**INSTITUTO SUPERIOR DE AGRONOMIA**

**Test of Applied Operations Research (Part I) - 25 May 2015/16**

Number: Name:

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**1.** (10val.) A farmer has the following resource endowments: 500 acres of land, 1500 hours of family labour and 120000€ of capital investment. She can use these resources to grow the following crops: corn, sorghum, wheat and soybeans. Any crop should not occupy more than 250 acres. Assume that the farmer works to maximize profit (revenue minus costs) from the production of these crops. She expects the following in terms of prices, crop yields, costs and labor requirements.

| Crop | Price (€/bushel) | Yield (bushel/acre) | Cost (€/acre) | Labor Requirement (hours/acre) |
|---|---|---|---|---|
| Corn | 2.75 | 120 | 250 | 3.25 |
| Sorghum | 2.65 | 100 | 200 | 3.00 |
| Wheat | 3.15 | 105 | 245 | 3.15 |
| Soybeans | 6.75 | 45 | 230 | 3.30 |

a) Formulate the problem as a linear program.

b) Solve the problem using the Excel Solver. What is the optimal solution to the problem?

c) Which constraints are binding? How do you interpret each binding constraint?

d) By how much should sorghum's current profit per acre increase in order for the optimal solution to change? Sorghum's current profit per acre decrease would change the optimal solution?

e) What is the shadow price for each constraint? How do you interpret this value?

f) What is the range of feasibility for the maximum number of hours of family labour with respect to the shadow price? How do you interpret this range?

g) How much the profit would change if one acre of soybeans were forced into the current optimal solution?

h) Assume that the farmer can invest part of her 120000€ to rent additional land at 100€ per acre and hire additional labour at 6€ per hour.

*i)* Reformulate the problem to allow these investments.

*ii)* Solve the new problem using the Excel Solver. Compare the optimal solution obtained with that of question b).

**Resolution:**

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**Test of Applied Operations Research (Part II) - 25 May 2015/16**

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**1.** (5 val.) Consider the following LP problem (P1):

$$\max z = 3x_1 + 4x_2 + x_3 \qquad (0)$$
$$\begin{cases} x_1 + x_2 + x_3 \leq 10 & (1) \\ 2x_1 - x_2 + x_3 \leq 3 & (2) \\ x_1 + x_2 \leq 2 & (3) \\ x_1, \quad x_2, \quad x_3 \geq 0 & (4) \end{cases}$$

Use the simplex method to solve (P1). Identify the optimal solution and the corresponding optimal value.

**2.** (5 val.) Consider the following LP problem (P2):

$$\max z = 3x_1 + 7x_2 + x_3 \qquad (0)$$
$$\begin{cases} x_1 + x_2 + x_3 \leq 4 & (1) \\ x_1 - 2x_2 + x_3 \geq 2 & (2) \\ x_1, \quad x_2, \quad x_3 \geq 0 & (3) \end{cases}$$

Using the Big M method, construct the first tableau for the simplex method and identify the resulting basic feasible solution for (P2).

**Resolution:**