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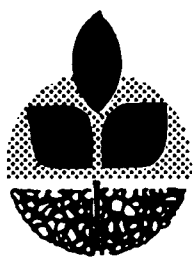
The Influence of Feed Costs and Milk Price on Forage Production on Coastal Dairy Farms



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ABSTRACT

Linear programming was applied to a simulated dairy farm operation typical for the north coast of Oregon to observe the selection of forage production methods and feed purchase activities necessary to maximize income when milk prices were $8 or $10 per hundred weight, 16 percent grain mixtures cost $130 or $160 per ton, alfalfa hay costs were $65, $75 or $95 per ton, and corn silage was $20 per ton. Green chop forage was selected during the forage growing season, and grass silage was selected during the winter season as the forms in which local forage should be utilized for maximum profit. Grain mixtures were selected at the minimum level to maintain milk production. Alfalfa was replaced by corn silage and a 41 percent protein concentrate except when alfalfa could be purchased for less than $75 per ton.

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THE INFLUENCE OF FEED COSTS AND MILK PRICE ON FORAGE PRODUCTION ON COASTAL DAIRY FARMS

Donald W. Claypool

INTRODUCTION

The comparative advantage of the north coastal area of Oregon for dairy farming historically has been its high forage production potential and its highly developed market outlet. In much of the area, dairymen can harvest forage soon after the first of April and continue harvest operations until the end of October. In the past, dairymen produced all their forage or purchased small amounts from neighboring farms. In more recent years, however, an increasing number of dairymen have purchased part or all their winter forage outside the area. Although these purchases have been mainly alfalfa, corn silage and corn cannery waste are in general use. Other cannery waste materials, ie. cauliflower and broccoli, have been purchased in limited amounts. Purchasing winter forage allows a dairyman to utilize all his forage producing potential during the forage harvesting season and thereby increase his herd size without acquiring more land. The demand for more local milk to supply the market, the scarcity and high cost of seasonal labor, the limited availability of land, the high cost of forage harvesting machinery, and the cost of purchased forage relative to that of locally produced forage are factors which have encouraged the purchase of forage from other areas. Since 1973, the price of forage and grain has been highly unstable. Under these conditions, it is appropriate to re-examine the cost of forage production practices to determine the combination of feed production and purchasing practices that will yield maximum income over several sets of price-cost conditions.

APPROACH TO THE PROBLEM

The financial and production records of seven dairymen in Tillamook County, Oregon, were examined in detail to determine production and cost coefficients. The dairymen were selected because of their utilization of locally produced forage and because each differed in his method of operation. Typical partial budgets for the dairy, pasture, green chop, and grass silage activities developed from the examination of these records appear in Appendix A. Cost and labor coefficients along with information on feeding values of forages, forage consumption, and yield were used to construct a linear programming model containing the activities and restraints described in Appendix B. The matrix of the linear program is presented in Appendix C. The program must operate within the confines of some model. The model dairy farm operation used here provided for a maximum of 100 acres of land with good forage producing potential. Pasture, green chop, and grass silage were considered as possible alternative methods of utilizing local forage. Hay was not considered as an alternative because average weather conditions in the area do not permit the harvest of hay throughout the forage growing season. Typically, the area gets less than 60 days of good hay making weather (See Appendix D, Probable Precipitation Table). In the model, two full-time people were available to manage and operate the dairy and limited hired labor was available. The facilities included a milking parlor and free loafing stalls. An upright silo with unloader and either a chain conveyor or tractor-with-bucket were available for silage storage and feeding. The cows were assumed to weigh an average of 1,250 pounds and produce an average of 14,000 pounds of milk with 3.7 percent fat. The

program was solved for maximum income using milk prices of $8 or $10 per hundred weight, in combination with grain costs of $130 or $160 per ton, alfalfa hay costs of $65, $75, or $95 per ton, and with or without the inclusion of a 41 percent protein supplement at a cost of $220 per ton. The above milk prices were chosen because they represent the low and high extremes of the range in milk prices paid to the dairymen for excess milk between October, 1973, and April, 1974, under federal ruling.

RESULTS OF THE LINEAR PROGRAMMING ANALYSIS

The six sets of assumptions on which the linear programming solutions were based are shown in Table 1. It appears that 127 cows are the optimum number to utilize the 100 acres of forage for maximum income except under the most favorable conditions. When the operation receives $10 per hundred weight for milk and can purchase a high quality grain mixture for $130 per ton (Set V), the increased consumption of the grain mixture indicated by the program allows for an increase in herd size to 138 cows.

When $10 per hundred weight was assumed as the price received for milk (Sets IV, V, VI) a sizeable income per cow above fixed costs was obtained even when the cost of grain was assumed to be $160 per ton. In marked contrast, an assumption of $8 per hundred weight (Sets I, II, and III) resulted in an income per cow above variable costs equal to or less than fixed costs. In the two sets of assumptions when income per cow was less than that of fixed costs, the assumed $10,000 annual income for the two full-time employees, which is included in the fixed costs, would be reduced by the amount of the difference. For example: Set I shows an

TABLE 1: INCOME PER COW AND PRODUCTION FACTORS AS INFLUENCED BY MILK PRICE AND FEED COST

Assumptions	Set I	Set II	Set III	Set IV	Set V	Set VI
Milk price	$8/cwt.	$8/cwt.	$8/cwt.	$10/cwt.	$10/cwt.	$10/cwt.
Variable costs:						
grain mixture	$130/ton	$130/ton	$160/ton	$160/ton	$130/ton	$160/ton
alfalfa hay	$ 75/ton	$ 75/ton	$ 75/ton	$ 75/ton	$ 75/ton	$ 65/ton
corn silage	$ 20/ton	$ 20/ton	$ 20/ton	$ 20/ton	$ 20/ton	$ 20/ton
41% protein supplement	--	$220/ton	$220/ton	$220/ton	$220/ton	$220/ton
Results						
Number of cows	127	127	127	127	138	127
Income per cow above variable costs	$291	$354	$324	$611	$643	$567
Income per cow[1] less total cost	-$ 62	$ 1	-$ 30	$258	$290	$214
Avg. feed intake per head per day - Apr. through Oct.						
pasture	20 lbs.	0 lbs.	0 lbs.	0 lbs.	0 lbs.	0 lbs.
green chop	163 lbs.	183 lbs.	183 lbs.	183 lbs.	180 lbs.	183 lbs.
grain mix	12 lbs.	12 lbs.	12 lbs.	12 lbs.	13 lbs.	12 lbs.
Avg. feed intake - Nov. through Mar.						
grass silage	40 lbs.	63 lbs.	63 lbs.	63 lbs.	60 lbs.	49 lbs.
corn silage	15 lbs.	50 lbs.	50 lbs.	50 lbs.	0 lbs.	24 lbs.
alfalfa hay	20 lbs.	0 lbs.	0 lbs.	0 lbs.	0 lbs.	18 lbs.
grain mix	5 lbs.	0 lbs.	0 lbs.	0 lbs.	20 lbs.	5 lbs.
41% protein concentrate	--	3 lbs.	3 lbs.	3 lbs.	1 lb.	0 lbs.
Acres of forage						
pasture	16 acres	0 acres	0 acres	0 acres	0 acres	0 acres
green chop	57 acres	64 acres	64 acres	64 acres	63 acres	64 acres
grass silage	27 acres	36 acres	36 acres	36 acres	37 acres	36 acres
Seasonal labor						
April & May	0 hrs.	0 hrs.	0 hrs.	0 hrs.	76 hrs.	0 hrs.
June,July,Aug.	304 hrs.	373 hrs.	373 hrs.	373 hrs.	450 hrs.	373 hrs.
Sept. & Oct.	[2]	0 hrs.	0 hrs.	0 hrs.	0 hrs.	0 hrs.

[1]Fixed costs include property tax other than cattle at 5%; interest on investment in land and buildings at a 7% rate, and $10,000 income to each of the two full-time employees.

[2]162 hours of the two full-time employees went unused during September and October.

income per cow, less fixed costs of -$60. Since there are 127 cows, total fixed costs exceeded income above variable costs for the entire operation by $7,620 (127 X $60). This deficit, shared equally by the two full-time employees, would result in income to each of $6,190. Obviously, price received for milk has a greater influence upon income of a dairy operation than any other factor. It is equally obvious that under the assumptions tested in this study an income based on a milk price of $8 per hundred weight will not cover all costs.

The differences in income within either the $8 per hundred weight or the $10 per hundred weight milk price assumptions are due primarily to differences in winter feed costs (November through March). The two largest differences occurred when a 41 percent protein supplement was added to the program as an alternate source of protein and when the price of grain was assumed to be $130 per ton at the same time the price paid for milk was assumed to be $10 per hundred weight. In the first instance, 3 pounds of 41 percent protein supplement plus an additional 23 pounds of grass silage and 35 pounds of corn silage replaced 5 pounds of the grain mixture and 15 pounds of alfalfa hay. Apparently high quality grass and corn silages are more economic sources of energy than is grain or alfalfa hay because grain and alfalfa hay were excluded from the ration when a 41 percent protein concentrate was available as an alternate source of protein. In the second instance, 20 pounds of grain replaced 50 pounds of corn silage and 2 pounds of protein concentrate. With the price of milk at $10 per hundred weight, it was more economical to increase the output of milk from the operation by adding 11 more cows and providing their energy needs in a more concentrated form - in grain instead of corn silage.

In all sets of assumptions, the 100 acres of forage were fully utilized to produce green chop and grass silage. Compared to green chop, pasture was not a significant source of forage because of its relatively low productivity.

Hired labor had a minor effect on income of the operation. It was used mainly in harvest of forage as silage.

APPLICATION OF RESULTS

These results apply only to the model described in the section, "Approach to the Problem". If the body weight of the cows, their level of production, or any other specification of the model is changed, the results change. Although the information presented in this study may not apply directly to any one farm situation, the following observations should be given serious consideration by all dairymen in the coastal area.

(1) Green chop forage was the primary source of forage from April through October for all combinations of milk prices and feed costs.

(2) Some form of concentrate feed (16 percent grain mixture or 41 percent protein supplement) must be fed to supply enough protein and energy to maintain production even with high quality forage.

(3) Alfalfa hay was included in the ration only in the absence of a concentrated protein source (41 percent protein supplement) or if its cost was favorable relative to grain ($65 vs. $130 per ton).

The fact that green chop was indicated in every combination of milk price and feed cost points to the importance of maximizing forage production. In this study, the per acre yield of energy from pasture and green chop was estimated at 3,690 mega calories and 6,820 mega calories, respectively.

The energy from one acre of pasture would be enough to maintain one cow per day throughout the forage growing period and enable her to produce 22 pounds of milk. The energy from one acre of green chop would be enough to maintain two cows per day and enable them to produce 36.6 pounds of milk. Assuming a milk price of $8 per hundred weight, green chop would earn $251 per acre more than pasture for the entire period. Production costs per acre for green chop were only $37 greater than for pasture.

The program specified that the cows should produce 14,000 pounds of milk, and that their daily dry matter consumption should not exceed, on the average, 3 percent of their body weight. To meet these specifications, a concentrated source of energy and protein must be fed in small to moderate amounts; otherwise, milk production would drop. For example, if the net price of milk is $8 per hundred weight and grain cost $160 per ton, a reduction in grain consumption equal to $1 savings in feed cost would result in a $2.51 reduction in income from milk. Obviously, it would be uneconomical to reduce the amount of grain below that necessary to maintain production. As cost of energy from grain increases relative to energy from forage, it becomes increasingly important to feed grain according to the needs of the cows. Cows that produce 14,000 pounds of milk per lactation will average 55 pounds per day during the first 100 days of their lactation. Fed high quality forage, they will need 16 pounds of grain per day to support this production. These same cows will average 37 pounds per day during the last 100 days of their lactation and require only 9 pounds of grain per day to meet their needs. If it is not desirable to feed individual cows according to their needs, the next best procedure is to

put cows in two or more groups according to their stage of production and feed each group differently.

Perhaps the most interesting result of this study is that alfalfa hay, unless it could be bought for $65 per ton, was not included in the rations when a source of protein concentrate was available. Alfalfa hay has cost coastal dairymen from $75 to $90 per ton delivered and at those prices, home-grown forages supplemented with a mixed grain or protein concentrate appear to be more economical. Although alfalfa hay is generally recognized as an excellent forage for dairy cattle, it should also be recognized that because of its high fiber content relative to grain (26-35 percent vs. 7-12 percent crude fiber), its value as a source of protein as well as energy is limited.

Summary

Linear programming was applied to a dairy farm model, which simulated operations on the north coast of Oregon, to observe the selection of forage production methods and feed purchase activities necessary to maximize income under several feed costs and milk price combinations. Forage alternatives considered in the program were pasture, green chop, grass silage, and alfalfa hay for the forage harvesting period and grass silage, alfalfa hay, and corn silage for the winter period. The model provided for a maximum of 100 acres of forage land, two full-time employees with limited seasonal labor, modern semi-automatic feeding facilities, and above average forage production potential. The cows in the model had a body weight of 1,250 pounds and produced an average of 14,000 pounds of milk which contained 3.7 percent fat.

If dairymen are receiving a net price of $8 per hundred weight for milk and are paying $75 per ton for alfalfa hay, $20 per ton for corn silage, and $130 per ton for a 16 percent crude protein grain mixture, maximum income for the model is obtained by milking 127 cows and utilizing home-grown forage as green chop and grass silage. The cows would receive an average of 12 pounds of grain and 183 pounds of green chop per day from April 1 to October 31. The rest of the year, they would receive an average of 5 pounds of grain, 20 pounds of alfalfa hay, 15 pounds of corn silage, and 50 pounds of grass silage. If a 41 percent protein supplement is available at $220 per ton, grain and alfalfa hay in the winter ration are replaced by 3 pounds of protein supplement and an additional 37 pounds of corn silage.

Return above variable costs under the above set of prices would be

$354 per cow. A fixed cost coefficient including property tax other than on cattle, depreciation at 5 percent, interest on investment at 7 percent, and management and labor cost at $10,000 per year for each of the two full-time employees should be subtracted from the above figure. This cost amounts to $353, leaving a net profit of $1 per cow.

If grain costs increase to $160, no change in the feeding program would occur, but a loss of $30 per cow per year would result. If net price of milk is increased from $8 to $10 per hundred weight, net profit per cow is increased to $258.

With milk at $10 and grain at $130 per ton, the maximum income was achieved by increasing the herd size to 138 cows and changing the winter feeding program to an average of 20 pounds of 16 percent grain, 1 pound of protein supplement, and 60 pounds of grass silage. Net profit per cow under these conditions was $290.

Alfalfa hay functions primarily as a source of protein and does not enter the program until the price is reduced to $65/ton, or when a 41 percent protein supplement is not available. At $65/ton, 18 pounds of alfalfa replace the protein supplement and part of the grain in the winter ration. The balance of the ration includes 27 pounds of corn silage, 49 pounds of grass silage, and 3 pounds of grain.

APPENDIX A

BUDGET FOR DAIRY COW--ONE COW[1]
1250 lb. cow, producing 14,000 lbs., 3.7% milk

Item	Quantity	Rate	$ Value
Income:			
sale of milk	141 cwt.	$ 7.66	$1080.06
sale of cull cows	0.212	$369.00	78.23
sale of calves			55.09
dividends & stock, TCCA[2]		TOTAL	28.57
			$1241.95
Costs:			
milk hauling			33.12
milk marketing fees			23.62
milking supplies			3.36
cow replacements			207.31
bedding			.38
breeding			13.59
vet & drugs			19.40
DHIA & other records			6.83
utilities			5.04
machine usage			17.38
taxes			4.50
insurance			1.55
miscellaneous (inc. interest)			12.82
TOTAL COSTS			$ 348.90
Return above non-feed costs			$ 893.05

Feed Requirements (567 kg B.W.; 6109 kg 4.0% milk)

	Maintenance	Milk	60 day-dry	Total
N.E. lact. (Mcal)[3]	2989	4521	774	8284
D.P. (kg)[4]	101.3	311.6	28.6	441.5
D.M. (kg) (3.0% B.W.)[5]				6209
D.M. (kg) from forage (≥ 60%)				3725

Labor (not including harvesting and feeding of forage)

(bi-monthly periods):	JF	MA	MJ	JA	SO	ND	TOTAL/YR.	PER COW
hrs.	803	754	662	662	662	803	4346	35.9

[1]This partial budget was developed from the records of one of the farms used in this study and is not intended to represent the average values used in the study.

[2]TCCA = Tillamook County Creamery Association.

[3]N.E. lact (Mcal) = net energy for lactation and maintenance expressed as mega calories.

[4]D.P. (kg) = digestible protein expressed as kilograms.

[5]D.M. (kg) (3.0% B.W.) = dry matter expressed as kilograms, with average consumption equivalent to 3% of the animal's body weight.

BUDGET FOR PASTURE--ONE ACRE

Item	Amount	Rate	$Value
Fertilizer	200 lbs.	$140/ton	$14.00
Machinery & Equipment			2.50
Fencing			1.50
Total Cost Shown			$18.00

Labor	JF	MA	MJ	JA	SO	ND	TOTAL/YR.	HRS./ACRE
hrs.	0	35	91	92	61	10	289	2.41

Nutrients Produced:

N.E. lact. (Mcal)	3672
D.P. (kg)	465
D.M. (kg)	2448

BUDGET FOR GRASS SILAGE--ONE ACRE

Items	$Value
Cost:	
Fertilizer	$14.00
Irrigation	13.12
Machinery: Silo plus harvesting & feeding equipment	61.00
Beet pulp	11.23
TOTAL COST	$99.35

Labor	JF	MA	MJ	JA	SO	ND	TOTAL	PER ACRE
production, harvest and feeding	44	27	320	4	4	44	443	9.6

Nutrients Produced:

N.E. lact. (Mcal)	5101
D.P. (kg)	204
D.M. (kg)	4081

BUDGET FOR GREEN CHOP--ONE ACRE

Item	$Value
Costs:	
Fertilizer	$21.00
Irrigation	34.40
Harvesting-machine & equipment	20.00
TOTAL COST	$75.40

Per day	JF	MA	MJ	JA	SO	ND	TOTAL/YR.	PER ACRE
Labor for production, harvest and feeding	0.35	1.02	1.90	2.21	1.70	0.57	468 hrs.	18.00
Nutrients produced								
N.E. lact. (Mcal	0	562.5	750	750	750	187	183,750	7,067
D.P. (kg)	0	76.2	101.6	101.6	101.6	25.4	24,892	958.4
D.M. (kg)	0	471.4	628.6	628.6	628.6	157.2	154,007	5,923

APPENDIX B. DESCRIPTION OF ACTIVITIES AND RESTRAINTS

PRODUCTION AND PURCHASE ACTIVITIES. The names enclosed in parentheses are used as headings of activity column of the matrix in Appendix C.

Dairy Activity (DAIRY) The dairy activity coefficients are based upon one 1,250 pound cow producing 14,000 pounds (6349 kilograms) of milk with a 3.7 percent fat test. Variable incidental costs included: milk hauling, milk marketing fees, milking supplies, cow replacement, bedding, breeding fees, veterinary service and drugs, DHIA fees, utilities, cost of equipment used in cleaning and hauling manure, taxes and insurance on the cow, building repair and maintenance, interest on investment in the cow at 8.5 percent, and miscellaneous expenses. These costs subtracted from gross income give the value found in the B row of the linear program matrix (see Appendix C) under the activity DAIRY. Gross income includes sale of milk, cull cows, sale of calves, and patronage dividends from Tillamook County Creamery Association. Values used in the B row are $718 and $1,000 for milk prices of $8 and $10 per hundred weight, respectively. Estimated labor required per year per cow was 36 hours. Labor requirements were determined in the partial budget for bi-monthly periods but coefficients used in the program were for four periods: November through March, April and May, June through August, and September and October. This was the case for all the activities described below.

Grain Purchase Activity (GRANPP-forage harvesting period, GRANPW-winter period) The purchase of grain was divided into two activities, as were all activities that were included in the feeding programs for the forage harvesting period and the winter period. The forage harvesting period activities extend from April 1 to October 30; the winter activity included

the remainder of the year. The grain activity was used in the program at two price levels, $130 and $160 per ton. The feed value of the grain was set at 850 kilo calories (kcal N.E. lact.) and 11 percent digestible protein (D.P.) per pound of dry matter. Such a grain mixture represents a very high quality dairy feed. This grain is slightly higher in energy than the minimum recommended for cows in full production (Nutrient Requirements of Domestic Animals Series, No. 3, National Academy of Science, Table 3).

Pasture Grazing Activity (PASTRH) The pasture grazing activity assumes an annual cost of $18 per acre. This included cost of fertilizer, use of machinery in spreading fertilizer and clipping pasture, and repair of fences. Total forage harvested per acre was estimated by first determining the total dry matter (D.M.) intake resulting from the consumption of grain and stored forage consumed during the year. This value was subtracted from the total possible D.M. intake of the herd, assuming daily D.M. intake equal to 3.0 percent of the cow's body weight. Estimated average pasture harvest was 13.5 tons per acre. Pasture was assigned a feed value of 680 kcal N.E. lact. and 11 percent digestible protein per pound of D.M. The dry matter of the pasture was assigned a value of 20 percent.

Green Chopped Forage Activity (CHOPH) The harvesting and feeding of fresh green chopped forage are an activity which assumes a cost of $75 per acre. This includes a cost of additional fertilizer above that used for pasture and an irrigation cost not included in pasture costs. Harvest began the first of April and continued to the end of October with an average labor requirement of 18 hours per acre-year. Annual yield was estimated at

45 tons of fresh forage per acre with a 14 percent dry matter (5714 kg-D.M.). Feed value was estimated from forage analyses of the one farm which practices season-long harvest at 540 kcal N.E. lact. and 11 percent digestible protein per pound of dry matter.

Annual labor requirement was estimated at 18 hours per acre.

Silage Activities (SILGHP-forage harvesting period, SILGHW-winter period) The silage harvest and feeding activity was assigned a cost of $100 per acre. This cost included interest on investment and depreciation of tower silos in addition to machinery costs for both harvest and feeding, irrigation, and fertilizer. All farms from which data were collected had tower silos and used silo unloaders. The methods used for distributing silage to the cows differed from farm to farm. These farms used beet pulp or molasses as a preservative and the cost of these materials was included in the per acre cost. Yield was estimated at 18 tons per acre of fresh forage averaging 25 percent D.M. Using results from local silage analyses as a basis, silage was assigned a feeding value of 567 kcal N.E. lact. per pound of silage D.M. with 5 percent D.P.

The amount of labor required for harvest and feeding was estimated at 9.6 hours per acre. This assumes that all harvesting operations were completed during May and June. The labor coefficients for the SILGHP activity and for the SILGHW are different because in the first activity silage is fed during the harvest season. In the second activity, it is fed in the winter period. This is the case in all activities that appear in both the pasture and winter periods.

Alfalfa Hay Purchase Activities (ALFAPP-feeding during forage harvesting period, ALFHAPA-feeding during winter period) The alfalfa purchase and

feeding activities were used in the linear program problem at costs of $65, $75, or $95 per ton. Table values for alfalfa in early bloom were used to assign a feeding value of 467 kcal N.E. lact. per pound of D.M. with 12 percent D.P. The D.M. content of the hay was estimated at 87 percent.

Corn Silage Purchase Activity (CRNSGPW) The corn silage purchase and feeding activity was given a cost value of $20 per ton. Feeding value of 772 kcal N.E. lact. per pound D.M. and 4.9 percent D.P. was assigned using table values.

Protein Supplement Purchase Activity (PROSW) The protein supplement purchase activity was added to the initial program after it was observed that protein was a limiting factor during the winter feeding period. A 41 percent crude protein supplement was made available at a cost of $220 per ton. An energy value of 1000 kcal N.E. lact. per pound was assigned to this feedstuff using table values.

Hired Labor Activities (HLBR1, HLBR2, HLBR3) Three hired labor activities were included in the problem. The two activities covering April-May and September-October are designated HLBR1 and HLBR3, respectively. Both periods provide for an average of one-third man day hired labor. The remaining activity, HLBR2, provides for an average of two-men days of hired labor for June, July, and August. Since school is not in session during this time, it is assumed that labor could be available. Hired labor is given a cost of $3 per hour.

RESTRAINT AND TRANSFER ROWS The names in parentheses are used as headings of rows of the matrix in Appendix C.

Forage Land (LAND) In this model, 100 acres was the maximum amount of forage land allowed. The restraint was set because essentially no land is available for enlargement of farms in the area. Farmers are forced to make the best use possible of the limited acreage available to them.

Labor (LBR0, LBR1, LBR2, LBR3) The restraints imposed in all four periods are based upon two men averaging a maximum of nine hours of work each day.

Cows (COW) This is a minimum restraint of at least 80 head of milking cows.

Net Energy (NELACP-forage harvesting period, NELACW-winter period) These are two transfer rows which associate the energy requirement of the cows with the energy available in the feeds. The energy is expressed in mega calories of net-energy for a lactating cow (Mcal, N.E. lact.) based upon the requirements of a 1,250 pound cow capable of producing 14,000 pounds of milk with an average fat content of 3.7 percent. This transfer row requires that the energy available in the feeds be equal to or greater than that required by the cows.

Digestible Protein (DPROP-forage harvesting period, DPROW-winter season) These are transfer rows which associate the digestible protein requirement of a cow with the digestible protein available in the feed. This row requires that the amount of digestible protein in the feeds be equal to or greater than that required by the cows.

Dry Matter From Grain (DMGRP-forage harvesting period, DMGRW-winter period) These are the transfer rows that associate the D.M. available in the grain with the upper consumption limits of a cow. Since it is not undesirable to

use grain in amounts greater than 60 percent of the total ration, these rows require that the grain purchase be equal to or less than 60 percent of the total D.M. consumed by the cows.

Dry Matter From Forage (DMFPL, DMFPH-forage harvesting period, DMFWL, DMFWH-winter period) These are transfer rows that relate D.M. consumption of a cow with the D.M. available in the forages. The DMFPL and DMFWL lines designate a minimum of 40 percent of the ration D.M. must be from forage. The DMFPH and DMFWH lines limit the forage intake to no more than 66 percent of the D.M. of the ration.

APPENDIX C

Resources and Restraints	ROWS	RHS	UNITS	Activities for Pasture Feeding Season GRANPP (ton)	PASTRH (acre)	CHOPH (acre)	SILGHP (acre)
	$OBJF	"B"	$	-160(1) -130	- 18	- 55	- 100
Forage land	LAND	≤ 100	acres		1	1	1
Labor: Nov., Dec., Jan., Feb., Mar.	LBR1	≤2550	hours		0.1	3.4	0.0
Labor: Apr., May	LBR1	≤1100	hours		0.4	3.7	4.3
Labor: Ju., Jy., Aug.	LBR2	≤1560	hours		2.2	7.8	11.5
Labor: Sept., Oct.	LBR3	≤1100	hours		0.4	3.9	0.6
Dairy cows	COWS	≥ 80	head				
NE lact., pasture season	NELACP	≤ 0	Mcal.	-1700	-3690	-6820	-5100
D. Prot., pasture season	DPROP	≤ 0	kg.	- 85.0	- 268	- 626	- 204
D.M.,fm. grain,pasture season	DMGRP	≥ 0	kg.	- 817			
D.M.,fm. forage,pasture season	DMFPL	≤ 0	kg.		-2460	-5714	-4085
D.M.,fm. forage,pasture season	DMFPN	≥ 0	kg.		-2460	-5714	-4085
Hired labor: Apr., May	HBR1	≤ 360	hours				
Hired labor: June,July,Aug.	HBR2	≤1560	hours				
Hired labor: Sept., Oct.	HBR3	≤ 360	hours				
NE lact., winter season	NELACW	≤ 0	Mcal.				
D. Prot., winter season	DPROW	≤ 0	kg.				
D.M.,fm. grain,winter season	DMGRW	≥ 0	kg.				
D.M.,fm. forage,winter season	DMFWL	≤ 0	kg.				
D.M.,fm. forage,winter season	DMFWH	≥ 0	kg.				

(1) Grain purchased: two prices will be applied to the problem: $160, $130.

(2) Alfalfa: hay purchased: three prices will be applied to the problem: alfalfa, $95,$75,$6

(3) Price of milk: two prices will be applied: $10/cwt., $8/cwt.

APPENDIX C (continued)

					Activities for Winter Feeding Season				
ALFHAP (ton)	DAIRY (cow)	HLBR1 (hrs)	HLBR2 (hrs)	HLBR3 (hrs)	GRANPW (ton)	ALFHAPW (ton)	CRNSGW (ton)	SILGHW (ton)	PROSW (ton)
- 95(2)	1000(3)				- 160(1)	- 95(2)			
- 75	718				- 130	- 75			
- 65		-3	-3	-3		- 65	- 20	- 100	- 220
								1	
0.84	16.3					0.84	0.40	1.43	
0.59	5.8	-1				0.25		3.90	
0.80	8.3		-1			0.29		10.60	
0.41	5.5			-1		0.07		-	
	1								
-1097	4840								
- 81.6	257.5								
	2171								
- 785	1445								
- 785	2370								
		1							
			1						
				1					
	3444				-1700	-1097	-386	-5100	-2000
	184.0				- 85.0	- 81.6	- 11	- 204	- 372
	1540				- 817				- 817
	1028					- 785	- 227	-4085	
	1700					- 785	- 227	-4085	

APPENDIX D

PRECIPITATION: AVERAGE TOTAL AND PER CENT PROBABILITY OF SELECTED AMOUNTS FOR WEEKLY PERIODS FROM 1931 TO 1960

PERIOD BEGINS	MEAN PCPN	PROB O-T	0.06	0.10	0.20	0.40	0.60	0.80	1.00	1.40	2.00
Mar 01	1.83	3	95	94	91	84	78	71	65	54	40
Mar 08	2.13	3	96	95	92	86	79	72	66	54	39
Mar 15	1.86	3	97	96	93	86	79	72	65	53	38
Mar 22	2.03	1	98	97	94	87	80	72	66	53	38
Mar 29	1.98	2	97	96	93	85	77	69	62	49	34
Apr 05	1.24	4	93	91	86	76	67	59	52	40	26
Apr 12	1.48	5	90	87	80	69	59	51	44	33	22
Apr 19	1.01	4	90	86	78	66	55	47	40	29	18
Apr 26	1.10	2	91	87	78	63	52	43	35	24	14
May 03	.74	2	89	84	73	57	45	36	29	18	10
May 10	.68	4	86	81	71	54	42	33	26	16	8
May 17	.88	6	86	81	70	54	41	32	25	16	8
May 24	.50	9	84	80	69	51	37	28	20	11	5
May 31	.63	12	83	79	69	52	39	29	21	12	5
Jun 07	.75	12	84	80	72	57	45	35	27	17	8
Jun 14	.87	12	83	79	71	57	46	36	29	18	9
Jun 21	.61	9	80	75	64	48	37	29	22	13	6
Jun 28	.46	8	77	71	57	39	27	19	14	7	3
Jul 05	.35	17	70	64	50	32	21	14	9	4	1
Jul 12	.31	26	60	54	42	26	16	10	7	3	1
Jul 19	.21	28	55	48	35	20	12	8	5	2	
Jul 26	.22	24	56	48	36	21	13	8	5	2	
Aug 02	.32	18	59	51	37	22	14	9	6	3	1
Aug 09	.19	17	59	50	35	18	10	6	3	1	
Aug 16	.20	18	63	55	41	24	15	10	7	4	1
Aug 23	.63	17	71	65	54	39	29	21	16	9	4
Aug 30	.57	18	71	66	57	43	33	25	19	12	6
Sep 06	.53	20	70	66	57	43	33	26	20	13	6
Sep 13	.76	17	73	68	59	45	35	28	22	14	8
Sep 20	.54	13	74	69	60	46	36	29	23	16	9
Sep 27	.92	13	79	75	67	55	46	39	33	24	15
Oct 04	1.53	8	88	85	79	69	60	52	45	34	22
Oct 11	1.20	5	93	91	86	76	67	59	51	39	26
Oct 18	2.08	4	94	93	89	81	73	66	59	48	35
Oct 25	2.23	6	93	92	89	84	78	72	66	55	41
Nov 01	1.93	10	89	89	88	84	79	74	69	58	44
Nov 08	2.59	8	92	91	90	86	81	76	71	61	48
Nov 15	2.79	6	93	92	90	85	79	74	70	60	49
Nov 22	2.48	8	91	90	88	83	78	73	68	60	48
Nov 29	2.65	4	95	95	93	88	83	78	73	63	50
Dec 06	2.55	1	99	98	96	91	86	80	75	64	50
Dec 13	2.67	2	98	97	96	91	87	81	76	66	52
Dec 20	2.87	1	99	99	97	94	90	85	81	71	56
Dec 27	2.96	1	99	99	97	94	90	85	80	71	57
Jan 03	2.77	2	98	97	95	91	86	81	76	67	54
Jan 10	2.71	2	98	97	95	91	86	81	76	66	53
Jan 17	2.93	2	98	97	95	90	85	80	75	65	51
Jan 24	2.20	1	98	97	94	88	82	76	70	60	47
Jan 31	2.61	1	98	97	94	89	84	78	73	63	50
Feb 07	2.93	3	96	96	94	91	87	83	78	69	55
Feb 14	2.32	5	95	94	93	89	84	80	75	65	51
Feb 21	2.71	4	95	94	91	85	80	74	68	58	45

SILAGE MAKING AND GREEN CHOP

HAY MAKING