Crispy Critters, Inc.

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You have been called in to help out a start-up biotechnology firm called Crispy Critters Inc. The founder of the firm has discovered a way of producing genetically engineered critters that will disassemble and decompose abandoned automobiles. The problem up until now has been that the genetic engineering techniques are imperfect, and along with the good, car-eating critter, another type of critter is also produced. This bad critter feeds on the car-eating variety and and will consume them before they make much of a dent in the car. The breakthrough at CCI is a method of separating the two types of critters so that the good ones outnumber the bad and survive long enough to eat cars.

CCI has two methods for growing batches of critters (both types intermixed) and two chemical agents which render the unwanted critters harmless. Any of the four combinations could be used, although the costs and characteristics of the combinations are different. You have been hired to help figure out how the firm can most profitably produce the car eating product.

Step One

The critters can be grown in one of two types of environment; the firm has long chemical names for the environments, but for simplicity just call them A and B. They differ in how easy it is to harvest the actual critters out of the material they are grown in. For every gram of environment A, 0.44 grams of critter mix (good ones and bad ones together) can be harvested. For every gram of environment B, 0.72 grams of critter mix (good ones and bad ones together) can be harvested.

The direct costs for a gram of A is $11, and $17.50 for B. The harvesting is done by salaried, trained technicians who can harvest up to 1000 grams of environment per week. These technicians will work enough overtime per week to process up to another 400 grams of environment at an additional cost of $4 per gram.

Step Two

The result of the harvesting is a mix of the two types of critters and if left as is, the bad critters will eat the car-eating variety. So the next step is to combine a chemical agent with the harvested mix and bake it to render most of the bad critters harmless. The chemical process is not perfect, however and it kills some of the good critters and misses some of the bad ones. The following table gives the composition of the mix (in percentages of one gram) after each agent is applied to batches from the two different growing environments:

	Agent 1	Agent 2
Harvested from A		
percent good critters	50	40
percent bad critters	5	6
Harvested from B		
percent good critters	60	30
percent bad critters	10	6

The percent of the mix that is not good or bad includes dead critters of both type and possibly small bits of the growing environments. So, for example, if Agent 1 is applied to 100 grams of the critter mix harvested from environment A, the result will be 50 grams of good critters, 5 grams of bad critters, and 45 grams of inactive material (dead critters).

Agent 1 costs $18 for each gram of harvested mix treated and Agent 2 costs $12.50 per gram of harvested mix. The technicians responsible for baking are capable of processing 800 grams of mix per week. They too are willing to work overtime, and can process another 300 grams of mix per week on overtime at a cost of $6.50 per gram. They have less capacity than the harvesters because only a portion of the grams of environment that the harvesters process goes on the baking step.

Final Product

The firm plans to combine the results of all the harvesting and baking combinations into one vat of critters. In order for the product to be successful, the mix has to be at least 40% good critters and no more than 7% bad critters. A gram of the final product is sold for $100.

Assignment

a.) What are the decision variables you will need for the problem? (hint: eight should be enough to define the solution.)

b.) Write a complete LP formulation for CCI using these variables. Describe each of the constraints and how you would implement an algorithm to optimize the profit for CCI.

c.) Create some slides describing the optimal solution in a way that the production department will understand how much of each raw material to buy and how much overtime the technicians should be scheduled for.

d.) The model solution will also create sensitivity information about the objective function and constraints. Which objective coefficients are sensitive enough that they should be investigated further? What do the shadow prices of the constraints tell you about how sensitive the solution is to the assumptions.

e.) The yield of the harvesting process is not known for sure and might be something that could be improved. What would the effect be of increasing the A harvest yield by an additional 10%? What if the yield of the B harvest could be increased by an additional 5%? Prepare a table showing the effects of each 1% change in the yields.

f.) The correct proportions of good and bad critters might be able to be changed and still create an acceptable product. What is the effect on profits of increasing the allowable bad critters from 7% to 10%? What about reducing the required good critters from 40% to 35%? Prepare a table showing the effects of each 1% move in each type of critter over the ranges.

g.) Should CCI consider increasing the staff in the harvesting and baking departments? The current staff costs are already established, and the overtime costs are what would be paid in addition to the staff members. New salaried employees would have a "full cost" of about $30 per gram for harvesting and $20 per gram for baking. What staffing levels would you use in each department, assuming the same amount of overtime available?