

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

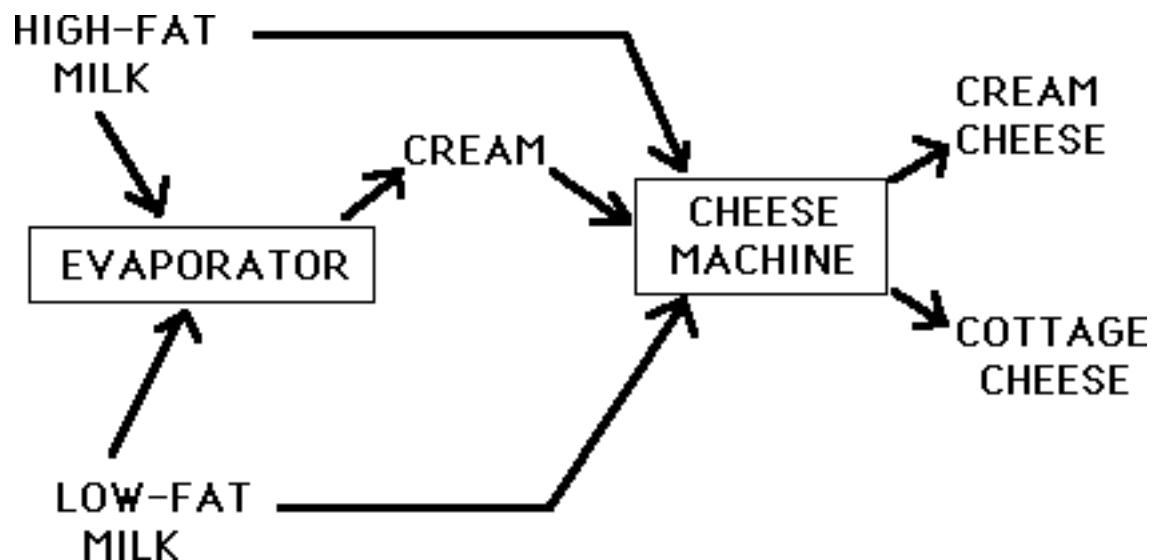
Lizzie's Dairy produces cream cheese and cottage cheese. Milk and cream are blended together to produce these two products. Both high-fat and low-fat milk can be used to produce cream cheese and cottage cheese. High-fat milk is 60% fat; low-fat milk is 30% fat. The milk used to produce cream cheese must 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

$$\begin{aligned} \text{MAX} \quad & 1.1 P1 + 0.8 P2 \\ & - 0.4 HFE - 0.4 LFE - 0.4 LF - 0.8 HF \end{aligned}$$

CONSTRAINTS

*Output=Input
for cream cheese*

$$P1 = HF1 + LF1 + C1$$

*Output= 0.9× 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*

$$0.1 \text{ HF1} \geq 0.2 \text{ LF1}$$

*Min. Fat Rqmt. for
milk in cottage
cheese*

$$0.25 \text{ HF2} \geq 0.05 \text{ LF2}$$

*Min. cream rqmt.
in cream cheese*

$$0.6 \text{ C1} \geq 0.4 \text{ HF1} + 0.4 \text{ LF1}$$

*Min. cream rqmt.
in cottage cheese*

$$0.8 \text{ C2} \geq 0.2 \text{ HF2} + 0.2 \text{ LF2}$$

MAX 1.1 P1 + 0.8 P2 - 0.4 HFE - 0.4 LFE - 0.4 LF - 0.8 HF

SUBJECT TO

- 2) $P1 - \text{HF1} - \text{LF1} - C1 = 0$
- 3) $P2 - 0.9 \text{ HF2} - 0.9 \text{ LF2} - 0.9 \text{ C2} = 0$
- 4) $P1 \geq 1000$
- 5) $P2 \geq 1000$
- 6) $\text{HFE} + \text{LFE} \leq 2000$
- 7) $\text{HF1} + \text{LF1} + C1 + \text{HF2} + \text{LF2} + C2 \leq 3000$
- 8) $-\text{HFE} + \text{HF} - \text{HF1} - \text{HF2} = 0$
- 9) $-\text{LFE} + \text{LF} - \text{LF1} - \text{LF2} = 0$
- 10) $-0.6 \text{ HFE} - 0.3 \text{ LFE} + C1 + C2 = 0$
- 11) $0.1 \text{ HF1} - 0.2 \text{ LF1} \geq 0$
- 12) $0.25 \text{ HF2} - 0.05 \text{ LF2} \geq 0$
- 13) $-0.4 \text{ HF1} - 0.4 \text{ LF1} + 0.6 \text{ C1} \geq 0$
- 14) $-0.2 \text{ HF2} - 0.2 \text{ LF2} + 0.8 \text{ C2} \geq 0$

END

SUB D1 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
2)	.000000	1.200000
3)	.000000	.859259
4)	.000000	-.100000
5)	.000000	-.059259
6)	962.962900	.000000
7)	888.888900	.000000
8)	.000000	-.800000
9)	.000000	-.400000
10)	.000000	2.000000
11)	.000000	-1.333334
12)	.000000	-1.333333
13)	.000000	-1.333334
14)	.000000	-1.533334

OBJ COEFFICIENT RANGES

VARIABLE	CURRENT COEF	ALLOWABLE INCREASE	ALLOWABLE DECREASE
P1	1.100000	.100000	INFINITY
P2	.800000	.059259	INFINITY
HFE	-.400000	.150000	.400000
LFE	-.400000	.200000	INFINITY
LF	-.400000	.080000	.400000
HF	-.800000	.093750	.400000
HF1	.000000	.250000	2.000000
LF1	.000000	.500001	.400000
C1	.000000	.250000	INFINITY
HF2	.000000	.400000	9.200002
LF2	.000000	.080000	.400000
C2	.000000	.266667	INFINITY

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	-159.259
2	.000	400.000
3	.833	740.741
4	.000	1000.000
5	.000	1000.000
6	1.667	962.963
7	.000	888.889
8	-1.500	1585.185
9	.833	940.741
10	-1.667	1037.037
11	.000	200.000
12	.167	148.148
13	.000	400.000
14	-1.000	222.222

