

Chapter VII Homework

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. Note under A when you crush a ton of beans you get 1600 lbs of meal and 400 lbs of oil.

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:

	Use per unit Manufactured			
Product (units)	Use of Soy Meal In lbs	Use of Soy Oil In lbs	Processing Cost In dollars	Selling Price in dollars
Margarine (lb)		2	0.05	1.00
Meat Substitute (lb)	0.08	0.2	0.10	0.49
Soy Sauce (gal)	.15	5	0.12	5.00

Processing capacity is limited to crushing 25 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. Felix the feed mixer needs to blend his feeds for sale to cattle feeders. Felix makes high protein catt le feed by four different recipes from five ingredients. The recipes and the ingredients are as follows

Ingredients:	Recipe Number				Ingredient costs
	1	2	3	4	
Corn (bu)	.1	.2	.1	.3	\$2.00
Soybeans (bu)	.3	.3	.2	.2	\$5.75
Sorghum (bu)	.1	.9	.1	.3	\$1.80
Wheat (bu)			.1	.5	\$3.25
Bulk (lbs)	14	.8	10	.9	\$0.10

Assume the firm can make 1000 bags of feed and that the feed sells for \$4.00. Also assume that it takes .3 hours of labor per bag and .001 hours per .lb of feed purchased. Assume the firm has 100,000 hours of labor

Chapter 6-7 homework set

- a. setup an LP to solve the problem:
 - b. Setup and interpret the dual equation for the major different types of variables.
3. Dollar Hog Company is planning its weekly hog cutting operation. Dollar buys hogs and can either skin them or scald them and then cut them up via one of four patterns. Technical data follow.

Table 1. Technical Data by Processing Type		
	Hog Processing Type	
	Skin	Scald
Cost/Hog	10	8
byproducts ^{1/} /hog	10 lbs.	30 lbs.
skin yield/hog	1	0
labor/hog	6	4
^{1/} byproducts in addition to those shown in Table 2.		

Table 2. Percent yield of product and labor use when cutting up the meat yield for four cutting patterns				
	Cutting Pattern			
Product	1	2	3	4
Ham	.20	.20		
Bacon	.10		.15	
Sausage	.25	.35	.45	.65
By-product	.25	.25	.20	.15
Waste	.20	.20	.20	.20
Labor/hog	0.5	0.2	0.2	0.1

Products sell for the following prices:

Skins: \$18 Bacon: \$2.45/lb. Ham: \$2.90/lb.
 Sausage: \$2.00/lb. By product \$0.50/lb

Hogs cost \$80, weigh 200 lbs after the skinning or scalding operation. labor costs \$6/hr. with 5000 man hours available. Waste costs \$0.10/lb. to dispose of.

- a. Formulate an LP

- b. Discuss how to derive a demand curve for hogs.
 c. Setup and interpret the dual equation for the major different types of variables.
4. Smears prepares prepackaged hardware for distribution through its chain of stores. Prepackaged hardware contains mixtures of various items or small packages of these items. Smears sells assorted packages of items containing #2, #4, and #6 bolts; #2, #4, and #6 nuts; #2, #4, and #6 washers; #6 and #10 wood screws; and #3 and #5 metal screws. The packages they sell are:

Packag e	Name	Composition by weight	Weight of Packaged Product
1	Handyman Set	Equal wt. of everything	1 lb.
2	Screw, bolt, washer set	10 of each size-	--
3	Bolt Pack	1 lb. of any of the bolts 1 size only	1 lb.
4	Nut Pack	1 lb. of any of the nuts 1 size only	1 lb.
5	Washer Pack	1 lb. of any of the washers 1 size only	1 lb.
6	Bolt Mix 1	20% #2, 30% #4, 50% #6	1 lb.
7	Bolt Mix 2	40% #2, 20% #4, 40% #6	1 lb.
8	Washer Mix	30% #2, 30% #4, 40% #6	1 lb.
9	Wood screw Mix	40% #6, 60% #10	1 lb.
10	Metal screw Mix	60% #3, 40% #5	1 lb.
11	Screw Mix	50% wood screw mix, 50% metal screw mix	1 lb.
12	Nut Mix	Equal weight of all types of nuts	1 lb.

In terms of raw materials:

Item	Items/lb.	Inventory in lbs.	Cents/lbs.	Maximum available at this price (lb)
#2 bolt	50	100 lbs	50	1,000
#4 bolt	100	50	40	500
#6 bolt	150	75	30	7,000
#2 nut	300	90	20	1,000
#4 nut	325	110	30	700

Chapter 6-7 homework set

#6 nut	350	10	40	1,000
#2 washer	500	3	10	600
#4 washer	550	25	10	1,500
#6 washer	600	200	10	unlimited
#6 wood screw	150	5	40	2,000
#10 wood screw	200	0	30	2,000
#3 metal screw	75	0	70	2,000
#5 metal screw	125	0	50	2,000

In terms of products...

Product	Price/Unit	Minimum Sales	Maximum Sales
1	\$1.00	100	500
2	.40	0	2,000
3	.75	0	--
4	.50	200	--
5	.70	0	1,000
6	.60	0	--
7	3.10	0	--
8	1.70	0	100
9	.85	50	--
10	2.05	0	--
11	.80	0	--
12	.75	0	--

- Formulate this as an LP including features which tell the number of bolts, nuts, washers and screws sold; the costs of purchases of bolts, nuts, washers and screws; and the total poundage sold.
 - How would you answer the question: "What items should Smears try to obtain more of?"
 - How would you answer the question: "What items should Smears try to sell more of?"
5. Betty Cracker is trying to formulate her plans for her manufacturing plant which makes delicious cracker crumb pies. Two types of pies are made: southern cracker and crumbly cracker. Each may be made via two recipes allowing substitution between sugar and high fructose corn syrup. Seven raw ingredients are used. The recipes and the ingredients costs are:

Recipes:

Chapter 6-7 homework set

	Southern Cracker 1	Southern Cracker 2	Crumbly Cracker 1	Crumbly Cracker 2
HFCS (cups)	1.2		1.2	
Sugar (Cups)		1		1
Cracker Crumb (oz)	12	12	12	12
Southern Flavor(oz)	5	5		
Crumbly Flavor (oz)			5	5
Milk (cups)	1	1	1	1
Water (cups)		0.2		0.2

Costs:

Ingredients	Units	Cost/Unit	Volume/Unit yield on
HFCS	gallons	5.00	1 gallon = 16 cups
Sugar	tons	600	1 ton = 10000 cups
Cracker crumb	100 lbs.	50	1 lb. = 16 ozs.
Southern flavor	tons	300	1 ton = 32000 ozs.
Crumbly flavor	tons	300	1 ton = 32000 oz.
Milk	1000 gallons	13.00	1 gallon = 16 cups
Water	gallon	0.01	1 gallon = 16 cups

Assume you have the capacity to:

- a) Bake 3000 pies
- b) Store 10 tons of either flavor individually
- c) Store 5 tons of sugar

Pies sell for \$2 each

Set up a profit max LP

6. MPP packing plant is trying to plan this week's cattle slaughter operation. At the MPP plant they make hamburger, steak, roasts, brisket, mixed roasts byproduct and waste materials. Animals may be of several different grades and may be cut several different ways. The yields in proportional terms by animal grades and cutting pattern are:

Table: Animal Proportional Yields by grade of animal

	Cull Cows	Feed Steers	Fed Heifers
--	-----------	-------------	-------------

Cutting method	1	2	3	1	2	3	1	2	3
Hamburger	0.5	0.33	0.4	0.48	0.09	0.15	0.48	0.09	0.15
Steak	0	0.05	0.05	0	0.15	0.18	0	0.15	0.18
Roasts	0	0.05	0.05	0	0.15	0.12	0	0.15	0.12
Brisket	0	0.05		0	0.05	0	0	0.05	0
Mixed Roast	0	0.05		0	0.05	0.04	0	0.05	0.04
Byproducts	0.3	0.3	0.3	0.32	0.3	0.31	0.32	0.3	0.31
Waste	0.2	0.17	0.2	0.2	0.21	0.2	0.2	0.21	0.2
Cost/head	125	125	125	225	225	225	220	220	220
Weight/head	1000	1000	1000	600	600	600	550	550	550
Labor hrs./head	3	4	3.7	3	5	4.7	3	5	4.7

Assume the hamburger sells for \$1.00

Steak for \$2.50

Roast for \$2.00

Brisket for \$1.25

Mixed roast for \$1.40

Byproduct for \$0.30

and waste costs \$.10 to dispose of

The animals available are

Cull Cows 100

Fed Steers 300

Fed Heifers 300

There are 2800 hours of labor available. The killing room can handle 600 animals.

Set up a profit max LP

7. Consolidated Meat Packers buys cattle, hogs and chickens. After slaughter, the resultant cuts of meat are sold directly or combined into hot dog, sausage, or dog food mixes. The meat packer sells hot dog mix, sausage, dog food, chicken parts, roasts, steak, ground beef, ham, and pork chops.
 - Cattle can be cut into parts or they can be entirely ground into hamburger (50% ground beef and 50% by-product). If cut into parts, steaks amount to 10% of carcass

- weight, roasts 12%, and ground beef 28%. The remaining amount of the carcass weight is by-product.
- Hogs yield 25% bulk pork, 20% pork chops, and 15% ham. The remainder is by-product.
 - Chickens yield 10% legs, 15% thighs, 25% breasts, and 15% miscellaneous meat. The remainder is by-product.
 - Cattle weigh 800 lbs. each and cost \$.55/lb.
 - Hogs weigh 250 lbs. and cost \$.60/lb.
 - Chickens weigh 3 lbs. and cost \$.30/lb.

The products, their selling prices, and minimum and maximum sales are

Product	Price (\$/lb.)	Min (lb.)	Max (lb.)
Hot dog mix	0.80		1100
Sausage	0.60	100	
Dog food	0.20		
Roasts	1.25		1200
Steaks	1.75		1300
Chicken legs	0.70		
Chicken thighs	0.75	300	
Chicken breasts	0.90		
Chicken misc.	0.25		
Ground beef	0.68	8000	11000
Ham	1.50	4000	7000
Pork chops	0.90		
By-product	0.10		

Note that bulk pork is not sold; it is simply put into other products. The other products are formulated as follows.

- Hot dogs cannot be more than 50% bulk pork nor more than 20% by-product. They are made from ground beef, bulk pork, and beef and pork by-product.
- Sausage is at least 70% bulk pork and no more than 20% ground beef. Any other meat can be used for the rest, including by-products, but no more than 5% by-products can be present.
- Dog food can be made from any meat, but cannot contain more than 35% by-product.
- Total supply is limited to 2000 cattle, 10,000 hogs, and 30,000 chickens.

Formulate a profit maximizing LP model.

8. Suppose that Ideal Forest Products Firm wishes to draw up a manufacturing plan.

Suppose Ideal makes plywood, 2"x4"s, 4"x4"s, wood chips and bark mulch. In making these products, Ideal uses several machines: the bark remover, the peeler, the saw, the assembler-gluer and the chipper. The fixed cost per day of operating each machine, the variable cost per hour of use, and the hours available are given below.

Machine Type	Fixed Cost/Day	Cost/Hour Used	Hours Available/Day
Bark Remover	\$160	\$5	32
Peeler	\$210	\$7	32
Saw	\$400	\$4	64
Assembler/Gluer	\$210	\$5	24
Chipper	\$180	\$2	32

The firm receives two types of logs. Currently, it counts on receiving 75 of each type of log. The two types of logs may be converted into different uses. Grade A logs may be made into plywood, sawn lumber, or chips. Grade B logs may be made into sawn lumber or chips. Chips are also a by-product of making plywood or sawn lumber. Bark mulch is a byproduct of using any log.

The yields of products are as follows:

- a. Use of any log yields 200 lbs. of bark.
- b. Use of a Grade A log for ...
 - i. plywood yields 40 sheets of plywood and 200 lbs of chips
 - ii. sawn lumber yields 40 2"x4"s, 15 4"x4"s and 100 lbs. of chips. or 20 2"x4"s, 25 4"x4"s and 95 lbs. of chips. or 70 2"x4"s, 0 4"x4"s and 105 lbs. of chips.
 - iii. chips yields 600 lbs. of chips.
- c. Use of a Grade B log for ...
 - i. sawn lumber yields 35 2"x4"s, 14 4"x4"s and 160 lbs. of chips. or 63 2"x4"s, 0 4"x4"s and 180 lbs. of chips.
 - ii. chips yields 600 lbs. of chips.

The resource usage by these cutting patterns is as follows:

- a. All logs take 10 minutes on the barking machine and it takes 2 minutes of handling to move the log onto and off of the machine.
- b. A plywood log takes 20 minutes on the peeler with 5 minutes of handling involved to load and remove.
- c. A sawn log takes 5 minutes to set up and 1 minute per 2"/4" plus 1/2 minute per 4"x4" of saw time.
- d. A sheet of plywood takes 4 minutes on the assembler-gluer plus 1 minute of handling time.
- e. A log to be chipped takes 5 minutes on the chipper.

The products produced sell for

Product	Unit	Price
Bark	\$/ton	40
Chips	\$/ton	30
2"x4"s	\$/20 8' boards	20
4"x4"s	\$/20 8' boards	45
plywood	\$/10 sheets	100

- Set up a linear programming model for optimum product mix
- Tell what types of information you would get from its solution.

- Charles Chicken manufactures chicken products. He has an integrated operation that raises, processes, and packages chicken for distribution. His operation is broken into 3 parts. Under chicken raising, he has the following situation:

Inputs per chicken	Intensive	Extensive	Not incubated
Price of young chick	\$0.20	\$0.20	\$0.25
Housing	4 sq. ft.	2 sq. ft.	3 sq. ft.
Feed	4 lbs. @ \$0.05/lb.	4.1 lbs. @ \$0.05/lb.	4.2 lbs. @ \$0.05 lb.
Farm Labor	1/2 hour	1/3 hour	1/4 hour
Cost of misc. services	\$0.10	\$0.15	\$0.17
Incubator space	0.1 sq. ft.	0.1 sq. ft.	0 sq. ft.
% of chickens that die or are unacceptable	10%	13%	15%
Body weight at maturity	3.0 lbs.	2.95 lbs.	3.1 lbs.

Of the limiting resources he has.

Housing	55,000 sq. ft.
Labor	5,000 hours
Incubator	3,000 sq. ft.

Furthermore, he may buy additional chickens with a body weight of 2.9 lbs. for \$0.75 of which 3% are rejected as unacceptable. Suppose you can not buy any more than 1000.

In his cutting operation, the following cutouts are true regardless of body weight:

% of Total Body Weight by Category	
Neck	3%

Chapter 6-7 homework set

Leg	15%
Thighs	20%
Breast	30%
Back	15%
Giblet	10%
Waste	7%

Cutting a chicken takes 2 minutes labor time. He has 25 men who work 8 hours each. Further, he may hire up to 10 more men for 8 hours/day for \$35.00 each or may get his existing people to work overtime at \$4.50/hr, up to 300 hours.

In his packaging operation, he formulates and sells several products.

Packed Breasts	in 3 lb packages @ \$1.00/lb.
Packed Thighs	in 3 lb packages @ \$0.95/lb.
Packed Legs	in 3 lb packages @ \$0.90/lb.
Whole cut up chickens	in 3 lb in same proportions as chickens are cut up excepting waste @ \$0.75/lb.
Chicken salad	3 lb of chicken meat (which comes from the procedure below) which takes 4 minutes of labor per pack (Giblets cannot go in) @ \$1.40/lb
Giblets	1 lb packages @ \$0.70/lb.
Backs	in 3 lb packages @ \$0.20/lb.
Necks	in 3 lb packages @ \$0.15/lb.
Boned Chicken Meat	in 3 lb packages @ \$1.05/lb.

For chicken salad or boned chicken, he bones out chicken meat as follows:

Necks	yield 10% meat
Legs	yield 60% meat
Backs	yield 20% meat
Thighs	yield 70% meat
Breasts	yield 85% meat

Waste must be disposed of @ .01/lb.

- a. Formulate a profit maximizing LP

Chapter 6-7 homework set

- b. Setup and interpret the dual equation for the major different types of variables.
 - c. Design a set of reports for management. Indicate how you would combine activities into the reports.
 - d. Draw a flow diagram of the formulation.
10. Louis Lots o' Turkey Co. wishes to find an optimum pattern for turning turkey into profits. LLOTC buys turkeys and produces several products: fresh turkeys, frozen turkeys, turkey hams, turkey roasts, lunch meat, turkey parts (legs, thighs, breasts), and ground turkey. To make these products, LLOTC has developed seven cutting patterns. These patterns are
- a) Fresh turkey preparation
 - b) Frozen turkey preparation
 - c) Turkey ham preparation
 - d) Turkey pressing
 - e) Turkey parts (1, 2, and 3)
 - f) Lunchmeats
 - g) Turkey grinding

All the patterns require 1 unit of kill capacity. In addition, the yield and input usage of the patterns are

Pattern	Output	Cost Input	Labor Input
Fresh turkey	1 fresh turkey	\$0.50	1/3 hr.
Frozen turkey	1 frozen turkey	\$0.75	1/2 hr.
Turkey ham	8 lbs. turkey hams	\$1.50	3/4 hr.
Turkey pressing	8 lbs. boneless turkey roast	\$1.40	1/2 hr.
Turkey parts 1	4 lbs. breast, 5 lbs. quarters	\$0.50	1/3 hr.
Turkey parts 2	9 lbs. quarters	\$0.50	1/4 hr.
Turkey parts 3	4 lbs. breast, 3 lbs. thigh, 2 lbs. leg	\$0.50	1/2 hr.
Lunchmeats	8 lbs. lunch meats	\$2.00	1 hr.
Turkey grinding	10 lbs. ground meat	\$0.25	3/4 hr.

500 units of kill capacity and 1000 hrs. of labor are available. The product prices and maximum that can be sold are

Product	Price	Maximum Sales
Fresh turkey	\$12.00/turkey	100
Frozen turkey	\$11.00/turkey	----
Turkey ham	\$ 2.50/lb.	75 lbs.

Turkey Roast	\$ 2.40/lb.	125 lbs.
Breast	\$ 1.30/lb.	50 lbs.
Leg	\$ 0.90/lb.	30 lbs.
Thigh	\$ 1.10/lb.	60 lbs.
Quarters	\$ 1.05/lb.	100 lbs.
Lunchmeats	\$ 1.75/lb.	----
Ground Turkey	\$ 0.90/lb.	----

Set up a profit maximizing model.

11. Suppose you are in charge of the Contgill grain and you have the problem of managing company storage. Further, you know today:
- Grain can be sold for \$2.00/bu. and you think the price will go up by 5 cents per bushel per month for the next 8 months, then down by 10 for the subsequent four months.
 - It costs you 2/month/bu. to keep the grain.
 - 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.
 - You have 10,000,000 bushels of grain on hand.
 - 0.1% of the grain spoils each month.

Set up a profit maximizing LP.

12. Suppose you are in charge of the U.S.D.A. butter supplies depository and you have the problem of managing the butter for the next year. Further, you know today:
- Butter can be sold for \$1.50/lb. and you think the price will go up by 4 cents per lb. per month for the next 6 months, then down by 10 for the subsequent six months.
 - It costs you 1cent month/lb to keep the butter
 - Six months from now 1/2 the butter you have on hand will be given away to the school lunch program by politicians seeking reelection. You must have at least 1000 lbs on hand to make them happy.
 - You have 27,000 lbs. of butter on hand.
 - 1% of the butter spoils each month.
- Set up a profit maximizing LP.
 - Setup
 - and interpret the dual equation for the major different types of variables.

13. Multicounty farming associates has two farms in two counties. The farms possess different soil characteristics so they have different yields, working rates and time available. The data are given below.

		Farm 1		Farm 2	
Planting Date	Harvesting Date	Corn Yield	Soybean Yield	Corn Yield	Soybean Yield
2	5	90	10	85	8
3	5	70	30	65	27
4	5	50	50	50	43
2	6	140	10	137	8
3	6	135	40	132	36
4	6	130	45	128	40
2	7	130	32	123	30
3	7	120	30	117	29
4	7	110	25	110	20

Plowing Dates	Farm 1	Farm 2
(Periods)	1-4	1-4 and 5-9

Working Rate	Acres/hr.	Labor/hr.	Acres/hr.	Labor/hr.
Plowing	4	1	5	1
Planting	10	1	10	1
Harvesting	3	2	5	2

Field Time (hours/period)

Period	Farm 1	Farm 2
1	10	12
2	15	17
3	20	22
4	25	25
5	20	19

6	15	17
7	15	17
8	10	12
9	5	3
Production Costs:	\$125.00 per acre for corn	
	\$ 50.00 per acre for soybeans	
Prices	\$ 3.00 per bushel for corn	
	\$ 6.00 per bushel for soybeans	

Two laborers are available year-round. Workers may work no more than the maximum of 25 hours on either farm or the maximum on the particular farm. There are 1000 acres of land in each farm.

Formulate a profit maximizing LP.

14. Roy owns a ranch in South Florida. Each year Roy produces approximately 1000 feeder calves which are sold in the fall for \$300/head. Roy is considering building a feedlot. Instead of selling his calves in the Fall, he can place them in a feedlot. The cattle will finish in six months and can be sold for \$500/head. Feed costs \$150/head. If he builds the feedlot, he can also buy calves in the spring for \$320/head, feed them and sell them in the fall for \$500/head, with feed costs at \$150/head.

The annual costs of a 1000 head feedlot facility are \$20,000. If he builds a feedlot, he may also build a waste disposal system. The system takes waste from the feedlot and converts it into methane gas. The annual system costs are \$11,000 and can produce up to 50,000 cubic feet of gas per year. The gas sells for \$.05/cu.ft.

An animal generates waste which can produce 50 cubic feet of methane gas per year. If he does not build the methane plant, waste disposal from the feedlot costs \$10/head per year.

Roy has a credit line at a local bank on which he can borrow to cover his short-term (feed, cattle purchase) credit needs. The interest rate 10 percent/year and loans must be "rolled over" every six months, i.e. the interest paid. His total credit line for short-term debt is \$30,000.

Assuming Roy's sole goal is to maximize his net returns for the next year beginning in the Fall. Also assume that no more than one feedlot and methane plant can be constructed but that partial facilities (i.e., a 750 head lot) can be constructed.

Formulate a mathematical programming model which will tell Roy how to meet his goal.

15. Aircraft scheduling company (ASC) has to service several planes in Chicago. These planes must be parked, inspected, serviced, gassed, and then depart. The planes arrived and their arrival and departure times are given below.

Flight Number	Arrival	Departure
---------------	---------	-----------

901	9:00	11:00
207	10:00	11:15
306	10:30	12:30
109	11:00	1:00

The time to execute each job is 15 minutes and the firm allows 15 minutes between jobs for the crews. The jobs must be done in the sequence arrive, park, inspect, service, gas, then depart.

Set up an LP that will tell ASC the minimum number of crews necessary for each process to do this job. Divide the time of the crews into 15-minute intervals.

16. The Peck family is studying whether to make an offer on some property. Currently, the Pecks own two farms and a feedlot in Illinois. The option they are considering is the purchase of some land in Montana. The land in Montana would be used to raise cattle which would be fed to slaughter age in Montana first and shipped to Illinois for feeding. Technical data follows:

Farm Data		Farm 1	Farm 2
Land Plowing	Acres/hour	3	2.5
	Labor /hour plowing	1	1
Planting Corn	Acres/hour	5	6
	Labor/hr of planting	1	1
Planting Soybeans	Acre/hour	6	8
	Labor/hr of planting	1	1
Harvesting Corn	Acre/hour	3	3
	Labor/hour	1.5	1.5
Harvesting Soybeans	Acres/hour	5	5.5
	Labor/hour	1.5	1.5

Corn yields in bushels on Farm 1 are:

		Planting Date	
		May	June
Harvest Date	October	120	110
	November	140	130

Corn yields on Farm 2 are 90% of those on Farm 1.

Soybean yields in bushels (bu) on Farm 1 are:

Chapter 6-7 homework set

		Planting Date	
		May	June
Harvest Date	September	40	38
	October	45	42

Soybean yields on Farm 2 are 110% of those on Farm 1. Plowing is done in December, March, April or May. Farm labor is shared between the farms and there are 60 hours in each month with 4 people working. Farm 1 has 300 acres, Farm 2 has 200 acres.

Feed Lot Data	Characteristics of Alternative Feeding Systems per Feeder Animal			
Method Number	1	2	3	4
Final Animal Weight/lbs.	900	870	900	920
Bushels of Corn	40	45	30	42
Bushels of Soybeans	10	5	20	6
Other Costs	20	25	15	30

Market Data:

Purchase cost of feeder animals	\$125/head
Market price of corn (same to both farms)	\$3.00/bu
Market price of soybeans (same to both farms)	\$6.75/bu
Cost of purchasing feed	120% of market price
Price of fed beef applicable to final animal weight	\$50/100 lbs
Cost of raising corn	\$100/acre
Cost of raising soybeans	\$ 60/acre

Transport Costs:

	To Feedlot	
	Corn	Soybeans
From Farm 1	\$0.05/bu	\$0.12/bu
From Farm 2	\$0.10/bu	\$0.05/bu

Assume purchased feed and crops sold to market have a zero transport cost.

Montana Proposal

Land/cow unit	5 acres
Number of feed animals raised in a year per cow unit	0.7
Land utilized per feeder raised for sale	5 acres
Cost/cow unit	\$55/year

Cost/feed animal to ship to Illinois	\$10/feeder
Weight of feeders raised to mature animals and slaughtered in Montana	600 lbs.
Cost/feeder raised to maturity in Montana	\$50
Annualized Land cost in Montana	\$5/acre
Price feeders raised to sale weight in Montana	\$.50/lb.
Maximum market potential in Montana	500 head of feeders raised to maturity

- a. Formulate a model for optimum firm size including both farms, the feedlot, and the Montana option.
 - b. Discuss how you would use this model to determine whether to invest in Montana land.
 - c. What types of formulations are implicit in this solution relative to those in the chapter (resource allocation, etc.)?
17. 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

The resources available are

	Florida	California
Land (acres)	35,000	42,000
Labor	200,000	300,000
Machines	90,000	100,000

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

Chapter 6-7 homework set

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	
To	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:

- Supply vegetables to the country at minimum cost.
- Determine the price of goods delivered (how will you get this?).

18. 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:

<u>Preparation</u> - Resources used when one acre of land is prepared for:			<u>Planting</u> - 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
<u>Cultivation</u> - Resources used when 1 acre of land is cultivated for			<u>Harvesting</u> - 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	25.00	50.00
Seed	9.00	9.25
Herbicide	6.50	9.00
Insecticide	0.00	2.00
Credit	1.00	1.50

Yields: Sam chooses to plant each crop for 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	May 29 - June 6	32
May 1 - 7	25	All weeks June 7 - Aug 31	40
May 8 - 14	25	Sept. 1 -15	70
May 15 - 21	25	Sept. 16 - 30	109
May 22 - 28	32	Oct. 1 - 15	102

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 of acres of each crop he should plant and when? How would it tell how much are his resources worth?

19. Assume you are hired by a meat packing firm that 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.
- Which plants produce which products
 - Where goods produced at plants should be shipped.
- Formulate this problem in a general summation notation fashion specifying the data you would need.**
20. Apply the homogeneity of units test to the improper model in Figure 6.5 and discuss any problems you find.
21. Give an example of the numerical procedure discussed in section 6.3.2 in the context of the bad model in Figure 6.5.
22. Reformat the joint products model from Chapter 5 as discussed in 6.5.1 and argue why one might wish to model in the way done in Chapter 5.
23. Setup and solve the problem in Table 6.7 with GAMS. Show how the formulation error manifests itself in the solution.
24. In the GAMS model for Figure 6.7 create a supply demand disappearance report table for chicken parts and display it.
25. Pete's Petroleum Products (PPP) is trying to establish a long term plan for its refinery operations. PPP makes 6 products from 3 kinds of crude oil. The breakout percentages are as follows:

Production of Products When Refining	Crude Oil Source		
	Middle East	West Texas	Mid Continent
	(Proportional Yield)		
Gasoline	.04	.18	.24
Naphtha	.14	.20	.22
Distillate	.09	.07	.09
Gas Oil	.18	.09	.11
Residuum	.54	.44	.32
Misc.	.01	.02	.02
Cost of refining 55-gallon barrel	\$ 2	\$2.5	\$ 3

PPP now has three plants: one in Texas, one in Ohio and one in South Carolina. The crude oil can be shipped in as follows:

	Source of Crude Oil
--	---------------------

Chapter 6-7 homework set

Destination Plant	Middle East	West Texas	Mid Continent
Texas	\$ 3	\$ 1	\$ 4
Ohio	\$ 8	\$ 4	\$ 2
South Carolina	\$ 2	\$ 6	\$ 4

In turn, the products are sold at each of the plants for the following prices:

Product	Texas	Ohio	South Carolina
Gasoline	\$.63	\$.73	\$.69
Naphtha	.37	.33	.40
Distillate	.45	.50	.51
Gas Oil	.30	.40	.39
Residuum	.10	.11	.12
Misc. (disposal cost)	-.01	-.02	-.01
Maximum sale in barrels	1,000,000	2,000,000	1,000,000

PPP may buy the crude oils at the following prices:

West Texas \$17 per 55 gallon barrel

Mid Continental 19 per 55 gallon barrel

Middle East 15 per 55 gallon barrel

West Texas supplies yield no more than 1,000,000 barrels this year while Mid Continental are limited to 200,000 and Middle East are unlimited.

PPP is also considering building some ships and will accept a non-integer answer. The ships can be of the following capacities (in 55 gallon barrels), costs per voyage and annual cost:

Ship Capacity			
Per Voyage	Cost/Voyage ^{b/}	Time/Voyage	Annual Cost
100,000	100,000	1 month	1,000,000
500,000	400,000	1 month	5,500,000
1,000,000	800,000	1 month	10,000,000
^{b/} These are voyages to South Carolina. Direct voyages to Texas cost 20% more and take 20% longer. Voyages to Ohio are not possible. Ships have 12 months available. If the ships are bought, then no other transport costs other than voyage and annual costs are incurred.			

Further, suppose that transshipping Middle East oil to Ohio costs \$3.00 from Texas or South Carolina.

Finally, PPP has a contract where for each gallon of gasoline sold at the above price in Ohio at least 1/2 gallon of Gas Oil must be sold. Gasoline available exceeding this limit may be sold at 2/3 price to local companies.

Formulate a profit maximizing LP assuming partial ships can be bought.

26. Hiram the agricultural producer wants to examine what he should do now that the farm program has been eliminated. Assume Hiram produces corn, cotton, and cattle at two locations.

Suppose that he has the following data and Land prep can be done Sept-April.

Corn Yield in Bushels

		Farm A			Farm B		
		Planting Date			Planting Date		
		March	April	May	March	April	May
Harvest Date	Sept	100	110	80	105	115	85
	Oct	90	105	110	90	100	105

Cotton Yield in Bales

		Farm A			Farm B		
		Planting Date			Planting Date		
		March	April	May	March	April	May
Harvest Date	Aug	1.1	1.0	.9	1.0	.9	.95
	Sept	1.2	1.1	.9	1.1	1	.9

Speed of Operations

	Land Preparation	Planting	Harvest
Corn	3 acres/hr	5 acres/hr	3 acres/hr
Cotton	4 acres/hr	5 acres/hr	4 acres/hr

Cost of Operations

	Land Preparation	Planting	Harvest
Corn	\$5/acre	\$90/acre	\$15/hr
Cotton	\$5/acre	\$150/acre	\$15/hr

Total Labor Time Available in a time period

Total Labor Time Available in a time period

Chapter 6-7 homework set

	Both Farms
Aug	180 hrs
Sept	160 hrs
Oct	120 hrs
Nov-Feb Total	110 hrs
March	110 hrs
April	140 hrs
May	160 hrs

Note labor cannot work more than 100 hrs in any month on farm 1.

Cow operation

Cost/cow 80

Labor use/cow 4 hrs/month

Price of cows sold \$1.00/lb

Sales Weight per cow which depends on amount of feed

$$CW = 500 + 20F - F^2$$

F = feed unit use during year

CW = Total cow weight

Land available

Farm 1 800 acres

Farm 2 600 acres

Feed unit detail

Two feeds can be used. For convenience we express them in a common feed unit

one feed unit equals 5 bushels of corn or 1/10 acre of pasture. Thus one can choose to feed corn or pasture

Pasture raising cost per acre/year \$5

Pasture land use is drawn from cropland.

Crop Prices at Farm Gate

	Farm A	Farm B
Corn	2.50 /bushel	2.25 /bushel

Chapter 6-7 homework set

Cotton	400 /bale	410 /bale
--------	-----------	-----------

Cows are fed from crops or pasture raised on the farm

Set up a model of this situation.