

Model 2

Results Listing and Comments

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Optimizing Water Resource Use in the TE Basin - Iraq
Solution Report SOLVE TE_02 Using NLP From line 167

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

MODEL	TE_02	OBJECTIVE	ag_ben_v	name of objective variable
TYPE	NLP	DIRECTION	MAXIMIZE	direction of optimization
SOLVER	CONOPT	FROM LINE	167	

**** SOLVER STATUS 1 Normal Completion good
**** MODEL STATUS 1 Optimal good, not Infeasible, not Unbounded
**** OBJECTIVE VALUE 42859.8131

RESOURCE USAGE, LIMIT	0.004	1000.000	good
ITERATION COUNT, LIMIT	4	2000000000	good
EVALUATION ERRORS	0	0	good

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

	LOWER	LEVEL	UPPER	MARGINAL
1-Mousil.1-wheat	.	.	+INF	.
1-Mousil.2-cotton	.	.	+INF	.
2-Basra .1-wheat	.	.	+INF	.
2-Basra .2-cotton	.	37.3832	+INF	.

Levels: Table remind us that we added a new province, Basra. The optimized LEVEL of land assigned to wheat is zero for both provinces. The LEVEL of land for cotton is _____ for Mousil, and _____ (1000 ha) for Basra.

By adding new opportunities, use of water for crops in Basra, the model takes advantage of the opportunity.

If optimizing total income is the goal, farmers should grow only cotton and only cotton in Basra. Why should they grow no wheat _____? Why should they grow nothing in Mousil _____?

Notice the optimized LEVEL of land, 37.38 (1000 ha), is larger than the 31.78 (1000 ha) used to grow cotton in in model 1. Why is land larger in model 2 than in model 1 _____? Did we tell the model that we now have more land _____?

Impact of more water: For model 2, we gave our farmers more water, 800 million cubic meters for both provinces. Model 1 gave farmers only 572 million cubic meters. More water means more land will be irrigated.

An optimization model always wants to optimize something (e.g. income). It's hungry for income. An optimization model looks for the allocation of water and land among crops and provinces to maximize income. Basra has higher cotton yields than Mousil (hotter climate), so higher revenue but only slightly higher costs.

Suppose Iraq's national water rights system assigns half (400) to crops in Basra, and half (400) to crops in Mousil (400). What will happen _____? Can you find a way to raise income given those rules _____?

Marginals: What do the 4 MARGINALS equal to zero mean _____? Added land, if it could be found, is worth nothing. Is that really true _____? Added land without added water is worth nothing.

NOTES

---- VAR T_hectares_v total land in prodn by province (1000 Ha - marginal is \$US per Ha)

	LOWER	LEVEL	UPPER	MARGINAL
1-Mousil	.	.	+INF	.
2-Basra	.	37.3832	+INF	.

Levels: Table shows total optimized LEVEL of land in production summed over crops, for each province, Mousil and Basra, T_hectares_v.

It shows you what you'd expect from the previous table. 37.38 (1000 ha) is total land that would be in production if income maximization is the goal.

Is that really the goal for the farmer _____?

Is it or should it be the goal for the country _____?

What are the limits of income maximization models, given that this one gives nothing to Mousil ___?

Marginals: Both MARGINALS are _____. What do those two zeros mean _____?

NOTES

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

	LOWER	LEVEL	UPPER	MARGINAL
1-Mousil.1-wheat	.	.	+INF	-44.1000
1-Mousil.2-cotton	.	.	+INF	-8.2459
2-Basra .1-wheat	.	.	+INF	-42.7414
2-Basra .2-cotton	.	800.0000	+INF	.

Levels: This table summarizes the optimized LEVEL of uses_crop_v. Optimized level of each crop in each province is what _____.

It tells us that all 800 (million cubic meters) water should be applied to cotton and only in Basra, if income optimization is the goal.

The model advises complete specialization of water for what crop _____ in what province _____?

Marginals: The MARGINALS give you valuable planning information that is important to inform water policy. What information do they tell you _____?

MARGINALS tell you that if Iraqi farmers insist on applying 1 more (million cubic meters) in Mousil, there will be loss 44.10 (\$US) on the 1st 1000 cubic meters for wheat and 8.24 (\$US) on the 1st 1000 cubic meters for cotton.

There's also a loss of \$US 42.74 for 1 extra (1000 cubic meters) water applied to wheat in Basra. Does that mean that you should not grow wheat in Basra _____?

If you insist on putting water to another crop or to another province you will suffer a cost in lost farm income.

NOTES

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR uses_v	.	800.0000	800.0000	53.5748
uses_v total water use		(million m ³ - marginal is \$US per 1000 m ³)		

Levels: This table tells you the LEVELS of uses_v, total water summed over crops and provinces.

What is that LEVEL _____?

It says that you should use all of your available water and let none go to waste. Recall that we told the GAMS model that the UPPER bound on water is 800 (million cubic meters).

Marginal: The MARGINAL (53.57) tells you lots of things:

1. Additional water is valuable and will be used for crop irrigation.
2. It could be a good idea to find or develop more water. How could this happen _____? desalination, treaties with upstream neighbors, conserving water in irrigation (difficult), developing drought resistant crops, reduced urban water use, reduced flows for key ecological assets, reduced use in urban areas, reduced outflows at Shatt El Arab to the Gulf.
3. It tells you the maximum you can justify spending to get the additional water. How much _____?
4. It says that Iraqi farmers can gain \$US 53.47 in added farm income per 1000 cubic meters added water if somebody could help them find added water

NOTES

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

	LOWER	LEVEL	UPPER	MARGINAL
1-Mousil.1-wheat	-INF	.	+INF	.
1-Mousil.2-cotton	-INF	.	+INF	.
2-Basra .1-wheat	-INF	.	+INF	.
2-Basra .2-cotton	-INF	42859.8131	+INF	.

This table tells us the optimized LEVEL of ag_ben_k_v, total farm income by crop. It repeats what we already know about total optimized farm income. How much income should be earned by each crop if total income is what should be optimized _____?

It advises Iraqi farmers that it's best (optimized) to earn income by farming only cotton and farming only in Basra. If farmers and ministry officials take the advice shown in the table, they'll earn 42,859 (in \$US 1000s).

Why are MARGINALS zero _____?

NOTES

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	LOWER	LEVEL	UPPER	MARGINAL
---- VAR ag_ben_v	-INF	42859.8131	+INF	.
ag_ben_v total farm income (objective)				(\$US 1000s - no marginals shown)

The table shows the optimized LEVEL OF ag_ben_v, namely the objective function (total farm income).

What is its interpretation _____? It's the maximum total net income that can be earned from all (both) crops in all (both) provinces.

But farmers must pay careful attention to their revenues and costs to earn this much. They cannot make mistakes. It's important for farmers and farm advisers to have good data, and to use it well.

NOTES