**Breeder.**

 **There is a farm called Sky Blue Farm. Recently, the breeder wants to use mathematical method to find out the strategy of running a business of farm, the most important thing is to maximize the total profit with limit resource and budget. The breeder owns 600 acres of land. He is going to breed each acre with cattle or sheep. Each acre bred with cattle yields $80000 profit, requires 6 workers, and required 7 tons of** **provender. Each acre planted with sheep yields $50000 profit, requires 4 workers, and required 5 tons of provender.** However, we cannot breed as much cattle as we want, as we have limit provender and workers. **There are currently 1400 workers and 1000 tons of provender available. Help the breeder maximize the profit from his land.**

**Discussion.**

 In this problem, there are two options (cattle and sheep) to take. **Our objective is to maximize profit as mentioned in the problem statement. This profit is determined by the acres of cattle present and/or the acres of sheep present. Suppose we feel that since cattle gives a larger profit per unit area, we can breed the entire land with cattle. But looking further we see that in this case, the amount of provender needed to breed cattle in all of the land would exceed the maximum amount of provender available. Similar scenario holds for breeding cattle throughout the land. Hence, we need to understand what combination of cattle and sheep can give us the maximum profit subject to the constraints of land, worker and provender availability.**

Therefore, our decision variable is how much land needs to be allocated for cattle and sheep respectively. If we can decide the number of each option, we can calculate the respective required quantity of animal, which will help us in calculating the total profit. In this problem, as the amount of land to be allocated to each animal increases to maximize the profit, the limit on the workers available tends to give an upper boundary to the possible increase in the amount of land that can be allocated for each animal. Note that in the optimal solution, all of the land available may not be utilized because of the worker and provender availability constraints. To note is that in the excel solver, the constraint for land available must be less than or equal to 600 acres rather than equal to 600 acres, the latter might result in no feasible solution to be present. This is because we might not have enough workers and provender to cover the whole land. Our objective is only to maximize profit within the constraints present, we do not have to care whether the entire land is utilized or not.

**Model.**

Parameters:

$P\_{i }$: *Profit margin for unit acre of animal* $i$*,* $ where i\in \left(cattle, sheep\right)$

$W\_{i }$: *Number of workers required for unit acre of animal* $i$*,* $where i\in \left(cattle, sheep\right)$

$F\_{i }$: *Tons of provendr required for unit acre of animal* $i$*,* $where i\in \left(cattle, sheep\right)$

$W\_{ }$: *Total number of workers available*

$F\_{ }$: *Total tons of provender available*

$L$:  *Total land available*

Decisions:

$x\_{i }$: *Amount of land to be allocated to animal* $i$*,* $ where i\in \left(cattle, sheep\right)$

Objective: *Maximize profit*

$$max\sum\_{i=cattle,sheep}^{}P\_{i }\* x\_{i }$$

Constraints:

$ x\_{i }\geq 0 \left(1\right)$ Land allocated cannot be negative

$\sum\_{i=cattle,sheep}^{}x\_{i}\leq L ($2) Land allocated to cattle and sheep cannot exceed total land available

$\sum\_{i=cattle,sheep}^{}w\_{i}\*x\_{i}\leq W ($3) Workers allocated to work on cattle and sheep cannot exceed total workers available

$\sum\_{i=cattle,sheep}^{}f\_{i}\*x\_{i}\leq F ($4) Provender used for cattle and sheep cannot exceed total available provender

Notes:

1. The constraints (2), (3), (4) ensures that the amount of land, workers, and provender utilized stay within their respective availability.

**Optimal Solution.** The following is the solution obtained from Excel Solver.



The optimal solution is to allocate 200 acres to cattle and 200 acres to sheep to yield a maximum profit of $26,000,000 .

