**Chapter VII Homework, 2021**

1. Soy City, Inc. purchases soybeans, crushes them, and uses the soy products to make margarine, meat substitute, and soy sauce. Soybeans may be classified as Grade A or Grade B. Crushed soybeans yield soybean meal and soybean oil. The characteristics of the two grades of soybean in terms of cost/ton and yield of meal and oil are

|  |  |  |  |
| --- | --- | --- | --- |
| Grade | Cost/Ton | % Meal | % Oil |
| A | 180 | 80 | 20 |
| B | 150 | 85 | 15 |

Processing costs are $15 per ton of soybeans.

Soybean meal may be sold directly as animal feed for $190/ton. The composition of other products, their cost of production, and selling price are:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Per lb. Manufactured | | | |
| Product (units) | Use of  Soy Meal | Use of  Soy Oil | Processing Cost | Selling  Price |
| Margarine (lb) |  | 2 | 0.05 | 1.00 |
| Meat Substitute (lb) | 0.08 | 0.2 | 0.10 | 0.49 |
| Soy Sauce (gal) |  | 5 | 0.12 | 5.00 |

Processing capacity is limited to crushing 2 tons of soybeans.

Formulate a LP model to maximize profits for this problem.

Setup and interpret the dual equation for the major different types of variables.

2. Suppose you are in charge of the Contgill grain and you have the problem of managing company storage. Further, you know today:

a) Grain can be sold for $2.00/bu. and you think the price will go up by 5 per bushel per month the next 8 months, then down by 10 for the subsequent four months.

b) It costs you 2/month/bu. to keep the grain.

c) Eight months from now your chairman has said 10% of the grain you have on hand must be committed to PL 480, for which you are not reimbursed. You must commit at least 50,000 bushels.

d) You have 10,000,000 bushels of grain on hand.

e) 0.1% of the grain spoils each month.

Set up a profit maximizing LP.

3. The U.S. economy contains two major winter vegetable producing regions ‑ California and Florida. Four vegetable crops grown in these areas are tomatoes, beans, corn, and peas. Production budgets for these two areas are:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Florida | | | California | | |
|  | Cost  /acre | Labor  /acre | Machinery/acre | Cost  /acre | Labor  /acre | Machinery/acre |
| Tomatoes | 100 | 12 | 1 | 90 | 14 | 0.7 |
| Beans | 95 | 6 | 1.2 | 80 | 8 | 1.3 |
| Corn | 75 | 4 | 3 | 80 | 3.5 | 2.3 |
| Peas | 55 | 3 | 1.8 | 60 | 7 | 2 |

Florida has 35,000 acres

200,000 laborers

90,000 machines

California has 42,000 acres

300,000 laborers

100,000 machines

Demand for crops in acres by region is:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | East | Mideast | Midwest | West |
| Tomatoes | 10,000 | 6,000 | 3,000 | 11,000 |
| Beans | 9,000 | 0 | 2,000 | 11,000 |
| Corn | 5,000 | 3,000 | 0 | 4,000 |
| Peas | 3,000 | 2,500 | 1,100 | 2,000 |

Transport costs are:

|  |  |
| --- | --- |
| Commodity | Cost/acre to  transport 1000 miles |
| Tomatoes | 10 |
| Beans | 5 |
| Corn | 9 |
| Peas | 4 |

Distances in thousand miles are:

|  |  |  |
| --- | --- | --- |
|  | From | |
|  | California | Florida |
| East | 2.5 | 0.5 |
| Mideast | 1.7 | 1.2 |
| Midwest | 1 | 2.1 |
| West | 0.5 | 2.6 |

Set up an LP to:

a) Supply vegetables to the country at minimum cost.

b) Determine the price of goods delivered (how will you get this?).

4. Sam, our friendly local farmer, wished to decide on a planting pattern for the coming year. Sam plants corn and soybeans and he is willing to plant either type of crop or any mixture of the two. Through historical data and educated guesses, Sam has the following data:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Preparation ‑ Resources used when one acre of land is prepared for: | | |  | Planting ‑ Working rate and resource usage when one hour of planting time is used for: | | |
|  | Corn | Soybeans |  |  | Corn | Soybeans |
| Cost | 2.46 | 2.10 |  | Acres Planted | 5 | 5 |
| Labor used (hours) | .80 | .58 |  | Cost | 3.00 | 2.85 |
|  |  |  |  | Labor hours required | 1.10 | 1.20 |
|  |  |  |  |  |  |  |
| Cultivation - Resources used when 1 acre of land is cultivated for | | |  | Harvesting ‑ Working rate and resource usage when spending 1 hour harvesting: | | |
|  | Corn | Soybeans |  |  | Corn | Soybeans |
| Cost | .16 | .50 |  | Acres Harvested | 3.00 | 4.75 |
| Labor used (hours) | .05 | .10 |  | Cost | 3.86 | 2.68 |
|  |  |  |  | Labor hours required | 2.40 | 1.70 |

Land preparation occurs between Jan. 1 and May 15. Sam cultivates all of his corn 3 weeks after planting and all of his soybeans 2 weeks after planting. Sam has a dual purpose combine which may be used to harvest either crop with negligible set‑up time.

Production Costs: Cost per acre of inputs by category for

|  |  |  |
| --- | --- | --- |
|  | Corn | Soybeans |
| Fertilizer  Seed  Herbicide  Insecticide  Credit | 25.00  9.00  6.50  0.00  1.00 | 50.00  9.25  9.00  2.00  1.50 |

Yields: Sam chooses to plant each crop during four 1‑week periods and harvest during two 2‑week periods. His yield data are as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Plant During Week | Harvest Corn During | | Harvest Soybeans During | |
| 9/1 - 9/15 | 9/16 - 9/30 | 9/16 - 9/30 | 10/1 - 10/15 |
| May 1-7 | 145 | 142 |  |  |
| May 8-14 | 145 | 142 | 45 | 47 |
| May 15-21 | 138 | 138 | 45 | 44 |
| May 22-28 | 126 | 124 | 44 | 42 |
| May 29-Jun 6 |  |  | 43 | 37 |

In his area, Sam finds he has the following hours available to him. (note: For simplicity, we assume Sam has adequate machinery to operate up to the maximum of the good hours per period; i.e., labor, not machines, are lim­iting and the limit is specified by the good hours/period.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Jan. - April |  | 99 |  | Sept. 1 -15 |  | 70 |
| May 1 - 7 |  | 25 |  | Sept. 16 - 30 |  | 109 |
| May 8 - 14 |  | 25 |  | Oct. 1 - 15 |  | 102 |
| May 15 - 21 |  | 25 |  |  |  |  |
| May 22 - 28 |  | 32 |  |  |  |  |
| May 29 - June 6 |  | 32 |  |  |  |  |
| All weeks June 7 - Aug 31 |  | 40 |  |  |  |  |

Currently, Sam has 600 acres. The current price of corn is $2.00. The current price of soybeans is $5.00. For labor, Sam has himself, and a full‑time hired man. During fall harvesting, Sam's son works on the farm 1/2 time.

Set up Sam's problem.

If you solved the problem how would the solution identify the number acres of each crop he should plant and when. How would it tell how much are his resources worth?

5. Assume you are hired by a meat packing firm which has W warehouses and P plants. Assume each of the plants makes N products by M processes. The plants have R resources. The warehouses each face fixed demand for all goods. Assume the firm has asked you to build a model for them to determine

(a) Which plants produce which products

(b) Where goods produced at plants should be shipped.

Formulate this problem in a general summation notation fashion specifying the data you would need

6. Apply the homogeneity of units test to the improper model in figure 6.5 and discuss any problems you find.