

Model 1

Results Listing and Comments

GAMS Rev 233 WIN-VIS 23.3.3 x86/MS Windows
 05/15/13 13:58:43 Page 3
 Optimizing Water Resource Use in the TE Basin - Iraq
 Solution Report SOLVE TE_01 Using NLP From line 153

S O L V E S U M M A R Y

MODEL	TE_01	OBJECTIVE	ag_ben_v	Name of variable used for objective
TYPE	NLP	DIRECTION	MAXIMIZE	Maximize don't minimize
SOLVER	CONOPT	FROM LINE	153	

**** SOLVER STATUS 1 Normal Completion Normal is good - anything else is bad
 **** MODEL STATUS 1 Optimal Optimal is good - infeasible or unbounded is bad
 **** OBJECTIVE VALUE 25928.1244

RESOURCE USAGE, LIMIT	0.008	1000.000	Good
ITERATION COUNT, LIMIT	4	2000000000	Good
EVALUATION ERRORS	0	0	Good

Click onto Sol_VAR then to hectares_v on your computer's GAMS listing

---- VAR hectares_v land in production by crop (1000 Ha - marginal is \$US per Ha)

	LOWER	LEVEL	UPPER	MARGINAL
1-Wheat	.	.	+INF	.
2-Cotton	.	31.7778	+INF	.

Level: LEVEL tell you the model's optimized quantities for the variable hectares_v. These are the hectares of land in production by crop. The number tells you that farmers maximize their total income for Mousil Province by planting _____ ha to cotton, and _____ ha to wheat.

LOWER equals . for both crops. That means lower bound is 0 for both wheat and cotton. Of course, land in production can never be negative. UPPPER is +INF for both crops. That means the upper bound is infinite for both crops. So LEVEL of hectares_v for both crops must be between 0 and infinity.

Table tells you the net income-maximizing combination of land planted to each crop. Remember, you have only 572 million cubic meters of water available total for both crops.

The table advises the farmer to plant all cotton and no wheat. Why _____?

But wheat, you say, is an important grain crop. Why shouldn't farmers plant wheat _____?

Later we can try re-running the model by reducing cotton and increasing wheat, and see what happens. You'll find it reduces total farm income.

Marginal: Table tells you MARGINAL impact of increasing the optimized hectares of land by one unit. Both MARGINALS are zero. That tells you added net income from one more unit of land brought into production. What does the zero mean _____? More land has no value without more water.

NOTES:

Click onto T_hectares_v

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR T_hectare~	.	31.7778	+INF	.
T_hectares_v total land in prodn				(1000 Ha - marginal is \$US per Ha)

Levels: Table LEVELS tell you optimized LEVEL of the variable T_hectares_v, which is total land in production, summed over crops. It tells you that _____ is optimized total land in production.

The LEVEL 31.78 tells you total land to plant to both crops with available surface water.

Does the LEVEL of the variable T_hectares_v measure total income _____?

Does the LEVEL of the variable T_hectares_v measure total water use _____?

Does the LEVEL of the variable T_hectares_v measure land planted to any one crop _____?

Does the LEVEL of the variable T_hectares_v measure total land planted to all crops _____?

Bounds: LOWER and UPPER bounds are still the same, 0 and infinity

Marginals: Notice that the MARGINAL is _____ What does that mean _____?

NOTES

---- VAR uses_crop_v total water use by crop (million m³ - marginal is \$US per 1000 m³)

	LOWER	LEVEL	UPPER	MARGINAL
1-Wheat	.	.	+INF	-35.8541
2-Cotton	.	572.0000	+INF	.

Levels: This result tells you the optimized LEVEL of total water use for each crop, uses_crop_v. The optimized LEVEL of total water use is _____ for wheat and _____ for cotton.

The table tells you that all 572 million cubic meters of water should be used to grow cotton.

Marginals: They tell you the MARGINAL impact (added value) of adding one unit of water to either crop.

Notice the negative MARGINAL for wheat = -35.85. What does that mean _____? It tells the farmer or water manager that if Iraqi farmers insist on growing wheat for any reason, there is a loss \$US 35.85 for the first extra unit (1000 cubic meters) of water taken from cotton and planted to wheat.

Why is there a loss of \$35.85? Does that mean that wheat is an absolute money loser _____?

NOTES:

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR uses_v	.	572.0000	572.0000	45.3289
uses_v total water use		(million m ³ - marginal is \$US per 1000 m ³)		

Levels: table tells you optimized LEVEL of uses_v. That variable is total water use applied to all land. The optimized LEVEL is _____? (in million cubic meters). The model recommends using all total water available (572) on crop irrigation. None is wasted.

Upper Bound: The UPPER BOUND is _____. So notice that the optimized LEVEL of total water use is also equal to its UPPER bound. Interesting. When any resource enters the optimal solution LEVEL at its UPPER BOUND, the results tell you that the model is hungry for more.

Marginals: Notice the MARGINAL equals \$US 45.33. This gives you important information for future planning. It tells you if farmers could find one more unit of water (in thousand cubic meters) from any source, they earn \$US 45.33 more net income. What are examples of new water sources? rain, conservation, infrastructure, purchase, rent, ditch lining, new storage capacity, reduced pump costs.

Q: Suppose you're skeptical. You don't believe the MARGINAL = \$US 45.33. How can you check to see if 1 more (thousand cubic meters) is worth to the farmer \$US 45.33 _____?

It also tells you the loss in income in \$US if you had 1 less (thousand cubic meters) of water.

Q: How can you check to see if 1 unit less water available reduces your income by \$US 45.33 _____?

NOTES

---- VAR ag_ben_k_v total farm income by crop (\$US 1000s - no marginals shown)

	LOWER	LEVEL	UPPER	MARGINAL
1-Wheat	-INF	.	+INF	.
2-Cotton	-INF	25928.1244	+INF	.

Level: This result shows the optimal LEVEL of total farm income by crop (ag_ben_k_v). That optimal LEVEL is _____?

It does not tell you what farmers actually earned. It tells you what farmers could earn if they want to maximize their income for the information given. What information did we give the model _____? The model has information on prices, yields, costs, water use, and total water available.

The table tells Iraqi farmers and extension advisers in Mousil Province to grow only cotton, and to plant no wheat at all if income maximization is their goal.

Compared to cotton, planting wheat loses money. Wheat earns some income, but less than cotton. That is, cotton earns more income than wheat. Based on the data we found on prices and costs, maximum net income that could be earned from these two crops (wheat and cotton) is \$ US 25,928 (in thousands).

This tells you what helps the farmers. However, suppose the government wants farmers to grow wheat to support national grain self-sufficiency _____?

Marginal: No marginal shown for the variable total farm income. Income is the objective. It is not a potentially scarce resource like land or water.

NOTES

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR ag_ben_v	-INF	25928.1244	+INF	.
ag_ben_v total farm income (objective)				(\$US 1000s - no marginals shown)

Level: This table shows ag_ben_v. It is the optimized LEVEL of total farm income that can be earned from both crops if all available water is put to best use in irrigated agriculture. That LEVEL is _____. If farmers don't use their water wisely, they won't earn this much income. It's the optimized LEVEL of income, not necessarily the actual level.

Notice that the table shows no breakdown between cotton and wheat. It shows only total net income that could be earned by irrigation farmers from the province. It exactly matches the optimal solution shown on page 1.

What if the government wanted to help farmers raise their income beyond this level _____?

Marginals: None shown because LOWER bound is - infinity and UPPER bound is + infinity.

NOTES