. The results showed that it was possible to utilize the previous historical and current precipitation records to predict a given yield potential and add nitrogen fertilizer to produce optimal yields (Table 4).

Table 4. Optimal yields at the optimal N fertilizer level for 5 different fallow-crop precipitation patterns, Wasco, Oregon

Pattern	DFNC	NFDC	NFNC	NFWC	WFNC
Total fallow precipitation level (inches)	12.03	14.62	14.62	14.62	19.06
Total crop precipitation level (inches)	7.12	5.22	7.12	11.40	8.05
Days to emergence	10	10	10	10	10
Soil N at end of fallow season (#N/A)	56.8	44.0	44.0	44.0	65.6
Actual yield (bu/A)	46.0	51.0	50.2	60.0	53.9

Predicted yield (bu/A)	39.5	49.7	53.1	60.6	68.7
Deviation from predicted	+6.5	+1.3	-2.9	-0.6	-14.8*
Optimum N fertilizer fertilizer level (#N/A)	40	54	54	67	54

*The WF treatment resulted in excellent stands and vigorous seedling growth from a mid-September planting; however, a heavy frost in mid-October caused winter kill and loss of early growth.

Earlier studies have shown that crop emergence within 10 to 20 days has little or no effect on grain yields provided an adequate and uniform stand is achieved. However, if because of late planting or dry seeding conditions, stand establishment is delayed by 30, 45, or 60 days, the resulting yield reductions can be as much as 5, 10, and 20 bu/A, respectively.

Temperature, evaporation and soil profile moisture storage

Even though precipitation during the fallow and crop periods is the dominant element in predicting grain yields, the amount of soil moisture stored in the profile at seeding is one of the critical factors that determines the actual yield. Extensive soil sampling to the rooting depth

throughout the entire field is required to obtain an accurate estimate of soil moisture. The inherent variability in most fields makes soil moisture sampling time-consuming, expensive, and generally impractical on a large scale.

A simple method is needed to estimate soil moisture storage under a current set of precipitation, temperature, wind, humidity, and radiation conditions. Although some models have been developed that include all of the above climatic factors, they require a high level of inputs, usually on a daily basis. Such a level of technology is often not available or feasible for use by producers at the farm level.

An analysis of long-term (10-20 years) soil profile moisture and pan evaporation data from three experimental stations (Moro and Pendleton, OR and Lind, WA) revealed that reasonably accurate values of soil moisture storage could be estimated using current precipitation and pan evaporation measurements. Pan evaporation measurements are made daily during the frost-free period at all official weather recording stations in Oregon. Total monthly pan evaporation values are used in a mathematical model to estimate fallow moisture storage prior to seeding. In field simulation experiments and verification trials on farmer fields, this method of estimating soil moisture storage has worked well with reasonable accuracy.

III. DETERMINATION OF THE PRODUCTIVITY INDEX

Recognizing that individual farms, or even fields within a farming operation, are not uniformly productive, a method is needed to adapt the management model to specific situations. For this reason, a Productivity Index was developed which compares an individual farm or field's production level with that of the base data level at the Sherman Experiment Station, Moro.

The Productivity Index (P.I.) for a given farm or field is designed to account for differences in soil type and depth, topographical differences and the management level that exist in a specific situation. The basic concept behind the P.I. is that a given amount of water will produce a given amount of grain, provided that none of the other factors (i.e. fertility status, soil and crop management techniques, weed control, planting, varieties, etc.) are yield constraints. The term used to describe this concept is called the Water Use Efficiency (W.U.E.). W.U.E. is calculated by determining the total precipitation received from harvest to harvest (i.e. total precipitation during fallow and crop periods) and dividing that value into the grain yield (e.g. 60 bu/acre divided by 25 inches total precipitation = 2.4 bu/inch of precipitation).

The average W.U.E. values for a producer's farm or field divided by the average W.U.E. values for the same harvest years at the Sherman Experiment Station is the P.I. An example of how the W.U.E. and P.I. values are determined is shown in Table 5. In calculating W.U. E., a minimum of 5 years is needed to obtain an adequate sample of a farm or field productivity potential. W.U.E. should not be more than a 10-year average because general changes in productivity due to new variety introductions or production techniques may make the earlier W.U.E. values obsolete.

The calculated P.I.'s (Table 5) are for 6 farms in Sherman and Wasco counties from actual data supplied by the operators. The P.I. values range from 0.56 (less productive than the Experiment Station) to 1.04 (more productive than the Experiment Station).

The farm's Productivity Index can be updated after each harvest season by calculating the W.U.E. value for the new yield level, then adding to the previous values and determining a new average W.U.E. value. The earliest W.U.E. value (e.g. 1978 harvest year in Table 5) should be deleted from the data before determining a new average W.U.E. value. Thus, after each season, the P.I. will be up-to-date with the current productivity of the farm.

IV. HOW TO USE THE COMPUTER PROGRAM (WFSONA)

This manual is to help familiarize users with the economic evaluation of Wheat Fertilization Strategies (WFSONA) program. The program is a simulation model to evaluate nitrogen fertilization options for dryland winter wheat production in North Central Oregon. The manual is written in three sections. The first presents highlights, the purpose, and main features of the program. The second provides descriptions on how to start, interact, and interpret results from the program. The third section provides a sample run of the program.

This computer program is designed to help farmers select an appropriate nitrogen fertilization strategy given the prevailing climatic, agronomic, and economic conditions. The program incorporates both prevailing agronomic and economic data. The agronomic sections of the program utilizes precipitation and evapotranspiration data to predict soil mineralized nitrogen, soil moisture, and yield. The economic section utilizes application costs and price of wheat to determine the marginal profitability of nitrogen use rates. The program offers suggested nitrogen application rates as well as allows the user to choose his own application rate and timing. Results from the program include predictions of yield and the increase in profits resulting from the applied nitrogen.

The program considers fertilization options at three times: May of the fallow season, seeding time, and March of the growing season. Two time periods are referred to within the program. The fallow period extends from August after harvest through the following August preceding planting. The crop season extends from September until harvest time. At each decision period (fallow, seeding, and crop season) the model requests weather, economic, planting, nitrogen application data, and past decisions for the immediately preceding period. The fallow period requires weather data from August through April. The seeding period requires weather data from May through August (September optional). The crop period requires weather data for September through March. The program also includes a prediction of yield at the harvest period should a producer want to make decisions concerning storage or marketing. The harvest period requires weather data for April through June. The harvest period yield prediction is valid or meaningful only if the weather and other data is supplied for the previous three periods.

Table 5. Determination of the Water Use Efficiency (W.U.E.) and Productivity Index (P.I.) of specific farms or fields.

Harvest year	Water use efficiency (W.U.E.) = $\frac{\text{Yield (bushels per acre)}}{\text{Precipitation (inches) Fallow + crop (24 months)*}}$						
	Location						
	Exp. Sta. (Moro)	A. Sherman Co.	B. Wasco Co.	C. Wasco Co.	D. Wasco Co.	E. Wasco Co.	F. Sherman Co
1978	$\frac{55.0}{21.69} = 2.53$	$\frac{41.0}{21.58} = 1.90$	$\frac{54.8}{24.13} = 2.27$	$\frac{27.0}{20.15} = 1.34$	$\frac{49.0}{21.61} = 2.27$	$\frac{17.0}{25.75} = 0.66$	--
1979	$\frac{45.6}{23.74} = 1.92$	$\frac{34.0}{25.49} = 1.33$	$\frac{46.0}{26.25} = 1.75$	$\frac{38.0}{27.72} = 1.37$	$\frac{39.0}{23.30} = 1.67$	$\frac{30.0}{28.00} = 1.07$	--
1980	$\frac{62.3}{25.75} = 2.42$	$\frac{52.0}{27.36} = 1.90$	$\frac{73.5}{27.39} = 2.68$	$\frac{51.0}{28.00} = 1.82$	$\frac{51.0}{24.68} = 2.07$	$\frac{40.0}{24.31} = 1.65$	$\frac{56.0}{25.36} = 2.21$
1981	$\frac{52.3}{29.21} = 1.79$	$\frac{80.0}{31.41} = 2.55$	$\frac{83.1}{33.02} = 2.52$	$\frac{55.0}{29.51} = 1.86$	$\frac{76.0}{28.29} = 2.70$	$\frac{33.0}{25.24} = 1.31$	$\frac{78.0}{28.53} = 2.73$
1982	$\frac{59.5}{26.22} = 2.27$	$\frac{54.0}{29.39} = 1.84$	$\frac{82.0}{28.90} = 2.84$	$\frac{43.0}{27.80} = 1.55$	$\frac{61.0}{25.34} = 2.41$	$\frac{31.0}{24.17} = 1.28$	$\frac{46.0}{28.40} = 1.62$
1983	$\frac{79.8}{31.09} = 2.57$	$\frac{62.0}{32.42} = 1.91$	$\frac{83.0}{33.61} = 2.47$	$\frac{49.0}{31.70} = 1.55$	$\frac{75.0}{30.89} = 2.43$	$\frac{40.0}{30.10} = 1.33$	$\frac{60.0}{34.38} = 1.75$
1984	$\frac{62.2}{30.70} = 2.02$	$\frac{49.0}{30.05} = 1.63$	$\frac{65.0}{33.92} = 1.92$	$\frac{41.0}{32.72} = 1.25$	$\frac{49.0}{30.76} = 1.59$	$\frac{40.0}{29.05} = 1.38$	$\frac{41.0}{32.46} = 1.26$
1985	$\frac{49.8}{22.01} = 2.26$	$\frac{56.0}{22.41} = 2.50$	$\frac{52.0}{25.24} = 2.06$	$\frac{31.0}{25.45} = 1.22$	$\frac{47.0}{22.86} = 2.06$	$\frac{27.0}{20.30} = 1.33$	$\frac{43.0}{24.18} = 1.78$
Ave W.U.E. =	2.22	1.95	2.31	1.50	2.15	1.25	1.89
**P.I. =	1.0	0.88	1.04	0.68	0.97	0.56	0.85

*August after harvest through July of harvest year

**Productivity Index (P.I.) = $\frac{\text{Average W.U.E. of farm or field}}{\text{Average W.U.E. of Exp. Station (same harvest years)}}$

How to Get Started and Enter Data

WFSONA is programmed in the BASIC computer language. It can be run on IBM or IBM compatible computers

To enter data to WFSONA you must first type the letter (or number) and then the return (enter,+) key. If you make a mistake typing, push the backspace key before you type the return key. Pushing the return key will enter your choice.

To run WFSONA you need to start the computer with a DOS disk. Once the computer has booted, you will have an A> prompt on your screen. You can now remove the DOS disk and insert the WFSONA program disk. You must have this disk in the A disk drive. You then type WFSONA+ return. WFSONA will load and you will see the introductory screen. When you are finished reading, type the return, enter, or +key once. You will see another screenfull of information about the program. Pushing the return key will start the execution of the program. After a moment the first question line will appear:

"Enter a productivity index for this region (0.5-2.0)"

The program is waiting for you to supply a value. You will need to have previously calculated your P.I. according to the procedure described in SECTION III. Pages 6 to 8. The Program will only use values between 0.50 and 2.00. (If no value is inserted, the program will use the default value 1.00.) These values indicate a productivity level of one-half to twice that of the base data in the program. After you have typed in a value (e.g., .95) and pushed the return key, the next question line will appear:

"Where are you ('F'allow, 'S'eeding, 'C'rop, or 'H'arvest)?"

"The program is waiting for you to supply a choice.

This prompt is asking you for which period you want to evaluate your nitrogen fertilization strategies. Suppose you select an F (for the fallow period) followed by a return. The program will ask you:

"Specify the precipitation (in.) from August through April of fallow year." Current values are: .43,.47, .79,1.61,1.73,1.81,1.02,1.01,.75

Do you want to modify these values?

The program is telling you what values are currently stored for precipitation and then asking you if you want to enter new values. Typing an N (no) at the prompt will tell the program you do not want to enter new values. The default value is N (no) if you type return without answering the questions. Typing a Y (yes) at the prompt will tell the program you want to enter new values. It will then inform you:

"Type nine data items separated by commas."

Each value (monthly rainfall in inches) is typed followed by a comma. The ninth item does not need to be followed by a comma. Once you have checked your data for correctness, type return to store new fallow precipitation values. The computer will take you to the next prompt. However, if you only typed 8 items or forgot some commas the machine will say:

"? redo from start"

You will need to re-enter all of the data separated by commas, then hit return.

Certain prompts do not give you a choice, you must enter data. These appear as:

"Specify the following values for the fallow season.
Application cost (\$/ac) . . . "

and

"What is your expected planting date?"

and

"How much nitrogen (lb/ac) did you apply at fallow season?"

These require you to type a number (or two numbers separated by commas for your planting date) and then type return to enter the value. Once you have supplied weather, fertilizer, planting, and economic data the program will generate a results table. For the fallow period the table appears like:

FALLOW SEASON DECISIONS (Made on May 1st of fallow year)

Mineralized Nitrogen (lb/ac N)	29.8
Suggested application of nitrogen (lb/ac N).	15
Predicted Grain Yield (bu/ac)	42.5
Increased return from application (\$/ac) .	\$15.10

"Do you want to evaluate another strategy?" (Y or N)

Mineralized nitrogen is the model's estimate of what soil mineralized nitrogen is at May 1, given the data you have already supplied. Suggested application of nitrogen is the model's determination of how much nitrogen should be applied during the fallow season given prevailing weather and economic conditions. If the model determines that nitrogen application will not increase revenues it will suggest 0 lbs. of nitrogen to be applied. Predicted yield is the model's estimate of yield at harvest time. This will include the suggested nitrogen application (if any) for the period. Increased return from application is the addition to revenue

forecast by the model from applying the suggested amount of nitrogen. It is not total profit, rather, it is the difference between revenues with and without the suggested nitrogen application. Finally the prompt:

"Do you want to evaluate another strategy?" (Y or N)

This requires a 'Y' or 'N' answer. Typing a 'Y' followed by a return will bring you to the "Where are you?" prompt to examine another strategy. Typing an 'N' followed by a return will exit you from WFSONA to DOS. All weather data supplied to the program will be saved for another run. You will see the operating system prompt (A>). The program can be stopped at any point by pushing ESC or ctrl+break keys. You will see an A> on the screen.

A Sample Application of WFSONA

Farmer Jones wants to use WFSONA to help him in his choice of nitrogen application for his winter wheat crop.

First he turns on his IBM or IBM compatible computer with a DOS disk in the A drive. When loaded, he receives an A DOS prompt, he takes the DOS disk out and replaces it with the WFSONA disk. He then types WFSONA (return). He then receives the first set of instructions about the program. On the screen he sees:

"Economic Evaluation of Wheat Fertilization Strategies

This program uses agronomic and economic information to evaluate the effects of nitrogen application on yields of dryland winter wheat for North Central Oregon. The purpose of the program is to assist farmers in selecting the timing and rate of nitrogen application based on prevailing growing, cost and price conditions.

Three application periods (Fallow, Seeding, and Spring time) during the cropping sequence, and a Harvest time period are considered.

External data requirements are: Your Productivity Index value, monthly precipitation and evapotranspiration rates (in inches), month and day of crop seeding and emergence, nitrogen application rates (pounds per acre), prevailing price of wheat (\$ per bushel) prevailing interest rate (in decimal form, i.e., .10), and cost of nitrogen (\$ per pound) and its application (\$ per acre).

Press return when ready."

He pushes the return (enter, or←) key when he is finished reading. A second screen of instructions appears.

The program will first ask where you are in terms of your production sequence.

FALLOW - Entering an 'F' will take you to the fallow period. This portion of the program provides an analysis of fertilization options at May 1st of the fallow season. The fallow season extends from August through the following August. This section of the program requires that you have data for August through April of the fallow season.

SEEDING - Entering an 'S' will take you to the seeding period. This option provides an analysis of fertilization strategies at planting time, in either September or October. The crop (growing) season extends from September until July. This section of the model requires you to have data for May through August of the fallow season.

CROP - Entering a 'C' will take you to the crop period. This option provides an analysis of fertilization strategies at April 1st of the growing season. This section of the model requires that you have data for September through March of the crop season.

HARVEST - Entering an 'H' allows you to predict the final harvest. Data are required for April through June of the crop season.

Press return when ready."

"Enter a productivity index for this region (0.5-2.0)"

Farmer Jones inserts his productivity index as previously calculated.

Fallow

Farmer Jones types return, and shortly he receives the prompt:

"Where are you ('F'allow, 'S'eeding, 'C'rop, or 'H'arvest time)?"

Since he wants to know about his fallow nitrogen options (he is using the program at May 1) he types an F followed by a return. He is asked for monthly rainfall in inches for 9 months of the Fallow season. Since Farmer Jones wants to supply new information he enters Y (and a return) at the prompt, and then enters the rainfall data separated by commas (then a return).

Specify the precipitation (in.) from August through April of Fallow year.

Current values are: .91 .87 .24 2.01 3.23 2.80 1.30
.75 1.42

Do you need to modify these values? Y

Type nine data items separated by commas.

.43,.47,.79,1.61,1.73,1.81,1.02,1.92,.75

He is then asked for the pan evaporation rate in inches for the previous month. He enters a Y at the prompt then the one data item.

Specify the evapotranspiration (in.) for April of
Fallow year.

The current value is: 4.53

Do you need to modify this value? Y

Type the corresponding data item.

4.84

Once he has typed return to enter the value, he is prompted for current cost, price and interest rate values.

Specify the following values for the fallow season.

Application cost (\$/ac) 1.32

Nitrogen cost (\$/lb n)18

Price of wheat (\$/bu) 4.08

Interest rate (%/100) 0.1

Jones figures that it will cost him \$1.32 per acre to apply nitrogen (machinery, gas, oil, and labor) plus material cost of \$0.18 per applied lb. of nitrogen. The current price of wheat is 4.08 per bushel and the loan rate from the bank is 10% or .1 in decimal form. He types in these data and a return after each item.

The model then evaluates the information and makes Farmer Jones an assessment of yield and suggested nitrogen application rates. If Jones wanted a printed copy of these results, he could push the shift + PrtSc keys, if his printer is turned on.

OSU/IPPC - Economic Evaluation of Wheat Fertilization Strategies

FALLOW SEASON DECISIONS (made on May 1st of Fallow year)

Mineralized nitrogen (lb/ac N) 35.7

SUGGESTED APPLICATION OF NITROGEN (lb/ac N). . . 0.0

Predicted grain yield (bu/ac). 39.03

Predicted profit from application (\$/ac) \$0.00

The model indicates that Jones does not need to apply any nitrogen, and his predicted yield would be 39.03 bu/acre. No additional revenue would be gained by applying nitrogen.

Farmer Jones decides to hold off on applying nitrogen until it appears more profitable.

Since he wants to go onto the seeding period he types a Y at the prompt. If he wanted to exit the program, he would have typed an N (and return).

"Do you want to evaluate another strategy?" (Y or N) Y

Seeding

Farmer Jones is at September 3 and is interested in the model's evaluation of his nitrogen strategy at planting time. He enters an S at the prompt:

"Where are you ('F'allow, 'S'eeding, 'C'rop or 'H'arvest)? S

He is then asked for rainfall data for four months.

Specify the precipitation (in.) from May through August of Fallow year.

Current values are: 1.06 1.14 .20 .04

Do you need to modify these values? Y

Type four data items separated by commas.

.87,.67,.24,.43

He types a Y then enters the four values (and a return). He is then asked for pan evaporation data for the same period.

Specify the evapotranspiration (in.) from May through August of Fallow year.

Current values are: 7.99 7.28 11.22 12.20

Do you need to modify these values? Y

Type four data items separated by commas.

6.93,8.54,11.34,9.84

Jones types a Y then enters the four values. He is then asked to provide estimates of September rainfall and pan evaporation.

Provide an estimate of what evapotranspiration (in.) will be or has been for September of crop year.

The current value is: 7.56

Do you need to modify this value? Y

Type the corresponding data item.

6.18

Provide an estimate of what precipitation (in.) will be or has been for September of Crop year.

The current value is: 1.18

Do you need to modify these values? Y

Type the corresponding data item.

.47

He is then asked for his expected planting and crop emergence dates. He expects to plant on September 15th (9,15) and his crop should emerge in ten days on September 25 (9,25).

Enter your estimated dates for planting and emergence.

For example, September 19th would be entered as 9,19; October 5th as 10,5.

What is your expected planting date? (month,day) 9,15

What is your expected date of crop emergence?
(month,day) 9,25

How much nitrogen (lb) did you apply at Fallow season? 0

The model asks Jones if he applied any Nitrogen (in pounds) during the fallow season. Since he did not, he types a 0 followed by a return.

He is then prompted for current price and interest rate data. Farmer Jones enters these four values, each followed by a return.

Specify the following values for seeding time.

Application cost (\$/ac) 1.42

Nitrogen cost (\$/lb)23

Price of wheat (\$/bu) 3.95

Interest rate (%/100) 0.09

The model then generates seeding time predictions.

OSU/IPPC - Economic Evaluation of Wheat Fertilization Strategies

SEEDING TIME DECISION (made in fall of crop year)

Estimated seeding date September 15
 Estimated number of days to crop emergence . . . 10 days
 Available nitrogen (lb/ac-N) 35.7
 SUGGESTED APPLICATION OF NITROGEN (lb/ac N). . . 37.0
 Predicted grain yield (bu/ac). 45.2
 Predicted profit from application (\$/ac). . . . \$17.00

The results confirm Jones' estimate of planting and emergence dates. It also suggests that Jones apply 37.0 lb of nitrogen. This application will allow a yield of 45.2 bushels per acre and an additional \$17.00 per acre in net revenue. He seeds his crop and applies 37.0 lb per acre of nitrogen.

Crop

Farmer Jones wonders whether it would be profitable to apply a top dressing at the end of March. He chooses the crop option at the prompt.

"Where are you ('F'allow, 'S'eeding, 'C'rop, or 'H'arvest)?" C

He is asked to supply monthly rainfall since planting.

Specify the precipitation (in.) from September through March of Crop year.

Current values are: .47 .83. 2.01 4.72 1.10 .71 .55

Do you need to modify these values? Y

Type seven data items separated by commas.

.47,.79,1.61,1.73,1.81,1.02,1.02

He also provides the actual value for September pan evaporation.

Specify the evapotranspiration (in.) for September crop year.

The current value is: 6.18

Do you need to modify this value? Y

Type the corresponding data item. 6.26

The model also requests Jones' actual planting and crop emergence dates, which were September 18th and September 30th.

What was your actual seeding date (month,day) 9,18

What was the emergence date of your crop (month,day) 9,30

Jones also indicates that he applied 37 lb of nitrogen at seeding time.

How much nitrogen (lb.) did you apply at seeding time? 37

He then supplies economic data to the model regarding his application and nitrogen cost, price of wheat, and current interest rates; each value followed by a return.

Specify the following values for the crop season.

Application cost (\$/ac)	1.42
Nitrogen cost (\$/lb n)18
Price of wheat (\$/bu)	4.22
Interest rate (\$/100)	0.09

The model then generates it's predictions for Jones given the weather and economic data he has entered.

OSU/IPPC - Economic Evaluation of Wheat Fertilization Strategies

CROP SEASON DECISIONS (made in March of Crop year)

Seeding date	September 18
Days to crop emergence	12 days
Available nitrogen (lb/ac N)	71.8
SUGGESTED APPLICATION OF NITROGEN (lb/ac N) . . .	15.1
Predicted grain yield (bu/ac)	53.1
Predicted profit from application (\$/ac)	\$0.94

The results confirm Jones' planting and emergence dates. The model also recommends an application of 15.1 lb of nitrogen as a top dressing. If he applies this amount of nitrogen his yield should be 53.1 bushels per acre. He should increase his profit by \$0.94 per acre from this application. Once he has reviewed the results, a copy can be printed by typing the shift + PrtSc keys. This will print all information that is on the computer screen if the printer is turned on. To exit the program disk, type an N plus Return. The prompt A will appear on the screen and the program can be removed.

Harvest

The program can be used to predict the final yield at harvest if desired. He chooses the harvest option at the prompt,

"Where are you ('F'allow, 'S'eeding, 'C'rop or 'H'arvest time)?" H

"Specify the precipitation (in.) from April through June of Crop year. Current values are: .09 .96 1.26

Do you need to modify these values? Y

Type three data items separated by commas: .72,.85,.65

Specify the evapotranspiration (in.) for April and May of crop year. Current values are: 5.69 9.21

Do you need to modify these values? Y

Type two data items separated by commas: 4.86,6.99

How much nitrogen (lb/ac) did you apply at Crop season? 15.1

After each prompt on the computer you must push return to continue to next step.

"OSU/IPPC - Economic Evaluation of Wheat Fertilization Strategies

HARVEST TIME RESULTS

Potential grain yield (bu/ac)	58.9
Mineralized nitrogen (lb/ac N)	35.8
Applied nitrogen (lb/ac N)	52.1
Predicted grain yield (bu/ac)	58.2

Do you want to evaluate another strategy (Y or N)? N

You may exit the program by typing 'N' (plus return) and removing the disk when the prompt A appears.

The harvest time results show that the improved climatic conditions increased yield from 53.1 to 58.2 bushels per acre. The increased yield resulted from favorable precipitation and temperature (resulting in lower pan evaporation values) conditions during April, May and June. The predicted yield at harvest would have approximated the predicted yield in March if climatic conditions had been nearer their long-term average.

If you want an updated yield prediction, after the crop fertilizing decision was made but before you have a complete data set from April through June, you can use the precipitation and evapotranspiration data that you have, and supply average values for the missing data.

V. SUMMARY

The overall objective of the program is to help growers make better nitrogen management decisions. The yield prediction model utilizes historical data for precipitation-yield relationships from the Sherman Branch Experiment Station, Moro, OR. It requires current climatic data, including precipitation and pan evaporation, as well as soil nitrogen (both fallow and crop) and stand.

The program was verified using actual farmer data with good results. Like all biological models, the prediction is not perfect. When climatic conditions are extreme, the model does not predict accurately. However, under most conditions, the model improves management decisions and, hopefully, will help make cereal growing more profitable.

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