

Lizzie's Dairy



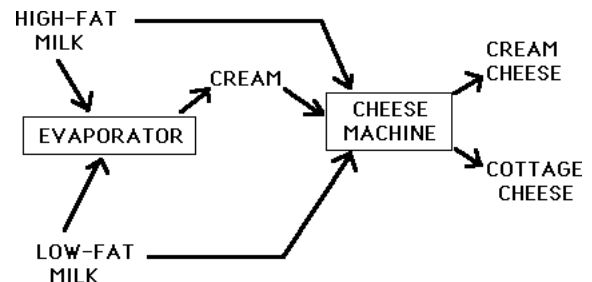
This Hypercard stack was prepared by:
Dennis L. Bricker,
Dept. of Industrial Engineering,
University of Iowa,
Iowa City, Iowa 52242
e-mail: dbricker@icaen.uiowa.edu

Lizzie's Dairy produces cream cheese and cottage cheese. Milk and cream are blended together to produce these two products. Both high-fat and low-fat milk can be used to produce cream cheese and cottage cheese. High-fat milk is 60% fat; low-fat milk is 30% fat. The milk used to produce cream cheese must average at least 50% fat, and the milk used to produce cottage cheese must average at least 35% fat. At least 40% (by weight) of the inputs to cream cheese must be cream. At least 20% (by weight) of the input to cottage cheese must be cream.

Both cottage cheese and cream cheese are produced by putting milk and cream through the cheese machine. It costs 40¢ to process 1 lb of inputs into a pound of cream cheese. It costs 40¢ to produce 1 lb of cottage cheese, but every pound of input for cottage cheese yields 0.9 lb of cottage cheese and 0.1 lb of waste. Each day, up to 3000 lb of input may be sent through the cheese machine.

Cream can be produced by evaporating high-fat and low-fat milk. It costs 40¢ to evaporate 1 lb of high-fat milk. Each pound of high-fat milk that is evaporated yields 0.6 lb of cream. It costs 40¢ to evaporate 1 lb of low-fat milk. Each pound of low-fat milk that is evaporated yields 0.3 lb of cream. The evaporator can process at most 2000 lb of milk daily

Each day, at least 1000 lb of cottage cheese and at least 1000 lb of cream cheese must be produced. Up to 1500 lb of cream cheese and up to 2000 lb of cottage cheese can be sold each day. Cottage cheese is sold for \$1.20/lb and cream cheese for \$1.50/lb. High-fat milk is purchased for 80¢/lb and low-fat milk for 40¢/lb.



Variables

P1 = pounds of cream cheese produced
P2 = pounds of cottage cheese produced
HF = pounds of High-Fat milk purchased
LF = pounds of Low-Fat milk purchased
HFE = pounds of high-fat milk put through evaporator
LFE = pounds of low-fat milk put through evaporator
HF1 = pounds of high-fat milk used to make cream cheese
LF1 = pounds of low-fat milk used to make cream cheese
C1 = cream input to make cream cheese
HF2 = pounds of high-fat milk used to make cottage cheese
LF2 = pounds of low-fat milk used to make cottage cheese
C2 = cream input to make cottage cheese

OBJECTIVE

$$\text{MAX } 1.1 P1 + 0.8 P2 - 0.4 HFE - 0.4 LFE - 0.4 LF - 0.8 HF$$

CONSTRAINTS

Output=Input for cream cheese $P1 = HF1 + LF1 + C1$

Output= 0.9x input for cottage cheese
 $P2 = 0.9 HF2 + 0.9 LF2 + 0.9 C2$

CONSTRAINTS

Minimum Rqmt. for cream cheese $P1 \geq 1000$

Minimum Rqmt. for cottage cheese $P2 \geq 1000$

CONSTRAINTS

Capacity of evaporator $HFE + LFE \leq 2000$

Capacity of cheese machine
 $HF1 + LF1 + C1 + HF2 + LF2 + C2 \leq 3000$

CONSTRAINTS

Balance equation for high-fat milk $HF = HFE + HF1 + HF2$

Balance equation for low-fat milk $LF = LFE + LF1 + LF2$

Balance equation for cream production $C1 + C2 = 0.6 HFE + 0.3 LFE$

CONSTRAINTS

Min. Fat Rqmt. for milk in cream cheese $0.1 HF1 \geq 0.2 LF1$

Min. Fat Rqmt. for milk in cottage cheese $0.25 HF2 \geq 0.05 LF2$

Min. cream rqmt. in cream cheese $0.6 C1 \geq 0.4 HF1 + 0.4 LF1$

Min. cream rqmt. in cottage cheese $0.8 C2 \geq 0.2 HF2 + 0.2 LF2$

```

MAX 1.1 P1 + 0.8 P2 - 0.4 HFE - 0.4 LFE - 0.4 LF - 0.8 HF
SUBJECT TO
2) P1 - HF1 - LF1 - C1 = 0
3) P2 - 0.9 HF2 - 0.9 LF2 - 0.9 C2 = 0
4) P1 >= 1000
5) P2 >= 1000
6) HFE + LFE <= 2000
7) HF1 + LF1 + C1 + HF2 + LF2 + C2 <= 3000
8) - HFE + HF - HF1 - HF2 = 0
9) - LFE + LF - LF1 - LF2 = 0
10) - 0.6 HFE - 0.3 LFE + C1 + C2 = 0
11) 0.1 HF1 - 0.2 LF1 >= 0
12) 0.25 HF2 - 0.05 LF2 >= 0
13) - 0.4 HF1 - 0.4 LF1 + 0.6 C1 >= 0
14) - 0.2 HF2 - 0.2 LF2 + 0.8 C2 >= 0
END
SUP P1 1500.00000
    
```

LP Model

LP OPTIMUM FOUND AT STEP 8

OBJECTIVE FUNCTION VALUE

1) -159.259400

VARIABLE	VALUE	REDUCED COST
P1	1000.000000	.000000
P2	1000.000000	.000000
HFE	1037.037100	.000000
LFE	.000000	.200000
LF	940.740720	.000000
HF	1585.185300	.000000
HF1	400.000000	.000000
LF1	200.000000	.000000
C1	400.000000	.000000
HF2	148.148140	.000000
LF2	740.740720	.000000
C2	222.222220	.000000

ROW	SLACK OR SURPLUS	DUAL PRICES	OBJ COEFFICIENT RANGES		
			VARIABLE	CURRENT COEF	ALLOWABLE INCREASE
2)	.000000	1.200000			
3)	.000000	.859259	P1	1.100000	.100000
4)	.000000	-.100000	P2	.800000	.059259
5)	.000000	-.059259	HFE	-.400000	.150000
6)	962.962900	.000000	LFE	-.400000	.200000
7)	888.888900	.000000	LF	-.400000	.080000
8)	.000000	-.800000	HF	-.800000	.093750
9)	.000000	-.400000	HF1	.000000	.250000
10)	.000000	2.000000	LF1	.000000	.500001
11)	.000000	-1.333334	C1	.000000	.250000
12)	.000000	-1.333333	HF2	.000000	.400000
13)	.000000	-1.333334	LF2	.000000	.080000
14)	.000000	-1.533334	C2	.000000	.266667

ROW	RIGHTHAND SIDE RANGES		
	CURRENT RHS	ALLOWABLE INCREASE	ALLOWABLE DECREASE
2	.0000	1000.000000	888.888900
3	.0000	999.999930	799.999930
4	1000.0000	500.000000	1000.000000
5	1000.0000	799.999930	999.999930
6	2000.0000	INFINITY	962.962900
7	3000.0000	INFINITY	888.888900
8	.0000	INFINITY	1585.185300
9	.0000	INFINITY	940.740720
10	.0000	622.222220	577.777700
11	.0000	60.000000	120.000000
12	.0000	222.222220	44.444442
13	.0000	577.777700	400.000000
14	.0000	577.777700	222.222220

ROW	(BASIS)	P1	P2	HFE	LFE	LF	HF
1	ART	.000	.000	.000	.200	.000	.000
2	HF1	.000	.000	.000	.000	.000	.000
3	LF2	.000	.000	.000	.000	.000	.000
4	P1	1.000	.000	.000	.000	.000	.000
5	P2	.000	1.000	.000	.000	.000	.000
6	SLK 6	.000	.000	.000	.500	.000	.000
7	SLK 7	.000	.000	.000	.000	.000	.000
8	HF	.000	.000	.000	.500	.000	1.000
9	LF	.000	.000	.000	-1.000	1.000	.000
10	HFE	.000	.000	1.000	.500	.000	.000
11	LF1	.000	.000	.000	.000	.000	.000
12	HF2	.000	.000	.000	.000	.000	.000
13	C1	.000	.000	.000	.000	.000	.000
14	C2	.000	.000	.000	.000	.000	.000

ROW	HF1	LF1	C1	HF2	LF2	C2	SLK 4
1	0.000	.000	0.000	0.000	0.000	.000	.100
2	1.000	0.000	0.000	.000	.000	.000	-.400
3	.000	.000	.000	0.000	1.000	0.000	.000
4	.000	.000	.000	.000	.000	.000	-1.000
5	.000	.000	.000	.000	.000	.000	.000
6	.000	.000	.000	.000	0.000	.000	.667
7	0.000	0.000	0.000	.000	.000	.000	1.000
8	0.000	.000	.000	0.000	0.000	.000	-1.067
9	0.000	.000	0.000	0.000	0.000	0.000	-.200
10	.000	.000	.000	.000	0.000	.000	-.667
11	0.000	1.000	0.000	.000	.000	.000	-.200
12	.000	.000	.000	1.000	0.000	.000	.000
13	.000	.000	1.000	.000	.000	.000	-.400
14	.000	.000	.000	.000	.000	1.000	.000

ROW	SLK 5	SLK 6	SLK 7	SLK 11	SLK 12	SLK 13
1	.059	.000	.000	1.333	1.333	1.333
2	.000	.000	.000	-3.333	.000	.667
3	-.741	.000	.000	.000	3.333	.000
4	.000	.000	.000	.000	.000	.000
5	-1.000	.000	.000	.000	.000	.000
6	.370	1.000	.000	.000	0.000	1.667
7	1.111	.000	1.000	.000	.000	0.000
8	-.519	.000	.000	-3.333	-3.333	-1.000
9	-.741	.000	.000	3.333	3.333	.333
10	-.370	.000	.000	.000	0.000	-1.667
11	.000	.000	.000	3.333	.000	.333
12	-.148	.000	.000	.000	-3.333	.000
13	.000	.000	.000	.000	.000	-1.000
14	-.222	.000	.000	.000	.000	.000

ROW	SLK 14
1	1.533
2	.000
3	.833
4	.000
5	.000
6	1.667
7	.000
8	-1.500
9	.833
10	-1.667
11	.000
12	.167
13	.000
14	-1.000

