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Alternative production systems for beef cows on a forage farm and a grain farm in Iowa

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INTRODUCTION

The production of feeder cattle is an important and growing segment of Iowa agriculture. Iowa ranks seventh among the states in beef cow numbers with 1.8 million head or 4.4 percent of the national herd on January 1, 1973. In 15 years, from 1958 to 1973, beef cow numbers in Iowa have doubled (10). Per capita consumption of beef and veal in the United States has increased from 91.4 pounds in 1955 to 118.4 pounds in 1972, and is expected to rise to 130 pounds by 1980. A United States Department of Agriculture study (36) projects that this level of demand will require an increase in the size of the national beef cow herd from the present 41.1 million head to 46.3 million head by 1980.

The rate of increase in cow numbers is expected to be greatest in the more humid regions of the country such as the eastern part of the Northern plains, the Southeast, and the southern and western Corn Belt. The traditional feeder calf producing regions of the West and Southwest will be limited in their future expansion by their ability to produce more feed. Iowa, as well as the other states in the more humid areas mentioned above, has undeveloped forage production potential which could be utilized by beef cows. Wedin (42) estimates that beef cow numbers in Iowa could be almost doubled with more complete utilization of feed from existing improved and unimproved pasture and hay land. Forage production technology is available which would allow expansion of beef cow numbers to three or four times their present level on the same acreage.

Worden (44) found that feed costs accounted for 61.2 percent of total costs in a study of 19 beef cow enterprises in southern Iowa. Costs of growing, harvesting, storing, and feeding, or pasturing forages made up 91.2 percent of feed costs or 55.8 percent of total costs. The cost of forage production is an important factor in determining the competitive position of feeder calf production on Iowa farms, and in determining the degree to which the potential for expansion of cow numbers in the state is realized.

A trend towards larger beef cow herds is indicated by comparison of herd size distribution in 1966 and 1970, as shown in Table 1. However, the industry in Iowa is dominated by relatively small producers, and this situation is expected to continue. For this reason it is important to study the feeder calf producing enterprise as part of a whole farm operation, and not as an isolated activity.

The objectives of this study were based on the relative importance of forage production and feeding costs in feeder calf production. These objectives were:

1. To collect and present costs and resource requirements for alternative forage growing, harvesting, and feeding systems.
2. To determine the combination of feeder calf and forage production which is part of the optimum farm plan under various Iowa farm resource situations at different cattle price levels.

TABLE 1. Size distribution of beef cow herds in Iowa[a]

Number of cows per herd	Less than 10		10 to 19		20 to 29		30 to 49		50 to 99		100 or more	
	Percent of those farms reporting cows								(Percent of total cows)			
1966	25.8	(6.8)	33.9	(23.7)	20.9	(24.5)	14.1	(25.9)	4.6	(14.6)	.7	(4.5)
1970	19.2	(4.2)	30.6	(17.6)	22.3	(21.4)	18.6	(27.8)	8.0	(20.7)	1.3	(8.3)

[a]Source: Iowa Crop and Livestock Reporting Service, Iowa Department of Agriculture (20).

PROCEDURE FOR ANALYSIS

The roles of feeder calf and forage production in the optimum organization of Iowa farms were explored in this study. Linear programming models were applied to two hypothetical farms. One had a large acreage restricted to forage production by soil conservation guidelines, and the second had a high proportion of land capable of continuous row crop production. Linear programming allowed examination of the feeder calf producing enterprise within the framework of a complete set of competitive and complementary crop and livestock enterprises. This is particularly relevant because feeder calf production in Iowa is most commonly a part of a general farming operation. The mathematics of linear programming and its economic interpretations are discussed by Heady and Candler (16). Its application to farm planning and mechanics of model building are presented by Beneke and Winterboer (5). These topics will not be discussed here.

Major emphasis in this study was placed on the feeding program for the beef cow herd. The requirements of the cow herd for energy, in pounds of total digestible nutrients (TDN), and crude protein were defined on a monthly basis. These requirements could be satisfied by a combination of grazing and harvested forage feeding activities which, in turn, supplied TDN and crude protein on a month by month basis.

An important aspect of building a forage system for the beef cow herd is the selection of a combination of forage harvesting equipment. Because linear programming cannot tie a variable level of machine use to a single valued fixed cost for the machine within the model framework, it

is not practical to select the optimum forage harvesting equipment combination with a single solution. Instead, separate solutions were run with different combinations of owned and custom operated forage harvesting equipment assumed, and the fixed costs were subtracted from the resulting program values.

Complete sets of solutions were run both with and without cattle feeding activities to explore the relationship of the beef cow herd to the cattle feeding enterprise. These two enterprises compete for some resources such as labor and some types of feed. However, the possibility of a supplementary relationship exists in the spreading of forage harvesting equipment fixed costs, the ability of the cow herd to utilize crop residues remaining after harvest of feed for the feedlot cattle, and the elimination of the cost of inter-farm transfer of feeder calves.

The collection of input-output and cost coefficients required a major share of the time expended in this study. This information was gathered from many sources which will be cited as they are encountered in the description of the model farms. As much of this information as was considered practical to include is presented to aid the reader in interpreting the results.

THE MODEL FARMS

The two model farms used in this study represent two distinctly different resource combinations. The first is the type of farm normally associated with feeder calf production because a high proportion of the land must be in forage production. The second represents a grain producing farm with a high percentage of land capable of continuous row crop production. Throughout the rest of this discussion they are referred to as the forage farm and the grain farm for the purpose of identification.

The model farms were assumed to be in the same area and were differentiated by varying proportions of the same soils. This simplified model building and aided in comparison of the results by eliminating the variables associated with climate and soils.

Resources

Land

The model farms were assumed to be located in the Otley-Mahaska-Taintor and Clinton-Keswick-Lindley soil association areas of southeastern Iowa. Four land classes were defined based on the characteristics of common soils of this area. The land classes and example soils from each class are shown in Table 2.

The following land use restrictions were based on guidelines developed by the Soil Conservation Service (35) and Oschwald et al. (28):

Class I. Continuous row cropping was allowed. Only one-half of this acreage could be planted to soybeans. Fall plowing of row crop residues was allowed.

Class II. One-half could be in row crops of which one-half could be in soybeans. This land had to be rotated so that row crops were not grown more than three consecutive years on the same field. Fall plowing of row crop residues was not allowed.

Class III. Row crops could be grown a maximum of one year in six. Soybeans and corn silage were not produced. Fall plowing of row crop residue was not allowed.

Class IV. Only unimproved permanent pasture was allowed.

Row crops included corn, soybeans, forage sorghum, and sorghum-sudangrass.

The model farms were assumed to be of equal total land value rather than equal acreage to allow comparison of results. Each land class was assigned the average of the corn suitability ratings (CSR) of the example soils in the class as noted in Table 2. The corn suitability rating system, which provides an index for ranking soils by their potential for row crop production, is discussed by Fenton et al. (9). Keokuk County, which is centrally located in these soil association areas, was used as a point of reference because its recent Soil Survey (35) was used as a source of soil information. The average farm land value for Keokuk County in November, 1972, was reported to be $363.00 per acre by Murray, Walker and Pritchard (26). The value for each land class shown in Table 2 was estimated by weighting this average land value by the average CSR for the land class.

TABLE 2. Land classes and example soils[a]

Land Class	Example soils	Slope %	CSR[b]	Average CSR (class)	Per Acre Yield Levels Corn (bu.)	Soybeans (bu.)	Hay (T.)	Assumed value per acre[c]
I	Mahaska silty clay loam	1- 3	95	91	120	45	5.0	$661
	Taintor silty clay loam	0- 3	88					
	Otley silty clay loam	2- 5	90					
II	Clinton silt loam, moderately eroded	5- 9	60	65	100	37	4.4	472
	Ladoga silt loam, moderately eroded	5- 9	65					
	Otley silty clay loam, moderately eroded	5- 9	70					
III	Adair clay loam, moderately eroded	9-14	15	40	80		3.2	290
	Clinton silt loam, moderately eroded	9-14	50					
	Ladoga silt loam, moderately eroded	9-14	55					
IV	Adair clay loam, severely eroded	9-14	5	13			2.0	94
	Keswick loam, moderately to severely eroded	9-14	5					
	Lindley loam, moderately eroded	14-18	28					

[a]Sources: Fenton, Duncan, Shrader and Dumenil (9), Oschwald, Riecken, Dideriksen, Scholtes and Schaller (28), Murray, Walker and Pritchard (26) and U.S. Dept. of Agric., Soil Cons. Serv. (35).

[b]Corn suitability rating from Fenton et al. (9).

[c]Assumed value per acre for each land class was determined from the average land value for Keokuk County, Iowa, November 1, 1972 (26) weighted by Corn Suitability Rating of the example soils in the class.

The grain farm was a 400 acre farm with 80%, 10%, 8%, and 2%, of its acreage in Classes I, II, III, and IV, respectively. The forage farm was determined to be 655 acres with 15%, 25%, 48%, and 12%, of its land in Classes I through IV, respectively. Ten acres of each farm were assumed to be in buildings, lots, and roads. Table 3 presents the land values of the model farms and the breakdown of the annual fixed land charge which was used in the analysis of the program values.

Labor

Labor availability on the model farms is summarized in Table 4. Two alternative labor situations were programmed. In the first set of solutions, labor was furnished by the operator with hourly part-time labor available during the cropping season. Additional solutions were run at the higher cattle price levels with a full-time employee added to the fixed labor supply. The cost of hourly part-time labor was $2.50 per hour. The full-time employee's salary, when included, was $6,000 and was subtracted from the value of the program as a fixed cost. The opportunity cost of operator labor also was assumed to be $6,000 per year.

The operator was assumed to be willing to work twelve hours per day on days suitable for fieldwork and eight hours per day on days unsuitable for fieldwork during the crop season and through the winter (December through February). The workday was increased to ten hours for days unsuitable for fieldwork in April and September to allow for the higher labor requirements of spring and fall calving and farrowing. A nine hour workday was assumed for March to allow for extra labor for spring farrowing. It was assumed that most farm operators would be

TABLE 3. Land value of model farms and associated land charge

A. Weighted per acre land values

Land Class	Assumed Value per Acre	Grain Farm % of Farm	Grain Farm Contribution to Land Value	Forage Farm % of Farm	Forage Farm Contribution to Land Value
I	$661	80	$528.80	15	$ 99.15
II	472	10	47.20	25	118.00
III	290	8	23.20	48	139.20
IV	94	2	1.88	12	11.28
Per Acre Farm Value			$601.08		$367.63

B. Whole farm value

1.	Grain farm 400 acres x $601.08 per acre	=	$240,432
2.	Forage farm 655 acres x $367.63 per acre	=	$240,798
3.	Average farm value		$240,615

C. Land charge

1.	Real estate tax		
	Farm value	$240,615.00	
	x Assessment: sales ratio[a]	.225	
	Assessed value	54,138.00	
	x Net millage[a]	80.9	
	Real estate tax		$4,380.00
2.	Return on investment		
	Farm value	$240,615.00	
	x Assumed fair rate of return on land	5.5%	
	Return on investment		13,239.00
3.	Total land charge		$17,619.00
4.	Land charge per acre		
	Grain farm $ 17,619 ÷ 400 =		$44.05[b]
	Forage farm $ 17,619 ÷ 655 =		$26.90[b]

[a]Assessment: sales ratio for improved rural real estate and net millage rate for Keokuk County, Iowa, James (22).

[b]Total land charge equals 7.3% of land value. A 1971 survey of cash rental rates in Iowa reported average gross rents of 6.4% of land value for farms valued from $600 to $699 per acre and 8.0% of land value for farms valued from $300 to $399 per acre, Howell (17).

TABLE 4. Labor availability on the model farms

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						(hours)						
Operator labor available	215	215	241	294	279	289	299	299	302	290	292	215
Full time employee labor (when included)	215	215	215	265	265	215	215	215	265	265	265	215
Maximum hourly part-time labor available				112	80	193	205	205	89	94	96	
Overhead labor requirements:												
Forage farm	50	63	71	83	77	75	65	103	104	76	52	61
Grain farm	52	64	70	85	82	79	70	97	103	83	55	60
Days suitable for fieldwork[a]				13.8	16.1	18.2	21.0	21.0	17.8	18.7	19.2	

[a]Source: "Background information for use with Crop-Opt System" (3); assumes a six-day work week.

willing to work extra hours during these periods to take care of their livestock. A six day work week was assumed.

The full-time employee, when included, was assumed to work ten hours per day in April, May, September, October, and November, and eight hours per day the remainder of the year. Part-time hourly labor was assumed to be utilized mainly for fieldwork and was basically limited to five hours per day suitable for fieldwork. However, an additional ten hours per week was allowed during April to assist with calving, and an additional 100 hours per month was allowed in June, July, and August for hay harvest.

Overhead labor requirements for the model farms were adapted from James and Trede (23) and subtracted from the labor available.

Machinery and equipment

Machinery and equipment costs are presented in Appendix A. Both model farms were assumed to have the same basic set of machinery including: two tractors, tillage equipment, four-row planting and cultivating equipment adequate to handle the cropping activities up to harvest, and common materials handling equipment. Fixed costs for this basic set of machinery are presented in Table A.1 for the forage farm and Table A.2 for the grain farm. The estimated lives of the row crop equipment are shorter on the grain farm because a larger acreage is suitable for row crop production. Therefore depreciation and total annual fixed costs are higher. Operating costs for the basic machinery are presented in Tables A.3 and A.4. Per unit operating costs are assumed to be the same for both farms.

Solutions involving several different forage harvesting equipment combinations were run for each farm situation; this aspect of the study will be more fully discussed in another section. Forage equipment costs are presented in Tables A.5, A.6, and A.7. Grain harvesting, corn drying, and fertilizer application were assumed to be custom hired at the rates presented in Table A.8.

Machinery operating costs were included in the computation of the net prices (gross income less variable costs) of the crop and livestock production activities. Fixed ownership costs were subtracted from the value of the program.

Crop storage and livestock facilities

The initial investment and annual costs per unit for facilities and related equipment for livestock production and for grain and baled hay storage facilities are presented in Table 5. The average annual cost per unit for livestock and crop storage activities was assumed to be the same, regardless of the level of the activity. The only exception to this was silage storage which will be discussed in more detail later. The initial investment in facilities for the livestock production activities included housing, feeding equipment, and handling facilities. In the case of the spring calving beef cow, no investment for shelter was assumed and the facility costs are for the corral and handling equipment plus some simple feeding equipment such as bunks for silage. Initial investment and fixed costs are increased for the fall calving beef cow activity to allow for shelter for the calves and for creep feeders. Low cost confinement facilities were assumed for the swine production

TABLE 5. Initial investment and annual costs of facilities for crop storage and livestock production activities[a]

Livestock activity or crop stored	Unit	Initial investment	Annual costs
Beef cow-spring calving	Cow-calf unit	$ 20.00	$ 3.60
Beef cow-fall calving[b]	Cow-calf unit	44.50	6.89
Hogs	Sow and two litters	405.00	62.15
Cattle feeding	One head	69.31	9.57
Soybeans or corn grain	Bushel	.45	.059
Baled hay	Ton	15.00	1.95

[a]Sources: James (22), Farm Planning and Financial Management (8), Howell and Stoneberg (18).

[b]In addition to equipment required for the cow-calf unit under the spring calving system, the fall calving activity assumes investment in a creep feeder and shelter for the calves.

activities. Cattle feeding facilities included an open lot with fenceline bunks and an open front pole shed for shelter. Feed storage facility costs are generally tied to the crop production activities in the model. Initial investment and annual costs per unit for grain and baled hay storage are included in Table 5. Annual costs were calculated as a percentage of initial investment according to the schedule shown in Table 6.

Because economies of scale are an important factor in the initial investment and annual costs of silos, and because costs for a range of silo sizes were available, a method to deal with the decreasing average

cost of silage storage was adapted from Stoecker (31). The initial investments for the various silo sizes presented in Silage Production and Use (29) were regressed on their capacities to obtain linear equations of the form $Y = a + bX$, where Y equals initial investment and X equals silo capacity in tons, for both concrete stave and bunker silos for the various types of silage considered in the model. The coefficients from

TABLE 6. Annual costs associated with crop storage and livestock production facilities as a percentage of initial investment[a]

Facilities	Annual Costs				
	Depreciation	Interest on investment	Repair & maintainence	Taxes & Insurance	Total
	Percent of Initial Investment				
Buildings, fences, grain bins, concrete stave silos	6.7	4.0	1.3	1.0	13.0
Bunker silos	10.0	4.0	1.5	.5	16.0
Equipment: feeders, waterers, silo unloaders	10.0	4.0	3.0	1.0	18.0

[a]Sources: James (22) and Silage Production and Use (29).

these linear regression equations are presented in Table 7. The annual cost percentages shown in Table 6 were applied to these figures to obtain the annual cost coefficients which are also presented in Table 7. The annual cost per ton was included in the net price of the silage production model, while the constant portion of silo annual cost was subtracted from the value of the program in the same manner as machinery and equipment

fixed costs. It was assumed that separate concrete stave silos, would be built for haylage and corn silage. Therefore, if both haylage and corn silage stored in a concrete stave silo entered a solution, the constant cost portion of the annual costs for two concrete stave silos was subtracted from the value of the program. Where a bunker silo was utilized, it was assumed that any combination of corn silage, forage sorghum silage, and cornstalk silage could be stored in the same silo.

TABLE 7. Silo initial investment and annual costs[a]

Type of silo and crop	Initial Investment		Annual Cost	
	a (Constant portion)	b (Investment per ton)	Constant portion	Cost per ton
Concrete stave silo plus unloader:				
Corn silage	$3658.72	$11.296	$558.25	$1.504
Haylage	3664.93	16.128	558.25	2.147
Bunker silo:				
Corn or forage sorghum silage	1207.18	4.399	193.15	.704
Cornstalk silage (stalklage)	1209.17	12.565	193.47	2.104

[a]Source: Silage Production and Use (29).

Capital

No restriction was placed on the amount of capital used on the model farms and no breakdown between equity and borrowed capital was assumed. In the determination of return to operator labor and management, a 5.5 percent charge was made against the value of the land. An eight percent return was charged against all other capital used in the model including the average value of machinery, equipment, and facilities, the average inventory value of breeding livestock, the value of the calves at the beginning of the feeding period, and short term operating capital. Short term operating capital includes purchased feed, seed, fertilizer, machinery operating costs, veterinary and other livestock expenses, and wages for hired labor. Interest was not charged against the investment represented in home-raised feed and young livestock. Short term operating capital was assumed to turn over in about one-half a year; therefore, only one-half of the annual interest rate or four percent was charged against it. Interest charges were included in the model activities whenever possible. Interest related to the investment in land and machinery and equipment, which was assumed for each solution, had to be subtracted from the value of the program after optimization, as were taxes, depreciation, and other fixed costs associated with those assets.

Cropping Activities

Crop activity costs, resource requirements, and yields are presented in Appendix B. A number of crop alternatives were included in the model for each land class except Class IV which was restricted to unimproved permanent pasture. The optimum cropping program was selected within the bounds of the previously stated land use restrictions. Crop activities were not set up as rotations although the final solutions could be interpreted as rotations.

Corn grain and soybeans were the only crops which could be grown for direct sale. All other crop activities produced forages which could only be utilized by the beef cow herd or the cattle feeding enterprise. Conversely, corn grain was the only feed which could be purchased, except for supplements, salt, and minerals; all forages required by the cattle enterprises had to be produced on the farm.

Plowing was separated from the crop production activities and fall plowing was allowed on Class I land. Timing of plowing was assumed not to affect crop yields; its major importance was its influence on labor distribution. The question of fall versus spring plowing was considered important in this study because fall plowing eliminates corn grain harvest residues as a possible winter feed source for the beef cow herd unless they are harvested. Soybean residue was assumed to be disked rather than plowed.

The alternative forage growing activities will be discussed in a later section.

Livestock Activities

Feeder calf production

Two feeder calf producing activities, spring calving and fall calving, were included in the model. Costs and resource requirements of these activities are presented in Tables D.1 through D.4.

In the spring calving activity the average birthdate of the calves was assumed to be April 15. A 90 percent calf crop was assumed. Calves were weaned at an average age of 195 days with steers weighing 450 pounds and heifers weighing 420 pounds (470 pounds and 440 pounds, respectively, on a 205 day basis). Creep feeding activities were included which could supplement the forage supply in late summer and fall (July through October) if it were profitable. From each cow-calf unit an average of .45 steer calf and .28 heifer calf were sold or placed in the feedlot, .15 cow was culled and sold, and .17 heifer was retained in the herd as a replacement.

The average birthdate of fall calves was assumed to be September 15. Fall calves were weaned on April 1 at an average of 195 days. Calf crop percentage and weaning weights were assumed to be the same as in the spring calving activity. Creep feeding (10.1 bushels of corn grain per cow calf unit) and shelter were assumed for the fall calves.

Cattle feeding

Costs and resource requirements of the cattle feeding activities included in the model are presented in Tables D.5 through D.8. Cattle feeding activities were arranged to accommodate the calves produced by the beef cow herd, and to utilize feeds which could be produced with the

same forage harvesting equipment required by the feeding program for the beef cow herd. Similar calves could be purchased and fed with the home-raised calves. Cattle were fed in an open lot with fenceline bunks and an open front shed for shelter. A maximum of 500 head could be fed in any solution.

Four alternative feeding activities, representing four different feeding programs, were included for both spring and fall steer and heifer calves, for a total of 16 possible activities. The number of activities which were competitive in any solution was limited by the forage harvesting equipment combination which was assumed. The alternative feeding programs for both steers and heifers are presented in Table D.5. They were assumed to allow equal rates of gain. Steers were assumed to gain an average of 2.4 pounds per day and to reach 1050 pounds after 250 days on feed. Heifers were assumed to gain an average of 2.1 pounds per day and to be marketed at 880 pounds after 219 days on feed.

The elimination of the cost of interfarm transfer of feeder calves represents a source of savings for the farmer who feeds out his own calves. A total of seven percent shrink was assumed for calves which were sold, with two percent accruing to the calf producer and five percent to the feeder. Therefore, the calf producer faces the alternatives of placing a home-raised 450 pound steer calf in his own feedlot, or being paid for 441 pounds of calf if he sells. He would have to pay for 474 pounds of calf to place a similar 450 pound purchased calf in his lot. In addition, total marketing and transportation costs of one dollar per hundredweight were assumed for feeder calves. The difference between

the opportunity cost of home-raised calves and the cost of purchased calves averaged $17.28 for steers and $14.92 for heifers in this model. No differences in veterinary or feedlot mortality rates (1.5%) were assumed although these could potentially add to the advantage of home-raised calves.

Swine

Two swine production activities were included in the model: a winter-summer activity with farrowings in December and June and a spring-fall activity with farrowings in March and September. These activities are described in Tables D.9 through D.12. Hogs were produced in partial confinement facilities. A limit of ten sows per activity for a total of 40 litters was established to prevent swine from dominating the solutions.

Prices

Solutions were run for three cattle price levels which were felt to be representative of the normal range of cattle prices. Prices for various classes of cattle were based on the prices selected for 1050 pound choice steers: $26, $32, and $38 per hundredweight. The relationships of the prices of heifers, steer and heifer calves, and cull cows, to the fed steer prices were based on the average relationships of these prices for the months relevant to the model for the years 1957-58 to 1971-72, as shown in Table 8.

With constant feeding costs, the break even margin between feeder cattle and fed cattle prices increases as the general cattle price level rises. Therefore, the margins used in this study were adjusted to absorb

TABLE 8. Selected cattle prices, Omaha, 1957-58 to 1971-72[a]

Year	450 lb. choice steer calves Oct.	1050 lb. choice steers July	Fed steer - steer calf price margin	420 lb. choice heifer calves Oct.	880 lb. choice heifers June	Fed heifer - heifer calf price margin	Cows, commercial Nov.
	Dollars per 100 pounds						
1957-58	25.25	26.75	+1.50	22.00	26.98	+4.98	15.25
1958-59	35.75	27.75	-8.00	33.00	27.78	-5.22	19.25
1959-60	33.25	25.08	-8.17	30.50	25.75	-4.75	15.82
1960-61	26.50	22.22	-4.28	24.25	22.65	-1.60	15.50
1961-62	28.40	25.45	-2.95	26.30	25.08	-1.22	15.75
1962-63	31.00	25.08	-5.92	27.75	22.35	-5.40	16.25
1963-64	29.00	22.75	-6.25	26.50	19.95	-6.55	14.58
1964-65	24.00	25.95	+1.95	21.75	26.25	+4.50	13.02
1965-66	27.50	25.02	-2.48	24.75	24.58	- .17	14.90
1966-67	30.25	26.18	-4.07	28.00	25.05	-2.95	14.85
1967-68	30.50	27.38	-3.12	26.25	25.75	- .50	15.22
1968-69	30.25	32.15	+1.90	27.00	33.05	+6.05	17.20
1969-70	35.25	31.22	-4.03	32.00	29.60	-2.40	19.18
1970-71	38.00	32.10	-5.90	34.50	31.92	-2.58	19.00
1971-72	38.25	38.58	+ .33	35.00	37.12	+2.12	21.55

[a]Source: U.S. Department of Agriculture Consumer and Marketing Service, Livestock Division (34).

some of this increase and to correct for unduly enhanced profitability for the cattle feeding activities at the higher price levels. Analysis of the price margins shown in Table 8 did not indicate a strong pattern supporting this adjustment, although it should be noted that there are few observations at the higher price levels.

The cattle prices used in this study are summarized in Table 9. The same prices were used for the activities involving both spring and fall dropped calves.

TABLE 9. Cattle prices assumed in this study

	Cattle Price Level		
	Low	Medium	High
	dollars per 100 pounds		
Slaughter steers[a]	26.00	32.00	38.00
Steer calves[b]	28.50	38.00	47.50
Slaughter heifers[a]	25.25	31.25	37.25
Heifer calves[b]	25.50	35.00	44.50
Cull cows	15.60	19.20	22.80

[a]This is the price before marketing costs which are assumed to be $.70 per hundredweight.

[b]This is the price realized by the calf producer. Add $1.00/cwt. in marketing costs to compute the cost of the calves to the feeder.

Listed below are the other assumed prices which are of major importance in this study:

Sale prices:

corn grain	$1.15 per bushel
soybeans	$2.75 per bushel

market hogs	$22.43 per hundredweight
sows	$17.98 per hundredweight
Purchase prices:	
corn grain	$ 1.22 per bushel
36 percent beef supplement	118.00 per ton
50 percent urea based beef supplement	90.00 per ton
36 percent hog supplement	128.00 per ton
fertilizer nutrients	
N(anhydrous ammonia)	4.9¢ per pound
N(ammonium nitrate or urea)	8.8¢ per pound
P_2O_5	8.3¢ per pound
K_2O	4.6¢ per pound
limestone	$ 5.00 per ton

Feeding Program for the Beef Cow Herd

As previously stated the development of the feeding program for the beef cow herd was considered a major part of this study. The approach taken was to define the cow's energy (TDN) and crude protein requirements on a monthly basis. These requirements were met with a combination of grazing activities, which supplied TDN and crude protein according to the growth patterns of the species involved, and harvested forage feeding activities. The basic method was adopted from Taylor (33), who utilized the monthly TDN system to develop the optimum pasture program, and

expanded with the addition of monthly crude protein requirements and a more detailed treatment of harvested forage feeding.

The monthly nutritional requirements of the cow and calf were based on estimates developed by Maddox (25), adjusted for Iowa conditions. The requirements of the replacement heifer and herd bull were taken from Gay and Zmolek (11). The TDN and crude protein requirements of the cow-calf unit for the spring and fall calving activities are presented in Table D.1. As noted, corn grain is fed in addition to the monthly requirements presented in the table to provide for the special energy needs of the replacement heifers and herd bulls.

The monthly TDN and crude protein production of the pasture activities included in the model are presented in Table B.5. These coefficients were derived from a summary of the seasonal production patterns of most of the major forage species grown in Iowa, Wedin (41). As indicated in Table B.5, the range of pasture alternatives was increased by allowing different management systems for the same species. For example, bromegrass could be fertilized with either 120 or 240 pounds of nitrogen, and could be harvested either one or two times, grazed continuously throughout the season, or three-season grazed (grazed in the early spring through early summer, then stock-piled for fall grazing).

Harvested forage feeding in each solution was limited by the forage harvesting equipment combination. Table 10 summarizes the alternative equipment combinations. Forage harvesting and handling equipment costs are presented in Tables A.5 through A.7. Harvested forage systems are described in more detail in Table C.1. Costs and labor requirements for

TABLE 10. Forage harvesting equipment combinations[a]

Equipment combinations	Abbreviated notation[b]	Equipment owned by farm operator	Alternative forages harvested
Custom bale and custom silage harvest	CB,CFH	mower-conditioner 1 flat rack 1 self-unloading forage wagon	baled mixed[c] or bromegrass hay, corn silage, forage sorghum silage
Own baler	OB	mower-conditioner baler, PTO, twine 2 flat racks	baled mixed[c] or bromegrass hay
Own stack-forming wagon	OSFW	mower-conditioner stack-forming wagon, 3 ton	stacked mixed[c] or bromegrass hay, stacked cornstalks
Own baler and custom silage harvest	OB,CFH	mower-conditioner baler, PTO, twine 2 flat racks 1 self-unloading forage wagon	baled mixed[c] or bromegrass hay, corn silage, forage sorghum silage

Own stack-forming wagon and custom silage harvest	OSFW,CFH	mower-conditioner stack-forming wagon, 3 ton 1 self-unloading forage wagon	stacked mixed[c] or bromegrass hay, corn silage, forage sorghum silage, stacked cornstalks
Own forage harvester and custom bale	OFH,CB	mower-conditioner 1 flat rack forage harvester with row crop head flail pickup head 2 self-unloading forage wagons	baled mixed[c], or bromegrass hay, corn silage, forage sorghum silage,[d] stalklage
Own forage harvester	OFH	mower-conditioner forage harvester with row crop head windrow pickup head flail pickup head 2 self-unloading forage wagons forage blower	mixed[c] or bromegrass haylage, corn silage, forage sorghum silage, stalklage

[a] In solutions where cattle feeding is allowed, a feeder-mixer wagon is added for fenceline bunk feeding.

[b] These notations are used to identify the equipment combinations in the discussion of the results.

[c] Alfalfa-bromegrass or birdsfoot trefoil-orchardgrass.

[d] Ensiled corn grain harvest residue, harvested with a flail pickup attachment on a forage harvester and stored in a bunker silo.

harvesting and feeding forages are presented in Tables C.2 and C.3. Table C.4 summarizes forage dry matter losses through harvest, storage, and feeding. Yields are presented in Table B.6.

Harvested forages, with the exception of stacked cornstalks, could be fed in any month of the year. Stacked cornstalks were left at the ends of the fields in which they were harvested and had to be consumed by April to allow for plowing of the headlands.

As previously stated, fall calves were assumed to be creep fed from December through March, consuming a total of 10.1 bushels of corn grain per cow-calf unit. The TDN and crude protein supplied by the creed feed were subtracted from the total requirements of the cow-calf unit. The amount of TDN furnished by the creep feed was approximately two-thirds of the calf's requirements beyond that which would be supplied through the cows's milk.

Creep feeding was available, through separate creep feeding activities, to spring calves from July through October. The calf could receive up to one-half of the TDN it would consume by itself (other than through the cow's milk) from creep feeding. The maximum level of creep feeding for spring calves was 7.3 bushels of corn grain per cow-calf unit over the four-month period. The purpose of creep feeding for the spring calving activity was to supplement the forage supply. No increase in weaning weights due to creep feeding was assumed. In a summary of creep feeding research from several states, Hawkins, Greathouse, and Henderson (15) report average amounts of creep feed consumed equivalent to 7.2 bushels of corn grain for spring calves and 13.5 bushels for fall calves.

These average amounts are comparable to the restrictions placed on creep feeding in this study.

A 30 percent crude protein supplement could be fed to the beef cow herd in any month. The cost of this supplement was assumed to be 5.4 cents per pound or 18.0 cents per pound of crude protein.

ORGANIZATION OF ANALYSIS

Table 11 outlines the solutions run for both model farms. All of the variables considered in the various solutions have been previously discussed. Individual solutions were differentiated by:

1. the farm: forage farm or grain farm,
2. the cattle price level,
3. whether a full-time employee was included,
4. whether cattle feeding was allowed,
5. the forage harvesting equipment combination.

A complete range of solutions was run with a full-time employee at the high cattle price level for both farms. The additional labor was added at the medium price level only for those forage harvesting equipment combinations where its inclusion at the high price level had increased net returns to the operator. No solutions involving a full-time employee were run at the low cattle price level on either farm or at the medium price level without cattle feeding on the grain farm. It was evident that the availability of additional labor would not increase the program values enough to justify the additional cost for these solutions.

The alternative solutions involving the different forage harvesting equipment combinations for each farm, cattle price level, labor, and cattle feeding situation comprise a set of solutions. For example, the seven solutions for the forage farm at the high cattle price level, with no cattle feeding, and without a full-time employee, form one set of solutions. The seven solutions for the forage farm at the high cattle price level, with no cattle feeding, but with a full-time employee, make

TABLE 11. Outline of solutions[a]

I. Forage farm					
A. Low cattle price level		B. Medium cattle price level		C. High cattle price level	
1. no cattle feeding	2. cattle feeding allowed	1. no cattle feeding	2. cattle feeding allowed	1. no cattle feeding	2. cattle feeding allowed
a. CB,CFH	a. CB,CFH	a. CB,CFH	a. CB,CFH	a. CB,CFH	a. CB,CFH
b. OB	b. OB	b. OB	b. OB	b. OB	b. OB
c. OSFW	c. OB,CFH	c. OSFW	c. OB,CFH	c. OSFW	c. OB,CFH
d. OB,CFH	d. OFH,CB	d. OB,CFH	d. OFH,CB	d. OB,CFH	d. OFH,CB
e. OSFW,CFH	e. OFH	e. OSFW,CFH	e. OFH	e. OSFW,CFH	e. OFH
f. OFH,CB	f. OSFW,CFH	f. OFH,CB	f. OSFW,CFH	f. OFH,CB	f. OSFW,CFH
g. OFH		g. OFH		g. OFH	
		3. with full-time employee; no cattle feeding	4. with full-time employee; cattle feeding allowed	3. with full-time employee; no cattle feeding	4. with full-time employee; cattle feeding allowed
		a. CB,CFH	a. CB,CFH	a. CB,CFH	a. CB,CFH
		b. OFH,CB	b. OB	b. OB	b. OB
		c. OFH	c. OB,CFH	c. OSFW	c. OB,CFH
			d. OFH,CB	d. OB,CFH	d. OFH,CB
			e. OFH	e. OSFW,CFH	e. OFH
			f. OSFW,CFH	f. OFH,CB	f. OSFW,CFH
				g. OFH	

[a]The abbreviations for the solutions refer to the forage harvesting equipment combination; see Table 10.

TABLE 11. Continued

II. Grain farm

A. Low cattle price level		B. Medium cattle price level		C. High cattle price level	
1. no cattle feeding	2. cattle feeding allowed	1. no cattle feeding	2. cattle feeding allowed	1. no cattle feeding	2. cattle feeding allowed
a. CB,CFH	a. CB,CFH	a. CB,CFH	a. CB,CFH	a. CB,CFH	a. CB,CFH
b. OB	b. OB	b. OB	b. OB	b. OB	b. OB
c. OSFW	c. OB,CFH	c. OSFW	c. OB,CFH	c. OSFW	c. OB,CFH
d. OB,CFH	d. OFH,CB	d. OB,CFH	d. OFH,CB	d. OB,CFH	d. OFH,CB
e. OSFW,CFH	e. OFH	e. OSFW,CFH	e. OFH	e. OSFW,CFH	e. OFH
f. OFH,CB	f. OSFW,CFH	f. OFH,CB	f. OSFW,CFH	f. OFH,CB	f. OSFW,CFH
g. OFH		g. OFH		g. OFH	
			3. with full-time employee; cattle feeding allowed	3. with full-time employee; no cattle feeding	4. with full-time employee; cattle feeding allowed
			a. CB,CFH	a. CB,CFH	a. CB,CFH
			b. OB,CFH	b. OB	b. OB
			c. OFH,CB	c. OSFW	c. OB,CFH
			d. OFH	d. OB,CFH	d. OFH,CB
			e. OSFW,CFH	e. OSFW,CFH	e. OFH
				f. OFH,CB	f. OSFW,CFH
				g. OFH	

up another set. The total of 118 solutions are divided into 19 sets of solutions.

Two alternative breakdowns were made of the program values of the linear programming solutions. The first was an estimate of the farm operator's labor and management return which was defined as:

the value of the program

minus:

a. the total land charge (Table 3),

b. machinery and equipment fixed costs for both basic and forage harvesting equipment (Appendix A),

c. the constant portion of silo annual costs (Table 7),

d. the salary of the full-time employee.

The second breakdown was an estimate of the rate of return to capital other than land. The return to non-land capital was defined as:

the value of the program

plus:

a. the total of all interest charges included in the framework of the activities in the optimum solution

minus:

a. machinery and equipment fixed costs, other than interest on investment, for both basic and forage harvesting equipment (Appendix A),

b. the constant portion of silo annual costs, other than interest on investment (Tables 6 and 7),

c. a standard charge of $6000.00 against operator labor and management,

d. the salary of the full-time employee,

e. the total land charge (Table 3).

This was divided by the total of all fixed capital and operating capital, except the value of the land, utilized in the solution to estimate the rate of return. Total non-land capital includes:

a. short-term operating capital, one-half of the total amount required assuming it will turn over twice per year,

b. the value of feeder cattle at the beginning of the feeding period,

c. breeding livestock,

d. the average value of basic and forage harvesting equipment,

e. the average value of crop storage and livestock facilities.

The return to operator labor and management and rate of return to non-land capital were used as measures of the returns generated in the linear programming solutions, instead of an estimate of net farm income, because they required no assumptions concerning the equity capital position of the farm operator.

COMPARISON OF ALL SOLUTIONS

All of the linear programming solutions for the forage farm are summarized in Table 12. The solutions for the grain farm are summarized in Table 13. The determination of return to operator labor and management and rate of return to non-land capital were discussed in the previous section. It should be noted again that the cattle feeding activities were restricted to a total of 500 head and the swine activities were restricted to 40 litters. Class IV land was restricted to unimproved permanent pasture. Therefore, the minimum level of unimproved permanent pasture is 77 acres on the forage farm and 8 acres on the grain farm.

As previously indicated, the solutions are divided into sets in which each solution represents an alternative forage harvesting equipment combination. The solution in each set which maximizes the return to operator labor and management is considered the best, or key, solution. (In general, the ranking of solutions in a set by operator labor and management return corresponds to the ranking by rate of return to non-land capital.) The key solution in each set is identified by a single asterisk(*). A more detailed breakdown and examination of the key solutions, which represent the "best" forage equipment combination for each farm situation, will be presented in the following section. Only general comments on relationships between all the solutions are included here.

As an indication of the competitiveness of alternative forage harvesting equipment combinations, each solution which has a return to labor and management within $500.00 of that of the key solution in the

TABLE 12. Summary of solutions for the forage farm

Forage harvesting equipment combination[a]	Return to operator labor and management	Program value	Livestock Activities: Beef cows (No.)	Livestock Activities: Cattle fed (No.)	Livestock Activities: Swine (Litters)	Crops in acres: Corn grain and soybeans	Crops in acres: Annual[b] forages	Crops in acres: Bromegrass & legume-grass[c] mixtures	Crops in acres: Fertilized permanent pasture	Crops in acres: Unimproved permanent pasture	Total annual labor requirement (hours)	Labor most restraining: Month(s)[d]	Labor most restraining: Shadow price[e]	Total capital used other than land	Rate of return on nonland capital (%)[f]
1. Low cattle price level, no cattle feeding															
CB,CFH	$-1,969	$21,381	218	--	40	182	16	207	94	146	3,166	4	$ 7.65	103,135	.34
OB	-1,231	22,032	179	--	40	194	--	209	32	210	3,164	4	7.95	89,783	.17
OSFW	- 653*	23,346	220	--	40	203	--	270	95	77	3,122	4,5,6,11	2.60	104,348	1.71
OB,CFH	-1,663	22,166	206	--	40	187	11	204	71	172	3,235	4	7.52	101,110	.50
OSFW,CFH	*Solution identical to OSFW														
OFH,CB	-3,159	21,668	218	--	40	190	9	210	98	138	3,240	2,3,4,5,6	2.60	109,430	-.28
OFH	-3,535	22,041	237	--	40	195	9	244	121	77	3,258	4,5,6	2.60	120,160	.15
2. Low cattle price level, cattle feeding allowed															
CB,CFH	-1,473	22,120	180	80	40	163	32	184	5	261	3,275	2,3,4	7.80	104,350	.91
OB	- 382**	22,978	162	79	40	192	--	208	--	246	3,322	2	24.99	97,833	1.55
OB,CFH	- 917	23,009	164	91	40	189	4	204	--	249	3,342	2,3	9.80	101,725	1.28
OFH,CB	-2,620	22,450	176	85	40	164	27	192	4	257	3,296	2,3,12	5.79	109,191	.20
OFH	-2,854	23,523	210	93	40	180	15	213	89	145	3,396	2,3	9.25	128,054	1.17
OSFW,CFH	- 259*	24,549	211	111	40	164	39	291	74	77	3,430	5,12	4.06	120,391	2.85
3. Medium cattle price level, no cattle feeding															
CB,CFH	5,522	28,872	263	--	40	162	44	208	164	77	3,318	3,4	15.90	129,970	7.69
OB	5,144	28,263	209	--	40	197	--	235	86	126	3,295	3	33.35	112,162	7.28
OSFW	6,740**	30,739	247	--	40	191	--	318	59	77	3,275	5	8.97	125,364	8.66
OB,CFH	5,632	29,461	261	--	40	153	43	215	138	87	3,419	3,4	17.36	130,880	7.78
OSFW,CFH	6,813*	31,378	276	--	40	179	30	319	39	77	3,486	4	15.09	137,850	8.66
OFH,CB	4,424	29,251	265	--	40	153	41	208	161	80	3,428	3	19.96	136,300	6.91
OFH	4,366	29,942	283	--	40	146	45	276	100	77	3,523	4	17.90	147,199	6.96

*The key solutions: those which give the highest return to operator labor and management in each set of solutions

**Solutions in which return to operator labor and management is within $500 of the return to operator labor and management of the key solution in the set

[a] See Table 10.

[b] Corn silage, forage sorghum silage, and sorghum-sudangrass.

[c] Bromegrass, alfalfa-brome, and birdsfoot trefoil-orchardgrass.

[d] Months in which labor is most restraining; identified by the numbers one through twelve which correspond to the months January through December, respectively.

[e] The value of an additional hour of operator labor in the month or months indicated in the previous column.

[f] Assuming the standard land charge shown in Table 3 and a standard charge of $6,000 for operator labor.

TABLE 12. Continued

Forage harvesting equipment combination	Return to operator labor and management	Program value	Livestock Activities: Beef cows (No.)	Cattle fed (No.)	Swine (Litters)	Crops in acres: Corn grain and soybeans	Annual forages	Bromegrass & legume-grass mixtures	Fertilized permanent pasture	Unimproved permanent pasture	Total annual labor requirements (hours)	Labor most restraining: Month(s)	Shadow price	Total capital used other than land	Rate of return on nonland capital (%)
4. Medium cattle price level, cattle feeding allowed															
CB,CFH	6,241	29,688	239	106	20	164	37	240	105	99	3,292	2	19.58	137,448	8.22
OB	6,243	29,603	180	112	33	194	--	226	38	187	3,412	2	56.55	120,443	8.26
OB,CFH	6,452	30,378	230	103	20	174	27	219	129	96	3,336	4	13.70	134,437	8.40
OFH,CB	5,195	30,119	239	106	20	169	31	238	123	85	3,351	2	20.86	143,940	7.46
OFH	5,283	31,660	227	112	32	185	18	266	100	77	3,440	2	49.87	150,413	7.60
OSFW,CFH	8,335*	33,143	231	103	40	193	11	310	54	77	3,512	2	26.81	141,519	9.72
5. Medium cattle price level, no cattle feeding, with full-time employee															
CB,CFH	1,945*	31,535	340	--	40	137	86	306	39	77	3,979	4	1.99	160,540	5.51
OFH,CB	1,204	32,271	389	--	40	92	128	348	--	77	4,525	4,8	2.60	183,095	5.43
OFH	1,038	32,682	392	--	40	92	125	351	--	77	4,429	6,8	2.60	187,689	5.41
6. Medium cattle price level, cattle feeding allowed, with full-time employee															
CB,CFH	6,533**	36,366	347	500	40	--	214	291	63	77	5,612	4,6,8	2.60	264,704	8.23
OB	5,551	35,151	227	199	40	163	4	367	34	77	4,508	4	2.60	175,958	7.79
OB,CFH	6,910*	37,222	340	478	40	11	185	296	76	77	5,622	6	6.02	258,421	8.38
OFH,CB	5,838	37,148	353	500	40	12	193	298	67	77	6,012	8	3.11	271,688	7.98
OFH	5,296	37,913	350	500	40	12	193	317	46	77	5,944	4,6,8	2.60	277,624	7.80
OSFW,CFH	6,393	37,441	317	329	40	52	157	360	--	77	4,860	6	2.60	214,597	8.36
7. High cattle price level, no cattle feeding															
CB,CFH	14,169	37,519	329	--	24	99	78	285	107	77	3,393	4	19.52	168,085	12.90
OB	11,995	35,258	235	--	30	180	--	272	117	77	3,298	2	39.75	132,822	12.57
OSFW	15,308	39,307	323	--	40	107	11	540	--	77	3,553	5	13.54	168,387	13.62
OB,CFH	14,302	38,131	325	--	26	109	62	284	113	77	3,539	4	19.77	168,337	12.98
OSFW,CFH	16,597*	41,162	337	--	40	91	43	384	50	77	3,577	4	14.29	175,449	14.09
OFH,CB	13,177	38,004	319	--	26	107	67	285	107	77	3,524	2,3,4	18.02	169,785	12.29
OFH	13,451	39,026	338	--	28	95	54	338	80	77	3,527	2,4	20.71	182,542	12.14

TABLE 12. Continued

Forage harvesting equipment combination	Return to operator labor and management	Program value	Livestock Activities: Beef cows (No.)	Cattle fed (No.)	Swine (litters)	Crops in acres: Corn grain and soybeans	Annual forages	Bromegrass & legume-grass mixtures	Fertilized permanent pasture	Unimproved permanent pasture	Total annual labor requirements (hours)	Labor most restraining: Month(s)	Shadow price	Total capital used other than land	Rate of return on nonland capital (%)
8. High cattle price level, cattle feeding allowed															
CB,CFH	16,038	39,631	296	180	--	97	71	298	102	77	3,447	4	31.08	192,142	13.23
OB	14,351	37,611	215	140	12	180	--	297	80	88	3,400	2	46.06	150,315	13.54
OB,CFH	16,192	40,264	296	183	--	94	72	288	114	77	3,525	4	27.58	194,390	13.29
OFH,CB	15,021	40,091	291	167	3	110	71	265	122	77	3,624	4	32.45	192,936	12.72
OFH	14,940	41,317	287	182	4	104	58	324	82	77	3,682	2	37.42	200,001	12.55
OSFW,CFH	18,226*	43,034	280	132	19	119	62	345	41	77	3,590	2	24.39	178,894	14.88
9. High cattle price level, no cattle feeding, with full-time employee															
CB,CFH	16,015**	45,605	497	--	40	--	195	374	--	77	4,707	4	9.42	246,030	12.10
OB	11,916	41,419	358	--	40	84	27	457	--	77	4,292	6	1.67	186,221	11.22
OSFW	10,519	40,758	338	--	40	97	42	429	--	77	3,578	-	--	178,807	10.61
OB,CFH	16,147*	46,243	498	--	40	--	193	375	--	77	4,783	4	8.16	247,876	12.13
OSFW,CFH	15,442	46,247	491	--	40	--	199	369	--	77	4,570	4	4.67	246,129	11.87
OFH,CB	15,183	45,976	502	--	40	--	201	367	--	77	5,065	8	5.58	251,524	11.69
OFH	14,771	46,312	504	--	40	--	201	367	--	77	4,998	8	4.57	255,941	11.47
10. High cattle price level, cattle feeding allowed, with full-time hired man															
CB,CFH	25,149**	54,836	442	500	40	--	163	302	103	77	5,681	4	24.40	338,651	13.68
OB	20,262	49,862	354	500	40	45	67	437	19	77	5,765	6	8.90	302,147	12.75
OB,CFH	25,623*	55,789	440	500	40	--	169	344	55	77	5,833	4	21.49	338,926	13.81
OFH,CB	24,368	55,404	438	500	40	--	186	320	63	77	6,092	4	12.68	340,724	13.45
OFH	23,543	55,886	402	500	40	--	200	369	--	77	6,092	4	6.91	335,188	13.24
OSFW,CFH	21,542	52,550	366	332	40	--	221	347	--	77	4,868	4,6	2.60	269,142	13.80

set is marked with a double asterisk (**). This is done to point out those situations in which the farm operator could select from a range of alternative combinations without seriously affecting his income potential.

The negative returns to operator labor and management on the forage farm at the low cattle price level are probably the most striking features of Table 12. While they represent a very unfavorable situation, the negative labor and management returns would have to be considered together with the farm operator's equity position to determine net farm income. Return to operator labor and management, as indicated earlier, is determined after a 5.5 percent return to land value and an eight percent to all other capital have been charged against the value of the program. If the farm operator had 100 percent equity in the land, the basic machinery plus $5000.00 worth of forage equipment, and 200 head of beef cows, the total return to his investment, at the low cattle price level, would be $19,156. His net farm income would range from $15,600 to $18,500 after subtraction of the negative labor and management returns of the solutions at the low cattle price level with no cattle feeding. He could, and probably would, continue to operate with this level of income. On the other hand a farm operator with a very low equity would not be able to survive at this price level in this farm situation.

Returns to operator labor and management increase sharply as the cattle price level increases. However, at the medium price level, it is only in the key solution, with cattle feeding allowed, that the return to operator labor and management is very much greater than the $6000.00 standard charge for operator labor.

In the sets without a full-time employee, the numbers of both beef cows and feeding cattle increase as the cattle price level increases. Swine numbers are reduced in solutions at the medium price level with cattle feeding and at the high cattle level without cattle feeding. They are reduced more sharply or forced out of the solutions entirely at the high price level with cattle feeding. In each of these situations, swine numbers are highest in the key solution.

Labor availability limits the cattle enterprises as indicated by the large increases in numbers of both beef cows and feeding cattle when a full-time employee is included. However, return to operator labor and management is increased substantially with the addition of a full-time employee only at the high cattle price level with cattle feeding allowed.

With the larger numbers of cattle at the higher cattle price levels, there are shifts in the cropping program. A major shift is from the production of grain to annual forages: corn silage, forage sorghum silage, and sorghum-sudangrass. There is also a shift from unimproved permanent pasture at the low cattle price level to improved permanent pasture and bromegrass and legume-grass mixtures at the medium and high cattle price levels.

Labor availability is most limiting in the month or months in which the shadow price for operator labor is highest. Shadow prices are generated by the linear programming routine for any resource which restricts the value of the program. They can be interpreted as the value of an additional unit of the restrictive resource, in this case the value of an additional hour of operator labor.

As indicated in Table 12, labor is generally most limiting in April on the forage farm, mainly due to the high labor requirement of the beef cow herd during the calving season. In many of the solutions in which cattle feeding is allowed, however, the shadow prices on operator labor are highest in February. Labor availability is critical during the winter months in these solutions because of the combination of high labor requirements for livestock chores and high overhead labor requirements. February is singled out as the month in which labor is most restrictive because overhead labor requirements were assumed to be highest in February (Table 4). In reality, there would be more flexibility in the supply of labor and requirements for overhead labor than is reflected in the structure of the model. The high shadow prices on February labor should probably be interpreted as representing a tight labor situation throughout the winter (December through February) rather than a situation unique to February.

The major reason that labor is not limiting in August through November in most of these solutions is that corn grain, soybeans, and, in some cases, silage are custom harvested. The highest shadow prices on labor in the solutions at the high cattle price level, with a full-time employee, with no cattle feeding, which involve owning a forage harvester are in August. This is the month in which most of the forage sorghum silage is harvested. Also, the solutions for the grain farm involving the owned forage harvester at the high cattle price level, with a full-time employee, with cattle feeding (Table 13) show the highest shadow prices for labor in September, when corn silage is harvested. These observations indicate that the reason the solutions involving ownership of a forage harvester

TABLE 13. Summary of solutions for the grain farm

Harvesting equipment combination[a]	Return to operator labor and management	Program value	Livestock Activities: Beef cows (No.)	Cattle fed (No.)	Swine (Litters)	Crops in Acres: Corn grain and soybeans	Annual forages[b]	Bromegrass & legume-grass mixtures[c]	Fertilized permanent pasture	Unimproved permanent pasture	Total annual labor requirement (hours	Labor most restraining: Month(s)[d]	Shadow price[e]	Total capital used other than land	Rate of return on nonland capital (%)[f]
1. Low cattle price level, no cattle feeding															
OSFW,CFH	$5,742**	$29,219	33	--	40	333	--	32	17	8	2,303	5	$2.60	$53,708	7.58
OB	5,959*	29,349	32	--	40	333	--	32	17	8	2,321	5	2.60	53,320	7.99
OSFW	5,732**	29,858	41	--	40	335	--	36	11	8	2,400	5	2.60	58,129	7.63
OB,CFH	5,502**	29,358	37	--	40	333	2	37	10	8	2,368	5	2.60	56,760	7.02
OSFW,CFH	Solution identical to OSFW														
OFH,CB	4,894	29,627	54	--	40	337	--	45	--	8	2,502	5,10	2.60	65,856	6.41
OFH	4,191	29,673	56	--	40	336	--	46	--	8	2,513	5,10	2.60	69,384	5.50
2. Low cattle price level, cattle feeding allowed															
CB,CFH	6,151*	29,871	34	215	40	265	68	28	22	8	3,024	5	6.59	85,981	8.22
OB	6,118**	29,605	32	23	40	332	--	34	16	8	2,386	5	2.60	56,674	8.12
OB,CFH	5,774**	29,970	33	213	40	267	67	30	19	8	3,035	5	6.59	87,120	7.79
OFH,CB	5,328	30,525	46	152	40	285	48	32	17	8	3,021	5	3.76	86,193	7.29
OFH	4,146	30,650	43	192	40	287	48	35	12	8	3,136	5	3.76	95,958	6.15
OSFW,CFH	5,470	30,405	43	194	40	271	64	35	12	8	3,015	5	4.22	89,375	7.48
3. Medium cattle price level, no cattle feeding															
CB,CFH	7,584**	31,061	112	--	40	270	45	36	32	8	2,590	4,5,6,10	2.60	80,290	10.01
OB	7,280	30,670	63	--	40	306	8	41	26	8	2,461	4,5	2.60	64,720	10.04
OSFW	7,807*	31,933	104	--	40	277	24	55	26	8	2,598	5,6	2.60	79,040	10.35
OB,CFH	7,192	31,148	112	--	40	270	45	36	32	8	2,602	4,5,6,10	2.60	81,975	9.51
OSFW,CFH	7,682**	32,374	116	--	40	278	36	58	10	8	2,693	4,5,6,10,11	2.60	85,891	10.03
OFH,CB	6,801	31,775	109	--	40	294	24	29	36	8	2,840	5,6,10	2.60	87,946	8.98
OFH	6,105	31,808	107	--	40	296	22	31	32	8	2,828	5,6,10	2.60	90,224	8.19

*The key solutions: those which give the highest return to operator labor and management in each set of solutions

**Solutions in which return to operator labor and management is within $500 of the return to operator labor and management of the key solution of the set

[a] See Table 10.

[b] Corn silage, forage sorghum silage, and sorghum sudangrass.

[c] Bromegrass, alfalfa-bromegrass, and birdsfoot trefoil-orchardgrass.

[d] Months in which labor is most restraining; identified by the numbers one through twelve which correspond to the months January through December, respectively.

[e] The value of an additional hour of operator labor in the month or months indicated in the previous column.

[f] Assuming the standard land charge shown in Table 3 and a standard charge of $6,000 for operator labor.

TABLE 13. Continued

Harvesting equipment combination	Return to operator labor and management	Program value	Livestock Activities: Beef cows (No.)	Cattle fed (No.)	Swine (litters)	Crops in acres: Corn grain and soybeans	Annual forages	Bromegrass & legume-grass mixtures	Fertilized permanent pasture	Unimproved permanent pasture	Total annual labor requirement (hours)	Labor most restraining: Month(s)	Shadow price	Total capital used other than land	Rate of return on nonland capital (%)
4. Medium cattle price level, cattle feeding allowed															
CB,CFH	10,360*	34,080	78	186	40	238	80	30	34	8	3,090	5	17.86	102,852	12.27
OB	9,264	32,751	61	176	40	292	15	60	15	8	3,022	5	4.12	93,770	11.51
OB,CFH	9,999**	34,189	64	205	40	243	76	33	31	8	3,118	5	17.43	103,543	11.91
OFH,CB	9,664	34,861	70	210	40	258	62	40	22	8	3,354	5	27.33	111,243	11.35
OFH	8,443	34,947	63	218	40	262	58	42	20	8	3,332	5	24.91	115,252	10.19
OSFW,CFH	10,136**	35,071	87	182	40	243	69	62	8	8	3,178	5	29.79	109,391	11.84
5. Medium cattle price level, cattle feeding allowed, with full-time employee															
CB,CFH	6,675*	36,635	75	500	40	145	187	50	--	8	4,232	-	--	171,995	8.41
OB,CFH	6,261**	36,700	72	500	40	148	185	50	--	8	4,223	-	--	172,524	8.18
OFH,CB	6,331**	37,768	99	500	40	160	170	52	--	8	5,060	9[g]	5.55[g]	181,763	8.22
OFH	5,127	37,871	99	500	40	160	170	52	--	8	5,017	9[g]	5.55[g]	185,826	7.60
OSFW,CFH	6,460**	37,635	126	500	40	126	198	59	--	8	4,761	-	--	188,551	8.28
6. High cattle price level, no cattle feeding															
CB,CFH	13,785*	37,262	249	--	40	154	120	108	--	8	3,250	5	15.95	142,464	13.49
OB	10,444	33,834	164	--	40	201	30	151	--	8	3,032	5	3.52	105,330	12.25
OSFW	11,071	35,197	110	--	40	279	22	64	17	8	2,624	5,6	2.60	87,703	13.84
OB,CFH	13,489**	37,445	256	--	40	143	123	106	10	8	3,288	5	16.20	146,063	13.16
OSFW,CFH	13,223	37,915	266	--	40	148	133	90	11	8	3,376	5	14.39	151,383	12.81
OFH,CB	12,797	37,751	263	--	40	144	128	95	14	8	3,556	5	17.07	151,658	12.52
OFH	12,073	37,776	270	--	40	149	137	75	22	8	3,592	5	17.04	158,077	11.88

[g]Time available for fieldwork in September was restraining in these solutions; the shadow prices shown are for field time rather than for operator labor.

TABLE 13. Continued

Harvesting equipment combination	Return to operator labor and management	Program value	Livestock Activities: Beef cows (No.)	Cattle fed (No.)	Swine (Litters)	Crops in acres: Corn grain and soybeans	Annual forages	Bromegrass & legume-grass mixtures	Fertilized permanent pasture	Unimproved permanent pasture	Total annual labor requirement (hours)	Labor most restraining: Month(s)	Shadow price	Total capital used other than land	Rate of return on nonland capital (%)
7. High cattle price level, cattle feeding allowed															
CB,CFH	16,350**	40,070	189	158	35	159	128	64	31	8	3,426	5	41.35	151,755	14.80
CB	13,751	37,240	65	273	40	268	14	79	22	8	3,307	5	15.44	128,559	14.06
CB,CFH	16,062**	40,261	197	152	35	152	131	64	35	8	3,448	5	38.21	155,156	14.54
CFH,CB	15,454	40,651	167	163	40	190	104	64	24	8	3,679	5	28.10	148,697	14.44
CFH	14,418	40,922	176	166	40	180	107	93	28	8	3,685	5	21.38	158,273	13.17
CSFW,CFH	16,479*	41,414	188	167	40	164	115	80	24	8	3,557	12	17.19	155,820	14.76
8. High cattle price level, no cattle feeding, with full-time employee															
CB,CFH	11,893*	41,610	463	--	40	--	285	98	--	8	4,670	4,6	2.60	232,804	10.57
CB	4,746	34,376	162	--	40	195	30	157	--	8	3,139	-	--	107,252	6.87
CSFW	4,981	35,347	112	--	40	268	21	70	14	8	2,622	-	--	91,609	6.94
CB,CFH	11,646**	41,842	453	--	40	--	277	106	--	8	4,606	4,6	2.60	229,486	10.50
CSFW,CFH	10,645	41,577	450	--	40	--	272	110	--	8	4,497	4,6	2.60	230,719	10.04
CFH,CB	10,797	41,717	455	--	40	--	283	96	3	8	4,901	4,6,8	2.60	232,988	10.10
CFH	10,344	42,013	457	--	40	--	285	97	--	8	4,903	4,6,8	2.60	237,285	9.86
9. High cattle price level, cattle feeding allowed, with full-time employee															
CB,CFH	20,393*	50,353	290	500	40	--	313	70	--	8	5,461	4,5,6	2.60	277,198	13.19
CB	17,179	47,406	207	500	40	104	47	200	31	8	4,970	4	2.60	241,773	10.57
CB,CFH	20,103**	50,542	281	500	40	--	312	70	--	8	5,436	4,5,6	2.60	275,185	13.14
CFH,CB	19,727	50,863	282	500	40	--	309	73	--	8	5,905	9	4.91	276,398	13.02
CFH	18,518	50,988	281	500	40	--	308	75	--	8	5,904	9	7.16	282,428	12.44
CSFW,CFH	19,158	50,333	267	500	40	--	312	69	--	8	5,268	4,5,6	2.60	271,256	12.87

are not more competitive when large amounts of silage are harvested is that the custom silage harvesting activity includes labor for hauling and unloading the silage as well as operation of the harvesting machine. Adjustments in the capacity of the forage harvesting equipment and in labor availability during August and September would probably be required to make ownership of a forage harvester realistic in these situations. Possibly the cost of custom silage harvesting was also unrealistically low considering the amount of labor assumed to be furnished by the custom operator. The custom rate for silage harvesting, hauling, and unloading was $15.00 per acre, and was based on a 1971 survey of custom rates paid by Iowa farmers (19). It appears unrealistic that a two-man operation harvesting 3000 to 4000 tons, or more, of silage, annually, would not involve ownership of forage harvesting equipment.

Requirements for non-land capital for the forage farm increase from about $100,000 to $120,000 at the low cattle price level to $180,000 to $200,000 at the high cattle price level without a full-time employee, and to $340,000 at the high price level with a full-time employee.

The key solutions at all price levels on the forage farm where no full-time employee is included are those involving the stack-forming wagon equipment combinations. The stack-forming wagon, by itself or combined with custom silage harvesting, has a clear advantage over all alternative equipment combinations. When a full-time employee is included, a combination of baling and custom silage harvesting is involved in the key solutions.

The returns to operator labor and management at the low cattle price level are more favorable on the grain farm as shown in Table 13. However, operator labor and management returns at the high cattle price level are higher on the forage farm than on the grain farm.

On the forage farm both beef cow and feeder cattle numbers increase with the cattle price level. However, on the grain farm the number of beef cows increases while the size of the cattle feeding enterprise decreases, with the increased cattle price level in the solutions with no full-time employee. Swine numbers are reduced only at the high cattle price level when cattle feeding is allowed, and then, only by five litters in each of two solutions on the grain farm.

Because a high percentage of the grain farm is Class I land, expansion of the beef cow herd requires a shift from grain to forage production. As in the case of the forage farm, most of the land shifted from grain production goes into the production of annual forages. The minimum acreage of unimproved permanent pasture is not exceeded in any solution on the grain farm.

Labor requirements are less on the grain farm than on the forage farm at the low and medium cattle price levels, particularly when no cattle feeding is allowed. Labor is generally most limiting in May indicating that competition between the livestock enterprises and corn and soybean planting would be more critical than the high labor requirements of the beef cow herd during the calving season. Labor is generally not limiting during the harvest season because of the use of custom harvesting for grain and silage, as previously discussed.

The non-land capital requirements for the grain farm are roughly $50,000 less than those for the forage farm for comparable solutions, basically due to reduced investment in the beef cow herd.

The selection of forage harvesting equipment appears to be less critical on the grain farm. There are one or two forage harvesting equipment combinations which give solutions competitive with the key solution for each set. Both the stack-forming wagon and the owned baler or custom baling, in combination with custom silage harvesting, are involved in competitive solutions.

General observations from the linear programming solutions presented in Tables 12 and 13 are summarized in the following statements:

1. Returns to operator labor and management are higher on the grain farm at the low and medium cattle price levels and higher on the forage farm at the high cattle price level. Operator labor and management returns are negative at the low cattle price level on the forage farm.
2. Both beef cow numbers and numbers of cattle fed increase as the cattle price level increases on the forage farm. The number of cattle fed decreases while the number of beef cows increases on the grain farm, indicating a substitution of beef cows for the feeding of purchased steer calves.
3. Swine numbers are affected more by competition from feeder calf production and cattle feeding on the forage farm than on the grain farm.
4. Increased forage production on the grain farm involves mostly a shift from grain crops to annual forages. Forage production

is increased on the forage farm both by a shift from grain to annual forages and by intensification of forage production through fertilization or seeding of unimproved permanent pasture.

5. Non-land capital and labor utilization are higher on the forage farm than on the grain farm for comparable labor availability and price situations.
6. The labor available during April for the calving season is critical on the forage farm. The competition between the crop and livestock enterprises for May labor is more critical on the grain farm.
7. The solutions involving the stack-forming wagon equipment combinations have a clear advantage over alternative solutions on the forage farm when a full-time employee is not included. The selection of a forage harvesting equipment combination is less critical on the grain farm.

ANALYSIS OF THE KEY SOLUTIONS

The discussion of the optimum organization of each model farm and how it is affected by changes in the cattle price level and in labor availability is based on analysis of the key solutions designated in the previous section. The key solutions for the forage farm are discussed first, followed by those for the grain farm.

The following information from each of the key solutions is presented in tables in this section:

1. a breakdown of the value of the program to estimate operator labor and management return;
2. a summary of livestock production and sales;
3. a summary of crop production and the distribution of harvested grain and forages;
4. monthly labor requirements and shadow prices for operator labor for the months in which labor is limiting;
5. an accounting of capital requirements and the estimated rate of return to capital;
6. a budget of costs and returns for the individual cow-calf unit.

The beef cow herd forage programs developed in the linear programming solutions are presented in Appendix E. A separate table for each key solution shows the total TDN and crude protein requirements for the beef cow herd on a monthly basis, and the TDN and crude protein furnished by the grazing and harvested forage feeding activities in each month. Shadow prices are presented for TDN and crude protein for the months in

which they are limiting. Excess availability of TDN and crude protein is also indicated.

The short term operating capital requirements presented in the capital accounting tables include variable production costs such as seed, fertilizer, purchased feed, and machinery operating expenses. The cost of full-time and part-time hired labor is also included. Only one-half of the total short-term operating expenses are included in the capital requirements, assuming an average six month turn over of such capital in the business. Capital investments in livestock per unit for livestock activities are presented in Tables D.4, D.8, and D.12. Capital invested in depreciable assets is included at their average values rather than initial investment costs. Average values of machinery and equipment are presented in Tables A.1, A.2, and A.5. Average values of crop storage and livestock facilities were assumed to be one-half of the initial investment costs which are presented in Tables 5 and 7. The determination of rate of return to non-land capital was discussed in the preceding section.

The beef cow-calf unit budgets tie together all of the costs and resource requirements for feeder calf production in the key solutions. Enterprise labor income is considered to be the residual return after variable and fixed costs plus a 5.5 percent return to land value and an 8 percent return to investment in livestock are deducted from receipts. A charge is included for a share of the fixed cost of the basic machinery set based on the estimated percentage of annual tractor use which is required to feed, care for, and produce feed for the cow herd. The

receipts credited to the cow-calf unit are based on sales of all calves plus cull cows. However, in the solutions in which some or all of the calves are fed out on the farm, the savings of the costs of inter-farm transfer of the calves is noted.

The Forage Farm

Livestock production

Livestock production activities in the key solutions for the forage farm without and with cattle feeding are summarized in Tables 14 and 15, respectively. In both situations, the size of the beef cow herd increases as the cattle price level rises and also when more labor is available. The number of beef cows is about the same both with and without cattle feeding at the low cattle price level. There are 45 and 57 fewer cows at the medium and high price levels, respectively, in the solutions with no full-time employee when cattle feeding is included. When a full-time employee is added to the labor supply, beef cow numbers at the medium cattle price level are the same in the solutions both with and without cattle feeding. At the high price level with a full-time employee, there are 58 fewer cows when cattle feeding is included. The size of the beef cow herd more than doubles between the low cattle price level and the high cattle price level with a full-time employee. The farm is carrying a cow-calf unit on 1.32 acres at the high price level with a full-time employee with no cattle feeding.

Spring swine farrowing is eliminated at the high cattle price level with no full-time employee when cattle feeding is allowed. The maximum number of litters are farrowed in all of the rest of the key solutions

described in Tables 14 and 15. As noted in the discussion of Table 12, swine numbers were below the maximum in several of the alternative solutions at both the medium and high cattle price levels when no full-time employee was included. Swine numbers were highest in the key solutions in these situations.

The cattle feeding program in the key solutions with no full-time employee is basically limited to feeding out the home-raised steer calves, although 18 home-raised heifer calves are fed out at the low cattle price level and eight purchased steer calves are fed at the high price level. The corn silage and corn grain feeding program is used exclusively in the solutions with no full-time employee.

TABLE 14. Livestock production and sales on the forage farm: solutions with no cattle feeding

Cattle price level:	Low	Medium	High	Medium	High
Full-time employee:	No	No	No	Yes	Yes
Forage harvesting equipment:[a]	OSFW	OSFW,CFH	OSFW,CFH	CB,CFH	OB,CFH
Beef cows-spring calving	220	276	337	340	498
Steer calves sold	99	124	152	153	224
Heifer calves sold	62	77	94	95	140
Gross income from calf sales	$18,933	$31,994	$49,078	$39,390	$ 72,552
Gross income from cull cow sales[b]	$ 5,256	$ 8,118	$11,757	$ 9,995	$ 17,381
Swine: litters farrowed	40	40	40	40	40
Gross income from swine sales[c]	$15,006	$15,006	$15,006	$15,006	$ 15,006
Total gross income from livestock sales	$39,195	$55,118	$75,841	$64,391	$104,939

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Assumes sale of .15 cow weighing 1018 pounds or 153 pounds per cow calf unit at the prices shown in Table 9.

[c]Sales of sows included.

TABLE 15. Livestock production and sales on the forage farm: solutions with cattle feeding allowed

Cattle price level:	Low	Medium	High	Medium	High
Full-time employee:	No	No	No	Yes	Yes
Forage harvesting equipment:[a]	OSFW,CFH	OSFW,CFH	OSFW,CFH	OB,CFH	OB,CFH
Beef cows-spring calving	211	231	280	340	440
Steer calves sold	--	--	--	--	--
Heifer calves sold	41	65	78	--	--
Gross income from calf sales	$ 4,305	$ 9,347	$14,350	--	--
Gross income from cull cow sales[b]	$ 5,034	$ 6,801	$ 9,750	$ 9,988	$ 15,341
Steers fed corn silage and corn grain	94	103	132	237	--
Steers fed baled mixed hay and corn grain	--	--	--	147	379
Total steers fed	94	103	132	384	379
Heifers fed corn silage and corn grain	18	--	--	94	121
Heifers fed baled mixed hay and corn grain	--	--	--	--	121
Total heifers fed	18	--	--	94	121
Gross income from fed cattle sales	$28,550	$33,433	$51,156	$149,901	$184,675
Swine: litters farrowed	40	40	19[d]	40	40
Gross income from swine sales[c]	$15,006	$15,006	$ 7,518	$15,006	$ 15,006
Total gross income from livestock sales	$52,895	$64,587	$82,774	$174,895	$215,022
Steer calves purchased	--	--	8	237	186
Heifer calves purchased	--	--	--	--	--
Total cost of purchased calves	--	--	$ 1,938	$43,799	$ 42,861

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Assumes sale of .15 cow weighing 1018 pounds or 153 pounds per cow-calf unit at the prices shown in Table 9.

[c]Sales of sows included.

[d]Winter-summer farrowing activity.

When the labor supply is increased with the addition of a full-time employee, all home-raised steer and heifer calves are fed out and enough additional steer calves are purchased to bring the total number of cattle fed to 478 head at the medium price level and the maximum 500 head at the high price level. The feeding program includes both baled hay and corn grain and corn silage and corn grain at the medium cattle price level, and shifts completely to baled hay and corn grain at the high cattle price level.

Crop production and utilization

The crop programs for the key solutions without cattle feeding are summarized in Table 16 and for the key solutions with cattle feeding in Table 17. The crop program is similar in the two solutions at the low cattle price level. Row crop production is at the maximum level on Class I and Class II land. In the solution with cattle feeding, corn silage for the cattle feeding enterprise rather than corn grain is produced on Class II land, therefore fewer acres of cornstalks are available for the beef cow herd. The remainder of the Class II land is in alfalfa-bromegrass which allows the shortest rotation and maximum row crop acreage. Class III land in each of these solutions produces 25 acres of corn grain and a combination of forages with large acreages of birdsfoot trefoil-orchardgrass and permanent bluegrass pasture. Stacked hay is the major harvested forage produced for the beef cow herd.

Class I land is used mostly for grain production in the solution at the medium and high cattle price levels without a full-time employee. The only important exception is that 41 acres of corn silage are produced

TABLE 16. Crop production and disposition on the forage farm: solutions with no cattle feeding

Cattle price level: Full-time employee: Forage harvesting equipment:[a]		Low No OSFW	Medium No OSFW,CFH	High No OSFW,CFH	Medium Yes CB,CFH	High Yes OB,CFH
Grain production:	Unit					
Class I Land-corn grain	Acres	49	49	42	12	--
-soybeans	Acres	49	49	49	49	--
Class II Land-corn grain	Acres	40	3	--	--	--
-soybeans	Acres	40	40	34	--	32
Class III Land-corn grain	Acres	25	45	--	45	--
Soybeans harvested and sold	Bushels	3,453	3,227	2,052	3,149	--
Corn grain harvested	Bushels	11,373	9,375	4,805	4,812	--
Corn grain purchased	Bushels	--	--	--	--	5,119
Corn grain fed	Bushels	4,593	4,700	4,805	4,812	5,119
Corn grain sold	Bushels	6,780	4,675	--	--	--
Gross income from crop sales		$16,986	$14,013	$5,581	$8,565	--
Forage production:[b]						
Class I Land-corn silage	Acres	--	--	--	--	11
-FS silage	Acres	--	--	--	37	86
-SS	Acres	--	--	7	--	--

Class II Land-corn silage	Acres	--	--	--	--	--
-FS silage	Acres	--	30	27	49	58
-Alf-Br[c]	Acres	81	61	65	81	47
-Br[c]	Acres	--	32	69	--	56
Class III Land-FS silage	Acres	--	--	4	--	29
-SS	Acres	--	--	6	--	9
-Alf-Br[c]	Acres	60	225	250	226	107
-Br[c]	Acres	35	--	--	--	--
-BFT[c]	Acres	95	1	--	--	165
-KBG	Acres	95	39	50	39	--
Forages harvested:						
Corn silage harvested	Tons[d]	--	--	--	--	190
Less storage loss	Tons	--	--	--	--	29
Corn silage fed to beef cows	Tons	--	--	--	--	161
Forage sorghum silage harvested	Tons	--	513	508	1,536	2,984
Less storage loss	Tons	--	78	77	234	455
Forage sorghum silage fed to beef cows	Tons	--	435	431	1,302	2,529
Hay harvested, method		Stacked	Stacked	Stacked	Baled	Baled
Hay harvested	Tons	408	454	588	274	194
Less storage loss	Tons	49	55	71	11	8
Hay fed to beef cows	Tons	359	399	517	263	186
Cornstalks stacked	Tons	210	173	88	--	--
Less storage loss	Tons	22	18	8	--	--
Stacked cornstalks fed to beef cows	Tons	188	155	80	--	--

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Utilization of pasture and harvested forages by the beef cow herd presented in more detail in Tables E.1 through E.5. See Table B.4 for explanation of abbreviations.

[c]Includes seeding.

[d]On a moisture basis.

TABLE 17. Crop production and disposition on the forage farm: solutions with cattle feeding allowed

Cattle price level Full-time employee Forage harvesting equipment[a]		Low No OSFW,CFH	Medium No OSFW,CFH	High No OSFW,CFH	Medium Yes OB,CFH	High Yes OB,CFH
Grain production:	Unit					
Class I Land-corn grain	Acres	49	43	27	--	--
-soybeans	Acres	49	49	29	--	--
Class II Land-corn grain	Acres	1	--	--	--	--
-soybeans	Acres	40	37	21	--	--
Class III Land-corn grain	Acres	25	33	42	11	--
Soybeans harvested and sold	Bushels	3,453	3,335	1,958	--	--
Corn grain harvested	Bushels	7,607	7,512	6,313	872	--
Corn grain purchased	Bushels	--	--	--	22,468	36,287
Corn grain fed	Bushels	7,607	7,512	6,313	23,334	36,287
Corn grain sold	Bushels	--	--	--	--	--
Gross income from crop sales		$9,392	$9,071	$5,326	--	--
Forage production:[b]						
Class I Land-corn silage	Acres	--	5	41	97	30
-FS silage	Acres	--	--	--	--	25
-SS	Acres	--	--	--	--	42
-Alf-Br[c]	Acres	--	--	--	--	--
Class II Land-corn silage	Acres	39	32	--	--	--
-FS silage	Acres	--	6	21	61	35
-SS	Acres	--	--	--	--	--
-Alf-Br[c]	Acres	80	72	59	52	55
-Br[c]	Acres	--	15	59	48	71
-BFT[c]	Acres	--	--	--	--	--

Class III Land-FS silage	Acres	--	--	--	--	--
-SS	Acres	--	--	--	10	--
-Alf-Br[c]	Acres	43	104	188	180	152
-Br[c]	Acres	41	51	--	--	--
-BFT[c]	Acres	127	68	39	16	66
-KBG	Acres	74	54	41	76	55
Forages harvested:						
Corn silage harvested	Tons[d]	564	539	694	1,630	511
Less storage loss	Tons	85	81	104	245	77
Corn silage fed to feedlot cattle	Tons	479	458	590	1,385	--
Corn silage fed to beef cows	Tons	--	--	--	--	--
Forage sorghum silage harvested	Tons	--	103	363	1,244	1,529
Less storage loss	Tons	--	15	55	189	234
Forage sorghum silage fed to beef cows	Tons	--	88	308	1,055	1,295
Hay harvested, method		Stacked	Stacked	Stacked	Baled	Baled
Hay harvested	Tons	421	416	473	368	392
Less storage loss	Tons	51	50	57	15	16
Hay fed to feedlot cattle	Tons	--	--	--	69	224
Hay fed to beef cows	Tons	370	366	416	284	152
Cornstalks stacked	Tons	140	138	116	--	--
Less storage loss	Tons	14	14	11	--	--
Stacked cornstalks fed to beef cows	Tons	126	124	105	--	--

[a] See Table 10 for explanation of abbreviations and equipment which is included.

[b] Utilization of pasture and harvested forages by the beef cow herd is presented in more detail in Tables E.6 through E.10. See Table B.4 for explanation of abbreviations.

[c] Including seeding.

[d] On a moisture basis.

on Class I land at the high cattle price level when cattle feeding is allowed. Grain production is replaced by production of forage sorghum silage on Class II land, especially in the solutions without cattle feeding. There is also a shift from row crops and alfalfa-bromegrass to bromegrass on Class II; this shift is also greater in the solutions without cattle feeding. On Class III land in these solutions, forage production shifts from bromegrass, birdsfoot trefoil-orchardgrass, and bluegrass to alfalfa-bromegrass. The shorter stand life of alfalfa-bromegrass allows more corn acreage on Class III land. However, no corn is grown on Class III land in the solution at the high cattle price level with no cattle feeding. The larger beef cow herds in the solutions with no cattle feeding place more pressure on the forage producing capacity of the farm. More harvested forage, both forage sorghum silage and stacked hay, is produced and the shifts in forage species on Class II and Class III land are more pronounced.

Annual forages, especially forage sorghum silage and sorghum-sudangrass, play a greater role as the increased size of the beef cow herd requires greater forage production in the solutions with a full-time employee. The same number of beef cows are included in the solutions with and without cattle feeding at the medium cattle price level with a full-time employee. Forage sorghum silage is produced on Class I land in the solution without cattle feeding. When cattle feeding is included, Class I land shifts completely to corn silage production and more forage sorghum silage is produced on Class II and Class III land to partially compensate for this shift. Alfalfa-bromegrass is the only perennial forage grown on

Class II land in the solution with no cattle feeding while a combination of alfalfa-bromegrass and bromegrass is included in the solution with cattle feeding. Alfalfa-bromegrass is the major forage grown on Class III land in both of these solutions.

In the solutions at the high cattle price level with a full-time employee, all Class I land is devoted to production of forage for the beef cow herd, mostly forage sorghum silage in the solution without cattle feeding, and a combination of forage sorghum silage and sorghum-sudangrass in the solution with cattle feeding. Forage sorghum silage is also produced on Class II and Class III land. The remainder of the Class II land is in a combination of alfalfa-bromegrass and bromegrass. In the solution with cattle feeding, alfalfa-bromegrass is the major perennial forage on Class III land, however, in the solution without cattle feeding, there is a very large acreage of birdsfoot trefoil-orchardgrass which differs from the pattern of the other solutions described in Tables 16 and 17.

The tonnage of forage sorghum silage harvested in the solution at the high cattle price level with a full-time employee with no cattle feeding allowed is almost double the amount harvested at the medium price level. The 498 head beef cow herd is supported on 1.32 acres per cow in this solution. In the corresponding solution with cattle feeding, the beef cow herd is reduced to 440 head and the amount of forage sorghum silage harvested is reduced by almost one-half.

It was noted in the discussion of livestock production in the key solutions for the forage farm that cattle feeding shifted from corn silage and corn grain to baled hay and corn grain when a full-time

employee was added to the labor supply. The baled hay and corn grain feeding activities are based on high concentrate feeding programs (Table D.5). They replace the silage based activities in these solutions because the purchase of corn grain is the only way that the livestock program can be expanded beyond the feed producing capacity of the model farm. The corn grain purchased, as shown in Table 17, is equivalent to approximately the production of 185 acres of Class I land at the medium price level and 300 acres at the high price level.

The beef cow herd forage systems for the solutions without cattle feeding are presented in Tables E.1 through E.5, and, for the solutions with cattle feeding, in Tables E.6 through E.10. At the low cattle price level (Tables E.1 and E.6), the grazing program is limited mainly to new seeding and regrowth after hay harvest. Three-season grazed fertilized bluegrass and bromegrass fertilized with 240 pounds of nitrogen provide important amounts of grazing in May, June, and September in the solution with cattle feeding. Stacked hay and stacked cornstalks make up the harvested forage supply. The only harvested forage required during the pasture season (May through October) is a small amount of hay fed in May. In general, the feed supply for the beef cow herd in these solutions involves resources which have no alternative use in the model.

The forage programs for the solutions at the medium and high price levels without a full-time employee and without cattle feeding are presented in Tables E.2 and E.3; the forage programs for the corresponding solutions with cattle feeding are presented in Tables E.7 and E.8. As previously indicated, there is a shift from grain to forage production to support the larger beef cow herds in these solutions. Some forage sorghum

silage is harvested, although stacked hay remains the major harvested forage. There is more feeding of harvested forages during the May through October pasture season, mainly in May, August, and September. Both hay and forage sorghum silage are fed during these months. Sorghum-sudangrass, which provides grazing from July through September, is included in the forage program at the high cattle price level with no cattle feeding (Table E.3). Three-season grazed bromegrass, fertilized with 240 pounds of nitrogen provides a relatively important source of grazing in May, June, and July, in each of these solutions.

The forage systems for the solutions with a full-time employee are presented in Tables E.4, E.5, E.9, and E.10. The larger beef cow herds in these solutions place more pressure on the farm's forage producing capability. There is a greater shift from grain to forage production with more emphasis on annual forages, especially forage sorghum and sorghum-sudangrass. Forage sorghum is the key forage species in these solutions. Forage sorghum silage is the major harvested forage and is fed in all months except June, July, November, and December. Forage sorghum regrowth after silage harvest is an important feed source for the cow herd in November and the major source in December in these solutions. The birdsfoot trefoil-orchardgrass on Class III land, which was mentioned earlier as a unique feature of the solution without cattle feeding at the high cattle price level (Table E.5), provides relatively important amounts of grazing in June, July, and August.

Baled mixed hay is fed in December when there is excess TDN available. There is a relatively high shadow price on crude protein in both of the solutions with no cattle feeding (Tables E.4 and E.5). Apparently

hay is fed as a protein source when the cows are meeting most of their energy requirements with the low quality forage sorghum regrowth. Supplemental protein could be fed to the beef cow herd through separate protein feeding activities at a cost of 5.4 cents per pound of supplement or 18 cents per pound of crude protein. The highest shadow price for crude protein in either of these solutions is 8.6 cents per pound in December at the high cattle price level.

A consistent feature of the beef cow herd forage systems described in Tables E.1 through E.10 is the close balance of energy needs and requirements indicated by the few cases of excess availability of TDN. This is due to the fact that most of the feeds utilized are sufficiently high in protein that meeting the energy needs is the major consideration in forage system planning. One exception is the case of excess TDN in December in the form of forage sorghum regrowth, with baled hay being fed as a supplemental protein source. The manageability of a forage system in which TDN supplies and requirements are completely balanced through most of the year is questionable. The farm operator would probably want to maintain an emergency feed supply in some form.

Grain feeding to the beef cow herd, with the exception of small amounts of grain required for the replacement heifers and herd bulls and creep feeding of calves, was not considered an alternative. The cost of TDN from corn grain is 2.7 cents per pound with the assumed purchase price of $1.22 per bushel. In several cases, mainly at the high cattle price level, the shadow price of TDN rises above 2.7 cents per pound, indicating that corn grain feeding should be considered as an alternative in

meeting the cow's energy requirements during critical periods such as the calving season.

Return to operator labor and management

Returns to operator labor and management for the key solutions without cattle feeding are presented in Table 18. As previously mentioned, the negative operator labor and management return at the low cattle price level must be considered together with the return to the operator's equity capital in determining net farm income. The addition of a full-time employee seriously depresses operator labor and management return at the medium cattle price level and does not affect it greatly at the high price level.

Operator labor and management returns for the key solutions with cattle feeding, presented in Table 19, are higher than those in the corresponding key solutions without cattle feeding. The difference is not large at the low cattle price level and labor and management returns remain negative. At the medium and high cattle price levels with no full-time employee, labor and management returns are respectively $1522 and $1647 higher when cattle feeding is allowed. The differences are greater when a full-time employee is added: $4965 at the medium price level and $9476 at the high price level.

A comparison of operator labor and management returns with and without a full-time employee indicates that, although there would be no financial advantage in adding a full-time employee when no cattle feeding is allowed, the farm could support a two-man operation at the high price level. When a cattle feeding enterprise is included, a two-man operation

TABLE 18. Return to operator labor and management on the forage farm: solutions with no cattle feeding

Cattle price level	Low	Medium	High	Medium	High
Full-time employee	No	No	No	Yes	Yes
Forage harvesting equipment[a]	OSFW	OSFW,CFH	OSFW,CFH	CB,CFH	OB,CFH
Program value	$23,346	$31,378	$41,162	$31,535	$46,243
Less:					
Land charge	17,619	17,619	17,619	17,619	17,619
Fixed costs of basic machinery	4,597	4,597	4,597	4,597	4,597
Fixed costs of forage harvesting equipment	1,783	2,156	2,156	941	1,420
Constant portion of silo fixed costs	--	193	193	193	193
Salary of full-time employee plus interest[b]	--	--	--	6,240	6,240
Return to operator labor and management	$-635	$6,813	$16,579	$1,945	$16,147
Less standard charge for operator labor	6,000	6,000	6,000	6,000	6,000
Management return	$-6,635	$ 813	$10,579	$-4,055	$10,147

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Eight percent annual interest charged for an average of one-half a year.

TABLE 19. Return to operator labor and management on the forage farm: solutions with cattle feeding allowed

Cattle price level	Low	Medium	High	Medium	High
Full-time employee	No	No	No	Yes	Yes
Forage harvesting equipment[a]	OSFW,CFH	OSFW,CFH	OSFW,CFH	OB,CFH	OB,CFH
Program value	$24,549	$33,143	$43,034	$37,222	$55,789
Less:					
Land charge	17,619	17,619	17,619	17,619	17,619
Fixed costs of basic machinery	4,597	4,597	4,597	4,597	4,597
Fixed costs of forage harvesting equipment	2,399	2,399	2,399	1,663	1,517
Constant portion of silo fixed costs	193	193	193	193	193
Salary of full-time employee plus interest[b]	--	--	--	6,240	6,240
Return to operator labor and management	$-259	$8,335	$18,226	$6,910	$25,623
Less standard charge for operator labor	6,000	6,000	6,000	6,000	6,000
Management return	$-6,259	$2,335	$12,226	$ 910	$19,623

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Eight percent interest was charged for an average of one-half a year.

would be viable at either the medium or high cattle price levels and addition of a full-time employee would increase operator labor and management returns by $7397 at the high price level.

Capital requirements

Investment in the beef cow herd dominates the non-land capital requirements, especially at the higher cattle price levels, for the key solutions without cattle feeding, as shown in Table 20. Other non-land capital requirements do not change as rapidly, increasing by $16,452 between the solution at the low cattle price level and the solution at the high price level with a full-time employee. Most of this increase is in short-term operating capital and feed storage facilities. This represents an increase of about one-third the original requirement for other non-land capital, while investment in the beef cow herd more than triples.

Capital requirements for the key solutions for the forage farm with cattle feeding allowed are presented in Table 21. The requirements for the solutions with no full-time employee are not considerably higher than those for the corresponding solutions with no cattle feeding. This is especially true at the medium and high cattle price levels where the investment in feeder cattle very nearly offsets the smaller investment in the cow herd. The total average fixed investment and annual fixed costs attributable to the cattle feeding enterprise, including feedlot facilities, feed storage, and feeding equipment, for the solutions without a full-time employee are:

TABLE 20. Capital utilized on the forage farm: solutions with no cattle feeding

Cattle price level	Low	Medium	High	Medium	High
Full-time employee	No	No	No	Yes	Yes
Forage harvesting equipment[a]	OSFW	OSFW,CFH	OSFW,CFH	CB,CFH	OB,CFH
Capital (other than land):					
Short term operating capital	$12,153	$13,184	$12,965	$16,608[b]	$21,384[b]
Breeding livestock					
Swine	2,115	2,115	2,115	2,115	2,115
Beef cow herd	55,966	85,252	123,803	104,969	183,006
Machinery and equipment[c]					
Basic machinery	18,126	18,126	18,126	18,126	18,126
Forage equipment	6,400	7,755	7,755	3,442	5,169
Livestock facilities and equipment[c]					
Swine	4,050	4,050	4,050	4,050	4,050
Beef cows	2,202	2,763	3,371	3,402	4,983
Crop storage facilities[c]	3,336	4,605	3,264	7,828	9,043
Total non-land capital	$104,348	$137,850	$175,449	$160,540	$247,876
Return to non-land capital[d]	$1,784	$11,933	$24,728	$8,858	$30,086
Rate of return to non-land capital	1.71%	8.66%	14.09%	5.52%	12.13%
Non-land capital plus land value[e]	$344,963	$378,465	$416,064	$401,155	$488,491
Return to non-land capital plus assumed fair return to land value[e]	$15,023	$25,172	$37,967	$22,097	$43,325
Rate of return to total capital	4.35%	6.65%	9.12%	5.51%	8.86%

[a] See Table 10 for explanation of abbreviations and equipment which is included.

[b] Includes the full-time employee's salary.

[c] Average value, not initial investment cost.

[d] Program value plus interest paid within the model less the land charge (Table 3); a standard charge for operator labor of $6,000; the full-time employee's salary of $6,000, when included and the fixed costs, other than interest, of machinery, etc.

[e] See Table 3.

TABLE 21. Capital utilized on the forage farm: solutions with cattle feeding allowed

Cattle price level	Low	Medium	High	Medium	High
Full-time employee	No	No	No	Yes	Yes
Forage harvesting equipment[a]	OSFW,CFH	OSFW,CFH	OSFW,CFH	OB,CFH	OB,CFH
Capital (other than land):					
Short term operating capital	$13,640	$14,169	$13,978	$37,132[b]	$45,147[b]
Feeder cattle	9,918	12,662	20,340	46,222	72,688
Breeding livestock					
Swine	2,115	2,115	1,031	2,115	2,115
Beef cow herd	53,602	71,429	102,649	104,876	161,520
Machinery and equipment[c]					
Basic machinery	18,126	18,126	18,126	18,126	18,126
Forage equipment	8,640	8,640	8,640	6,054	5,524
Livestock facilities and equipment[c]					
Swine	4,050	4,050	1,962	4,050	4,050
Beef cows	2,109	2,315	2,795	3,399	4,398
Cattle feeding	3,858	3,556	4,582	16,567	17,330
Crop storage facilities[c]	4,333	4,457	4,791	9,880	8,028
Total non-land capital	$120,391	$141,519	$178,894	$258,421	$338,926
Return to non-land capital[d]	$3,473	$13,756	$26,637	$21,667	$46,823
Rate of return to non-land capital	2.85%	9.72%	14.88%	8.38%	13.81%
Non-land capital plus land value[e]	$361,006	$382,134	$419,509	$499,036	$579,541
Return to non-land capital plus assumed fair return to land value[e]	$16,676	$26,995	$39,876	$34,906	$60,062
Rate of return to total capital	4.62%	7.06%	9.50%	6.99%	10.36%

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Includes the full-time employee's salary.

[c]Average value, not initial investment cost.

[d]Program value plus interest paid within the model less the land charge (Table 3); a standard charge for operator labor of $6,000; the full-time employee's salary of $6,000; when included; and the fixed costs, other than interest, of machinery, etc.

[e]See Table 3.

	Average fixed investment	Annual Fixed costs
Low cattle price level	$7,092	$2,017
Medium cattle price level	$6,204	$1,746
High cattle price level	$7,816	$2,199

The capital requirements for the solutions with a full-time employee which include feeding large numbers of purchased calves are roughly $90,000 to $100,000 higher than in the corresponding solutions with no cattle feeding. Much of this added capital requirement takes the form of purchased calves and purchased corn grain (Tables 15 and 17).

Labor requirements

Table 22 shows the labor requirements for the key solutions for the forage farm with no cattle feeding. The shadow prices on operator labor in April indicate that high labor requirements during the calving season are an important limitation on beef cow numbers in the solutions without a full-time employee at the medium and high cattle price levels and with a full-time employee at the high price level. An important reason that labor is not limiting during the harvest season is that both grain and silage are custom harvested, as previously discussed.

Labor requirements and shadow prices for operator labor for the key solutions with cattle feeding are presented in Table 23. Available operator and hired labor is more fully employed than in the solutions without cattle feeding, as indicated by the fact that there are shadow prices for operator labor during more months of the year. Labor is most limiting in May and December at the low cattle price level and during the

TABLE 23. Labor required on the forage farm: solutions with cattle feeding allowed

Cattle price level	Low		Medium		High		Medium		High	
Full-time employee	No		No		No		Yes		Yes	
Forage harvesting equipment[a]	OSFW,CFH		OSFW,CFH		OSFW,CFH		OB,CFH		OB,CFH	
	Labor furnished by operator (and full-time employee, if included)[b]									
	Hrs.	(Shadow price[c])	Hrs.	(Shadow price[c])	Hrs.	(Shadow price[c])	Hrs.	(Shadow price[c])	Hrs.	(Shadow price[c])
January	212		215	(5.45)	215	(8.90)	430		430	
February	215		215	(26.81)	215	(24.39)	430		430	(1.68)
March	236		241	(5.45)	241	(8.90)	456		456	(5.19)
April	294	(2.60)	294	(5.45)	294	(14.15)	559	(2.60)	559	(21.49)
May	279	(4.06)	279	(7.88)	279	(8.90)	544	(1.41)	544	(.05)
June	289	(2.60)	289	(2.60)	289	(9.27)	504	(6.02)	504	(3.96)
July	270		290		299		430		514	(.44)
August	281		283		299	(2.60)	514	(.05)	514	(2.60)
September	230		257		271		368		361	
October	242		247		224		252		303	
November	292	(2.60)	292	(2.60)	292	(2.60)	472		474	
December	215	(4.06)	215	(5.45)	215	(11.40)	367		389	
Total	3,055		3,117		3,133		5,326		5,478	

		Hourly part-time labor hired			
April	54	112	112	--	112
May	73	80	80	--	--
June	117	177	193	28	71
July	--	--	--	--	--
August	--	--	17	--	--
September	--	--	--	--	--
October	--	--	--	--	--
November	34	48	15	--	--
Total	278	417	417	28	183
Total hours required	3,122	3,486	3,577	3,979	4,783

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Includes overhead labor.

[c]The value of an additional hour of operator (or full-time employee) labor, expressed in dollars per hour.

TABLE 22. Labor required on the forage farm: solutions with no cattle feeding

Cattle price level	Low	Medium	High	Medium	High
Full-time employee	No	No	No	Yes	Yes
Forage harvesting equipment[a]	OSFW	OSFW,CFH	OSFW,CFH	CB,CFH	OB,CFH
	Labor furnished by operator (and full-time employee, if included)[b]				
	Hours (Shadow price[c])	Hours (Shadow price[c])	Hours (Shadow price[c])	Hours (Shadow price[c])	Hours (Shadow price[c])
January	166	188	215 (8.42)	245	328
February	183	210	215 (8.42)	245	309
March	201	230	241 (8.42)	318	346
April	294 (2.60)	294 (15.09)	294 (14.29)	559 (1.99)	559 (8.16)
May	279 (2.60)	279 (4.74)	279 (8.42)	391	444
June	289 (2.60)	289 (2.60)	289 (10.23)	464	504 (2.60)
July	233	256	299 (.69)	239	306
August	250	299 (1.86)	299 (2.60)	396	502
September	205	268	284	309	407
October	266	269	245	291	355
November	292 (2.60)	292 (2.60)	292 (2.60)	290	314
December	186	195	208	204	226
Total	2,844	3,069	3,160	3,951	4,600

			Hourly part-time labor hired		
April	112	112	112	80	112
May	80	80	80	23	16
June	152	160	193	193	193
July	--	--	6	--	19
August	--	--	7	--	15
September	--	--	--	--	--
October	--	--	--	--	--
November	31	43	59	--	--
Total	375	395	457	296	355
Total hours required	3,430	3,512	3,590	5,622	5,833

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Includes overhead labor.

[c]The value of an additional hour of operator (or full-time employee) labor, expressed in dollars per hour.

winter months at the medium and high cattle price levels with no full-time employee. Only in the solution at the high cattle price level with a full-time employee is labor most limiting during the calving season (April).

Beef cow-calf enterprise costs and returns

Beef cow-calf unit budgets based on the key solutions with no cattle feeding are presented in Table 24. Total fixed and variable costs per unit, not including investment in land and livestock, do not vary by more than three dollars between the five solutions. Some trade-offs between costs are evident. For example, at the medium cattle price level, fixed costs of forage equipment are $6.04 higher for the solution without a full-time employee which includes ownership of a stack-forming wagon than for the solution with a full-time employee in which all forages are custom harvested. However, variable forage production and feeding costs and feed storage facility fixed costs are higher in the solution with a full-time employee, and the net difference in total costs between the two solutions is $.90. The same is true at the high cattle price level where the net difference between the two solutions is only $.24.

Intensification of forage production for the beef cow herd at the higher cattle price levels reduces the investment in land per cow-calf unit in these solutions even though Class I land is shifted from grain to forage production. Total investment in land per unit decreases by $105.00 and land cost per unit (taxes plus 5.5 percent return to investment) decreases by $7.73 between the solution at the low cattle

TABLE 24. Beef cow-calf unit budgets for the forage farm: solutions with no cattle feeding[a]

Cattle price level	Low	Medium	High	Medium	High
Full-time employee	No	No	No	Yes	Yes
Forage harvesting equipment[b]	OSFW	OSFW,CFH	OSFW,CFH	CB,CFH	OB,CFH
Total receipts[c]	$109.85	$145.09	$180.40	$145.09	$180.40
Expenses:					
Variable costs:					
Cash expenses (Table D.3)	$21.07	$21.07	$21.07	$21.07	$21.07
Corn grain	2.35	2.35	2.35	2.35	2.35
Variable forage growing and harvesting costs	25.94	25.47	25.60	27.81	25.77
Variable feeding costs	--	.65	.53	1.76	2.32
Interest on short term operating capital	1.97	1.98	1.98	2.11	2.06
Total variable costs	$51.33	$51.52	$51.53	$55.10	$53.57
Return over variable costs	$58.52	$93.57	$128.87	$89.99	$126.83
Fixed costs:					
Livestock facilities and equipment (Table 5)	$3.60	$3.60	$3.60	$3.60	$3.60
Forage equipment	8.09	7.80	6.39	2.76	2.84
Beef cow share of basic machinery[d]	10.85 (52)	10.64 (64)	10.63 (78)	10.26 (76)	8.86(96)
Feed storage facilities	--	1.88	1.48	5.15	5.42
Real estate taxes	10.47	9.24	9.44	8.89	8.54
Total fixed costs	$33.01	$33.16	$31.54	$30.66	$29.26
Return over fixed and variable costs	$25.51	$60.41	$97.33	$59.33	$97.57

Land required per cow-calf unit (Acres):					
Class I			.02	.10	.19
Class II	.36	.44	.47	.38	.32
Class III	1.29	.95	.91	.77	.62
Class IV	.34	.27	.22	.22	.15
Total investment in land	$576.00	$509.00	$520.00	$489.00	$471.00
5.5 percent return to land value	$31.67	$27.97	$28.58	$26.91	$25.87
Eight percent return to investment in livestock (Table D.4)	$20.33	$24.68	$29.38	$24.68	$29.38
Total return to investment in land and livestock	$52.00	$52.65	$57.96	$51.59	$55.25
Residual return to labor	$-26.49	$7.76	$39.37	$7.74	$42.32
Labor required (hours):					
Non-feed labor (Table D.2)	3.49	3.49	3.49	3.49	3.49
Feeding labor	.66	.92	.78	1.72	1.71
Feed production labor	1.47	1.48	1.34	1.16	1.01
Total	5.62	5.89	5.61	6.37	6.21
Labor income (per hour)	$-4.71	$1.32	$7.02	$1.22	$6.81

[a] A cow-calf unit includes one cow, .9 calf, .17 replacement heifer, and .04 bull.

[b] See Table 10 for explanation of abbreviations and equipment which is included.

[c] Assumes sale of .45 steer calf (441 pounds), .28 heifer calf (412 pounds), and .15 cull cow (1018 pounds) at the prices shown in Table 9.

[d] Allocated to the beef cow herd on the basis of the percentage of total tractor hours which were required for feed production, feeding, and chroring. The figure in parentheses is the percentage of basic machinery fixed costs which is charged to the beef cow herd in each solution.

price level and the solution at the high cattle price level with a full-time employee.

One of the factors underlying the shift from stacked hay and stacked cornstalks to baled hay and silage when a full-time employee is added is that more labor is available for forage feeding. A comparison of the labor requirements presented in Table 24 indicated that feed production labor requirements per unit are actually less in the solutions with a full-time employee than in the solutions without a full-time employee, due to custom harvesting of silage. However, labor utilized for feeding increases by .8 and .93 hours per unit at the medium and high cattle price levels, respectively, when a full-time employee is added. The levels of silage feeding are 3.8 and 5.4 tons per cow-calf unit in the solutions with a full-time employee at the medium and high price levels, respectively. Silage feeding is limited to 1.6 and 1.3 tons per unit in the corresponding solution with no full-time employee where winter labor is more restrictive.

Costs and returns per cow-calf unit for the key solutions with cattle feeding are presented in Table 25. Per unit costs for the solutions without a full-time employee do not differ significantly from those for the corresponding solutions without cattle feeding. In the solutions involving a full-time employee, total fixed costs are $5.96 lower at the medium price level and $7.10 lower at the high price level than in the corresponding solutions without a full-time employee. The major reason is the spreading of basic machinery fixed costs. This did not occur in the solutions with no cattle feeding because the beef cow herd's share of basic machinery fixed costs increased almost proportionately with herd

TABLE 25. Beef cow-calf unit budgets for the forage farm: solutions with cattle feeding allowed[a]

Cattle price level	Low	Medium	High	Medium	High
Full-time employee	No	No	No	Yes	Yes
Forage harvesting equipment[b]	OSFW,CFH	OSFW,CFH	OSFW,CFH	OB,CFH	OB,CFH
Total receipts[c]	$109.85	$145.09	$180.40	$145.09	$180.40
Expenses:					
Variable costs:					
Cash expenses (Table D.3)	$21.07	$21.07	$21.07	$21.07	$21.07
Corn grain	2.35	2.35	2.35	2.35	2.35
Variable forage growing and harvesting costs	$26.70	$27.43	$25.68	$25.26	$23.57
Variable feeding costs	--	.15	.46	1.47	1.71
Interest on short term operating capital	2.00	2.04	1.98	2.00	1.94
Total variable costs	$52.12	$53.04	$51.51	$52.15	$50.64
Return over variable costs	$57.73	$92.05	$128.89	$92.94	$129.76
Fixed costs:					
Livestock facilities and equipment (Table 5)	$3.60	$3.60	$3.60	$3.60	$3.60
Beef cow share of forage equipment[d]	8.45	7.96	6.84	2.93	1.80
Beef cow share of basic machinery[e]	9.80(45)	9.53(48)	8.88(54)	6.35(47)	5.53(53)
Feed storage facilities	--	.36	1.07	4.40	4.12
Real estate taxes	10.94	10.19	9.72	8.67	7.96
Total fixed costs	$32.79	$31.64	$30.11	$25.95	$23.01
Return over fixed and variable costs	$24.94	$60.41	$98.78	$66.99	$106.75
Land required per cow-calf unit (Acres):					
Class I	--	--	--	--	.22
Class II	.38	.44	.49	.47	.31
Class III	1.34	1.19	.96	.81	.45
Class IV	.36	.33	.27	.22	.17

Total investment in land	$602.00	$560.00	$535.00	$477.00	$438.00
5.5 percent return to land value	$33.09	$30.81	$29.42	$26.25	$24.10
Eight percent return to investment in livestock (Table D.4)	$20.33	$24.68	$29.38	$24.68	$29.38
Total return to investment in land and livestock	$53.42	$55.49	$58.80	$50.93	$53.48
Residual return to labor	$-28.48	$4.92	$39.98	$16.06	$53.27
Labor required (hours):					
Non-feed labor (Table D.2)	3.49	3.49	3.49	3.49	3.49
Feeding labor	.61	.65	.75	1.60	1.31
Feed production labor	1.52	1.41	1.37	1.16	.91
Total	5.62	5.55	5.61	6.25	5.71
Labor income (per hour)	$-5.07	$ .89	$7.13	$2.57	$9.33
Cost of inter-farm transfer of feeder calves saved due to feeding of home-raised calves (per cow-calf unit)[f]	$7.40	$7.78	$9.19	$11.95	$14.16

[a]A cow-calf unit includes one cow, .9 calf, .17 replacement heifer, and .04 bull.

[b]See Table 10 for explanation of abbreviations and equipment which is included.

[c]Assumes sale of .45 steer calf (441 pounds), .28 heifer calf (412 pounds), and .15 cull cow (1018 pounds) at the prices shown in Table 9. This represents the opportunity cost of home-raised calves fed on the farm where they were produced.

[d]Allocated between the beef cow herd and the cattle feeding enterprise on the basis of the proportions of forages consumed.

[e]Allocated to the beef cow herd on the basis of the percentage of total tractor hours which were required for feed production, feeding, and choring. The figure in parentheses is the percentage of basic machinery fixed costs which is charged to the beef cow herd in each solution.

[f]The opportunity cost of home-raised calves fed on the farm subtracted from the cost of purchasing similar calves, divided by the number of cow-calf units.

size. Forage equipment fixed costs are lower in the solutions with a full-time employee but are balanced by higher feed storage facility fixed costs in both solutions.

The cost savings related to the feeding of home-raised calves are noted, although they are not credited directly to the cow-calf unit. The costs saved include actual marketing costs plus the value lost to both the calf producer and the feeder due to shrink. Those values have been discussed previously and, as indicated in Table 25, are relatively important.

The Grain Farm

Livestock production

Livestock production activities in the key solutions for the grain farm without and with cattle feeding are summarized in Tables 26 and 27, respectively.

The beef cow herd includes only 32 and 34 cows in the solutions without and with cattle feeding, respectively, at the low cattle price level. Herd size increases as the cattle price level rises. The increase is much greater in the solutions with no cattle feeding; there are 26 more cows in the solution without cattle feeding at the medium price level, and 62 more at the high price level, than in the corresponding solutions with cattle feeding.

Fall-calving cows are part of the livestock program at the high cattle price level in the key solutions without a full-time employee both with and without cattle feeding and with a full-time employee with cattle

TABLE 26. Livestock production and sales on the grain farm: solutions with no cattle feeding

Cattle price level	Low	Medium	High	High
Full-time employee	No	No	No	Yes
Forage harvesting equipment[a]	OB	OSFW	CB,CFH	CB,CFH
Beef cows-spring calving	32	104	228	463
Beef cows-fall calving	--	--	22	--
Steer calves sold	15	47	112	208
Heifer calves sold	9	29	70	130
Gross income from calf sales	$2,784	$12,029	$36,307	$67,413
Gross income from cull cow sales[b]	$773	$3,053	$8,698	$16,149
Swine: litters farrowed	40	40	40	40
Gross income from swine sales[c]	$15,006	$15,006	$15,006	$15,006
Total gross income from livestock sales	$18,563	$30,088	$60,011	$98,568

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Assumes sale of .15 cull cow weighing 1018 pounds or 153 pounds per cow-calf unit at the prices shown in Table 9.

[c]Sales of sows included.

TABLE 27. Livestock production and sales on the grain farm: solutions with cattle feeding allowed

Cattle price level	Low	Medium	High	Medium	High
Full-time employee	No	No	No	Yes	Yes
Forage harvesting equipment[a]	CB,CFH	CB,CFH	OSFW,CFH	CB,CFH	CB,CFH
Beef cows-spring calving	34	78	144	75	284
Beef cows-fall calving	--	--	44	--	6
Steer calves sold	--	--	--	--	--
Heifer calves sold	--	--	--	--	--
Gross income from calf sales	--	--	--	--	--
Gross income from cull cow sales[b]	$822	$2,301	$6,541	$2,208	$10,105
Steers fed corn silage and corn grain	205	164	115	479	370
Steers fed baled mixed hay and corn grain	--	--	--	--	50
Total steers fed	205	164	115	479	420
Heifers fed corn silage and corn grain	9	22	52	21	80
Heifers fed baled mixed hay and corn grain	--	--	--	--	--
Total heifers fed	9	22	52	21	80
Gross income from fed cattle sales	$56,329	$59,173	$60,842	$161,602	$187,656
Swine: litters farrowed	40	40	40	40	40
Gross income from swine sales[c]	$15,006	$15,006	$15,006	$15,006	$15,006
Total gross income from livestock sales	$72,157	$76,480	$82,389	$178,816	$212,767
Steer calves purchased	193	131	33	453	296
Heifer calves purchased	--	--	--	--	--
Total cost of purchased calves	$26,954	$24,281	$7,474	$83,675	$68,050

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Assumes sale of .15 cow weighing 1018 pounds or 153 pounds per cow-calf unit at the prices shown in Table 9.

[c]Sales of sows included.

feeding. Although they did not enter these solutions in numbers equal to the spring calving cows, the fact that they are competitive in these solutions indicates that fall-calving or split-season calving should be considered more closely, especially for this type of farm. No price advantage was given to fall-dropped calves, and some possible economies of split-season calving, such as greater utilization of herd bulls, were not considered.

The addition of a full-time employee does not affect the size of the cow herd at the medium price level with cattle feeding. At the high cattle price level with no cattle feeding, the size of the cow herd almost doubles when a full-time employee is added. The farm is supporting a cow-calf unit on .86 acre in this solution. The addition of a full-time employee with cattle feeding at the high cattle price level permits an increase of the cow herd from 188 head to 290 head.

The beef cow herd and the cattle feeding enterprise are very competitive in the solutions with no full-time employee. The number of cattle fed decreases from 214 to 167 head between the low and high cattle price levels and shifts from feeding mostly purchased calves to mostly home-raised calves. The maximum 500 head are fed out in both solutions with a full-time employee. With the expansion of the cow herd from 75 head at the medium price level to 290 head at the high price level, the number of calves purchased decreases from 453 to 296. All cattle are fed corn silage and corn grain except in the solution at the high cattle price level with a full-time employee where 50 head of steer calves are fed baled hay and corn grain.

The maximum number of litters of swine are farrowed in each of the key solutions for the grain farm. As indicated in Table 13, swine numbers on the grain farm were reduced below the maximum 40 litters only in two of the alternative solutions at the high cattle price level with cattle feeding with no full-time employee.

Crop production and utilization

Crop production for the grain farm is summarized in Table 28 for the key solutions without cattle feeding and in Table 29 for the key solutions with cattle feeding.

The maximum allowable acreage of soybeans and of total row crops are produced on Class I and Class II land in both solutions at the low cattle price level. The remainder of the Class II land is in alfalfa-bromegrass. The largest share of the Class III land is in permanent bluegrass pasture, however, there is some alfalfa-bromegrass and birdsfoot trefoil-orchardgrass. The main difference in the crop programs between the two solutions is the shift of 66 acres of Class I land from corn grain to corn silage for cattle feeding. The major forage harvested for the cow herd is baled mixed hay, although two acres of forage sorghum are harvested for silage in the solution with cattle feeding.

Class I and Class II land is shifted from grain to forage production in the solutions at the medium and high cattle price levels with no full-time employee. The Class I land devoted to feed production for the beef cow herd at the medium price level is limited to 37 acres

TABLE 28. Crop production and disposition on the grain farm: solutions with no cattle feeding

Cattle price level Full-time employee Forage harvesting equipment[a]		Low No OB	Medium No OSFW	High No CB,CFH	High Yes CB,CFH
Grain production:	Unit				
Class I land-corn grain	Acres	156	119	--	--
-soybeans	Acres	156	156	154	--
Class II Land - corn grain	Acres	10	--	--	--
- soybeans	Acres	10	2	--	--
Class III land - corn grain	Acres	2	--	--	--
Soybeans harvested and sold	Bushels	6,938	6,684	6,526	--
Corn grain harvested	Bushels	19,027	13,685	--	--
Corn grain purchased	Bushels	--	--	4,823	5,045
Corn grain fed	Bushels	4,236	4,360	4,823	5,045
Corn grain sold	Bushels	14,791	9,325	--	--
Gross income from crop sales		$35,437	$28,624	$17,751	--
Forage production:[b]					
Class I land - corn silage	Acres	--	--	--	23
-FS silage	Acres	--	--	78	173
-SS	Acres	--	24	42	89
-Alf-Br[c]	Acres	--	13	38	28
Class II land-corn silage	Acres	--	--	--	--
-FS silage	Acres	--	--	--	--
-SS	Acres	--	--	--	--

Class II land-Alf-Br[c]	Acres	20	19	--	9
-Br[c]	Acres	--	17	39	30
-BFT[c]	Acres	--	--	--	--
-KBG	Acres	--	--	--	--
Class III land-FS silage	Acres	--	--	--	--
-SS	Acres	--	--	--	--
-Alf-Br[c]	Acres	3	5	31	31
-Br[c]	Acres	--	--	--	--
-BFT[c]	Acres	10	--	--	--
-KBG	Acres	17	26	--	--
Forages harvested:					
Corn silage harvested	Tons[d]	--	--	--	379
Less storage loss	Tons	--	--	--	57
Corn silage fed to beef cows	Tons	--	--	--	322
Forage sorghum silage harvested	Tons	--	--	1,499	3,317
Less storage loss	Tons	--	--	229	508
Forage sorghum silage fed to beef cows	Tons	--	--	1,270	2,809
Hay harvested, method		Baled	Stacked	Baled	Baled
Hay harvested	Tons	43	116	65	105
Less storage loss	Tons	2	14	3	4
Hay fed to beef cows	Tons	41	102	62	101
Cornstalks stacked	Tons	--	252	--	--
Less storage loss	Tons	--	25	--	--
Stacked cornstalks fed to beef cows	Tons	--	227	--	--

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Utilization of pasture and harvested forages by the beef cow herd presented in more detail in Tables E.11 through E.14. See Table B.4 for explanation of abbreviations.

[c]Including seeding.

[d]On a moisture basis.

TABLE 29. Crop production and disposition on the grain farm: solutions with cattle feeding allowed

Cattle price level Full-time employee Forage harvesting equipment[a]		Low No CB,CFH	Medium No CB,CFH	High No OSFW,CFH	Medium Yes CB,CFH	High Yes CB,CFH
Grain production:	Units					
Class I land-corn grain	Acres	90	82	82	--	--
-soybeans	Acres	156	156	82	145	--
Class II land-corn grain	Acres	8	--	--	--	--
-soybeans	Acres	10	--	--	--	--
Class III land-corn grain	Acres	1	--	--	--	--
Soybeans harvested and sold	Bushels	6,938	6,599	3,489	6,139	--
Corn grain harvested	Bushels	11,161	9,428	9,396	--	--
Corn grain purchased	Bushels	--	--	--	18,304	20,323
Corn grain fed	Bushels	10,240	9,428	9,396	18,304	20,323
Gross income from crop sales		$19,903	$17,949	$9,490	$16,698	--
Forage production:[b]						
Class I land-corn silage	Acres	66	57	49	155	149
-FS silage	Acres	--	6	40	12	108
-SS	Acres	--	11	26	--	55
-Alf-Br[c]	Acres	--	--	33	--	--
Class II land-corn silage	Acres	--	--	--	--	--
-FS silage	Acres	2	6	--	17	--
-SS	Acres	--	--	--	--	--
-Alf-Br[c]	Acres	20	24	--	16	15
-Br[c]	Acres	--	6	39	6	24
-BFT[c]	Acres	--	--	--	--	--
-KBG	Acres	--	3	--	--	--

Class III land-FS silage	Acres	--	--	--	--	--
-SS	Acres	--	--	--	3	--
-Alf-Br[c]	Acres	2	--	7	--	27
-Br[c]	Acres	--	--	--	--	-
-BFT[c]	Acres	6	--	--	28	4
-KBG	Acres	22	31	24	--	--
Forages harvested:						
Corn silage harvested	Tons[d]	1,116	963	817	2,600	2,509
Less storage loss	Tons	168	144	122	389	376
Corn silage fed to feedlot cattle	Tons	948	808	695	2,211	1,932
Corn silage fed to beef cows	Tons	--	11	--	--	201
Forage sorghum silage harvested	Tons	31	220	772	519	2,073
Less storage loss	Tons	5	33	127	79	317
Forage sorghum silage fed to beef cows	Tons	26	187	645	440	1,756
Hay harvested, method		Baled	Baled	Stacked	Baled	Baled
Hay harvested	Tons	33	40	94	21	87
Less Storage loss	Tons	1	2	11	1	4
Hay fed to feedlot cattle	Tons	--	--	--	--	23
Hay fed to beef cows	Tons	32	38	83	20	60
Cornstalks stacked	Tons	--	--	173	--	--
Less storage loss	Tons	--	--	17	--	--
Stacked cornstalks fed to beef cows	Tons	--	--	156	--	--

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Utilization of pasture and harvested forages by the beef cow herd is presented in more detail in Tables E.15 through E.19. See Table B.4 for explanation of abbreviations.

[c]Including seeding.

[d]On a moisture basis.

in the solution without cattle feeding and 17 acres in the solution with cattle feeding. At the high cattle price level this is expanded to 158 acres and 99 acres in the solutions without and with cattle feeding, respectively. Soybeans remain at or near maximum acreage on Class I land except at the high price level with cattle feeding. Production of corn silage for cattle feeding requires 57 acres of Class I land at the medium price level and 49 acres of Class I land at the high price level.

Sorghum-sudangrass is the most important forage grown for the beef cow herd on Class I land at the medium price level. Forage sorghum becomes the major forage species at the high price level. Some alfalfa-bromegrass is grown on Class I land, especially at the high cattle price level. Class II land shifts from grain, annual forages, and alfalfa-bromegrass, at the low and medium cattle price levels to bromegrass at the high cattle price level. Class III land shifts from fertilized permanent bluegrass pasture at the low and medium cattle price levels to alfalfa-bromegrass at the high price level in the solutions without cattle feeding; Class III land remains mostly in fertilized permanent pasture in the solutions with cattle feeding. Stacked hay and cornstalks are the harvested forages for the solution at the medium cattle price level with no cattle feeding. Forage sorghum silage and hay are the major harvested forages in the solutions with cattle feeding, although there is a fairly large amount of stacked cornstalks fed at the high cattle price level.

The farm is devoted entirely to forage production for the beef cow herd in the solution at the high cattle price level with no cattle feeding with a full-time employee. Annual forages are raised on all but 28 acres of the Class I land, with 173 acres of forage sorghum and 89 acres of sorghum-sudangrass. Class II and Class III land is in alfalfa-bromegrass and bromegrass. Forage sorghum silage and some corn silage are the major harvested forages, with a relatively small tonnage of baled hay.

The cattle feeding enterprise requires about 150 acres of Class I land for corn silage production in the solutions with a full-time employee. Soybean acreage remains near the maximum on Class I land at the medium price level and only 12 acres are used to produce forage sorghum silage for the beef cow herd. Seventeen acres of Class II land are also used for forage sorghum production. The rest of the Class II land is in alfalfa-bromegrass and bromegrass; most of the Class III land is in birdsfoot trefoil-orchardgrass.

The Class I land which is not used for corn silage production in the solution at the high cattle price level with cattle feeding with a full-time employee is utilized for the production of forage sorghum and sorghum-sudangrass for the beef cow herd. The Class II land is in alfalfa-bromegrass and bromegrass and the Class III land is mostly in alfalfa-bromegrass. Forage sorghum silage and baled hay are the major harvested forages utilized by the cow herd in both of the solutions with cattle feeding with a full-time employee, although some corn silage is fed

to the beef cows at the high price level. Corn grain purchases are equivalent to the production of about 155 acres of Class I land at the medium cattle price level and 170 acres of Class I land at the high cattle price level.

The beef cow herd forage systems for the key solutions for the grain farm without cattle feeding are outlined in Tables E.11 through E.14; those for the corresponding solutions with cattle feeding are presented in Tables E.15 through E.19.

Cornstalk grazing is the major feed source for the cow herd in December and January in the solutions at the low cattle price level (Tables E.11 and E.15). There is excess TDN availability in these months in both solutions. Baled mixed hay is fed in January as a crude protein source. New seeding and regrowth of birdsfoot trefoil-orchardgrass and alfalfa-bromegrass after harvest are major sources of grazing during the pasture season, although three-season grazed fertilized bluegrass pasture provides important sources of grazing in May, June, and September. Baled mixed hay is the major harvested forage with the largest amounts of hay being fed in February, March, and April. Some hay is fed in May and November in the solution without cattle feeding, and August, October, and November in the solution with cattle feeding. Twenty-six tons of forage sorghum silage are also fed in April in the solutions with cattle feeding.

Annual forages become more important in the forage systems for the solutions without cattle feeding at the medium and high cattle price levels without a full-time employee (Tables E.12 and E.13), as Class I land is shifted from grain to forage production. Sorghum-sudangrass is

the source of grazing in July, August, and September, in both solutions. Forage sorghum silage is harvested from 80 acres of Class I land at the high cattle price level, and forage sorghum regrowth is an important source of grazing in November and the major source in December. Some alfalfa-bromegrass is raised on Class I land in these solutions. Most of it is harvested as hay but about seven acres are rotationally grazed at the high cattle price level. Class II land shifts from alfalfa-bromegrass to three-season grazed bromegrass, and Class III land shifts from fertilized bluegrass to alfalfa-bromegrass in these solutions. At the high cattle price level (Table E.13), Class II land is utilized completely for three-season grazed bromegrass and Class III land is used completely for rotationally grazed alfalfa-bromegrass. All harvested forages are taken from the Class I land. A combination of stacked hay and stacked cornstalks is fed to the cow herd from December through April in the solution at the medium cattle price level. Energy and crude protein supplies and needs completely balanced, and a constant shadow price of 9.2 cents per pound of crude protein is observed through the winter period. Stacked hay is also fed in May. Forage sorghum silage is the major harvested forage at the high price level and baled mixed hay is used to balance the crude protein requirements. Forage sorghum silage is fed throughout the May through October pasture season except in July.

Cornstalks are part of the forage systems in the solutions at the medium and high price levels with cattle feeding with no full-time employee (Tables E.16 and E.17). Cornstalk grazing is the major energy source in December and January at the medium price level, while stacked cornstalks are the major harvested forage in February and March at the

high price level. Approximately 17 acres of Class I land are utilized for production of forage sorghum and sorghum-sudangrass at the medium cattle price level; nearly 100 acres of Class I land are devoted to forage production for the beef cow herd at the high cattle price level, including 66 acres of annual forages and 33 acres of alfalfa-bromegrass from which one crop of hay is harvested. Class II land shifts from alfalfa-bromegrass to three-season grazed bromegrass at the high price level, and Class III land is mostly in fertilized three-season grazed permanent bluegrass pasture in both solutions. The three-season grazed pastures provide the major source of grazing in the spring, early summer, and fall. The winter feed supply at the medium price level shifts from cornstalk grazing in December and January to baled hay in February to forage sorghum silage in March and April. Forage sorghum silage is also fed in August, September, and October. Forage sorghum silage balanced with stacked mixed hay is the major harvested forage combination fed through the winter at the high price level, although stacked cornstalks are important as an energy source in February and March. Forage sorghum silage is fed throughout the year, except in November and December, with relatively large amounts being fed in September and October.

About the same number of beef cows are included in the solution with cattle feeding at the medium price level with a full-time employee (Table E.18) as in the corresponding solution without a full-time employee. The forage systems are also similar, however more forage sorghum silage is produced and more is fed during the May through October pasture season.

Annual forages dominate the forage systems at the high cattle price level with a full-time employee, as outlined in Tables E.14 and E.19, for the solutions without and with cattle feeding, respectively. Forage sorghum silage is the major harvested forage and is fed in all months except November and December, when forage sorghum regrowth becomes the major feed source, and April, when corn silage replaces the forage sorghum silage. Forage sorghum silage feeding is reduced during July, August, and September when sorghum-sudangrass grazing is available. Total forage sorghum and corn silage feeding per cow-calf unit equals 6.7 tons in the solution without cattle feeding and 6.4 tons in the solution with cattle feeding. Three-season grazed bromegrass is the major perennial forage on Class II land, and alfalfa-bromegrass harvested for hay is the major crop on Class III land. A relatively small amount of baled mixed hay is used to balance the silage fed to the cows during the winter feeding period from January through April. Both TDN and crude protein needs and supplies are balanced throughout the year except during July, August, and September, when excess crude protein is available, and December, when excess TDN is available.

Return to operator labor and management

Operator labor and management returns for the key solutions for the grain farm are presented in Tables 30 and 31, for those solutions without and with cattle feeding, respectively. Labor and management returns are positive in all solutions, although there is a negative management return at the low cattle price level with no cattle feeding when $6,000 is charged against operator labor.

TABLE 30. Return to operator labor and management on the grain farm: solutions with no cattle feeding

Cattle price level	Low	Medium	High	High
Full-time employee	No	No	No	Yes
Forage harvesting equipment[a]	OB	OSFW	CB,CFH	CB,CFH
Program value	$29,349	$31,933	$37,262	$41,610
Less:				
Land charge	17,619	17,619	17,619	17,619
Fixed costs of basic machinery	4,724	4,724	4,724	4,724
Fixed costs of forage equipment	1,047	1,783	941	941
Constant portion of silo fixed costs	--	--	193	193
Salary of full-time employee plus interest[b]	--	--	--	6,240
Return to operator labor and management	$5,959	$7,807	$13,785	$11,893
Less standard charge for operator labor	6,000	6,000	6,000	6,000
Management return	$-41	$1,807	$7,785	$5,893

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Eight percent annual interest charged for an average of one-half a year.

TABLE 31. Return to operator labor and management on the grain farm: solutions with cattle feeding allowed

Cattle price level	Low	Medium	High	Medium	High
Full-time employee	No	No	No	Yes	Yes
Forage harvesting equipment[a]	CB,CFH	CB,CFH	OSFW,CFH	CB,CFH	CB,CFH
Program value	$29,871	$34,080	$41,414	$36,635	$50,353
Less:					
Land charge	$17,619	$17,619	$17,619	$17,619	$17,619
Fixed costs of basic machinery	4,724	4,724	4,724	4,724	4,724
Fixed costs of forage harvesting equipment	1,184	1,184	2,399	1,184	1,184
Constant portion of silo fixed costs	193	193	193	193	193
Salary of full-time employee plus interest[b]	--	--	--	6,240	6,240
Return to operator labor and management	$6,151	$10,360	$16,479	$6,675	$20,393
Less standard charge for operator labor	6,000	6,000	6,000	6,000	6,000
Management return	$151	$4,360	$10,479	$675	$14,393

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Eight percent interest was charged for an average of one-half a year.

There is only $192 difference in management returns between the solutions without and with cattle feeding at the low cattle price level. In all other cases the return to labor and management is considerably higher in the solutions with cattle feeding than in the corresponding solutions without cattle feeding.

The addition of a full-time employee decreases operator labor and management return by $1,892 at the high cattle price level with no cattle feeding and by $3,685 at the medium price level with cattle feeding. Labor and management returns are increased by $3,914 at the high cattle price level with cattle feeding with the addition of a full-time employee. Cattle feeding would have to be included in the livestock program of this farm, with the restrictions placed on swine numbers, to justify a two man operation. Even with cattle feeding included, the increase in operator labor and management return at the high price level with the addition of a full-time employee is approximately equal to the decrease in labor and management return at the medium price level when a full-time employee is included.

Capital requirements

Capital requirements for the key solutions for the grain farm without cattle feeding are presented in Table 32, and those for the key solutions with cattle feeding are presented in Table 33.

Total non-land capital requirements are $32,661 higher in the solution with cattle feeding than in the solution without cattle feeding at the low cattle price level. Of this difference, $27,174 is required for the investment in feeder cattle and cattle feeding facilities. The

TABLE 32. Capital utilized on the grain farm: solutions with no cattle feeding

Cattle price level Full-time employee Forage harvesting equipment[a]				
Capital (other than land):				
Short term operating capital	$10,024	$10,206	$14,051	$21,015[b]
Breeding livestock				
Swine	2,115	2,115	2,115	2,115
Beef cow herd	8,235	32,058	91,595	170,041
Machinery and equipment[c]				
Basic machinery	18,594	18,594	18,594	18,594
Forage equipment	3,814	6,400	3,442	3,442
Livestock facilities and equipment[c]				
Swine	4,050	4,050	4,050	4,050
Beef cow herd	324	1,039	2,494	4,630
Crop storage facilities[c]	6,164	4,578	6,123	8,917
Total non-land capital	$53,320	$79,040	$142,464	$232,804
Return to non-land capital[d]	$4,262	$8,181	$19,216	$24,600
Rate of return to non-land capital	7.99%	10.35%	13.49%	10.57%
Non-land capital plus land value[e]	$293,935	$319,655	$383,079	$473,419
Return to non-land capital plus assumed fair return to land value[e]	$17,501	$21,420	$32,455	$37,839
Rate of return to total capital	5.95%	6.70%	8.47%	7.99%

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Includes full-time employee's salary.

[c]Average value, not initial investment cost.

[d]Program value plus interest paid within the model less the land charge (Table 3); a standard charge for operator labor of $6,000; the full-time employee's salary of $6,000, when included; and the fixed costs, other than interest, of machinery, etc.

[e]See Table 3.

TABLE 33. Capital utilized on the grain farm: solutions with cattle feeding allowed

Cattle price level	Low	Medium	High	Medium	High
Full-time employee	No	No	No	Yes	Yes
Forage harvesting equipment[a]	CB,CFH	CB,CFH	OSFW,CFH	CB,CFH	CB,CFH
Capital (other than land):					
Short term operating capital	$13,189	$12,994	$14,481	$31,561[e]	$36,272[e]
Feeder cattle	19,732	22,280	23,881	61,094	73,812
Breeding livestock					
Swine	2,115	2,115	2,115	2,115	2,115
Beef cow herd	8,743	24,159	68,861	23,172	106,395
Machinery and equipment[b]					
Basic machinery	18,594	18,594	18,594	18,594	18,594
Forage equipment	4,327	4,327	8,640	4,327	4,327
Livestock facilities and equipment[b]					
Swine	4,050	4,050	4,050	4,050	4,050
Beef cows	344	783	1,875	751	2,897
Cattle feeding	7,442	6,436	5,785	17,330	17,330
Crop storage facilities[b]	7,445	7,114	7,538	9,001	11,406
Total nonland capital	$85,981	$102,852	$155,820	$171,995	$277,198
Return to nonland capital[c]	$7,068	$12,625	$22,998	$14,471	$36,560
Rate of return to nonland capital	8.22%	12.27%	14.76%	8.41%	13.19%
Nonland capital plus land value[d]	$326,596	$343,467	$396,435	$412,610	$517,813
Return to nonland capital plus assumed fair return to land value	$20,307	$25,864	$36,237	$27,710	$49,799
Rate of return to total capital	6.22%	7.53%	9.14%	6.72%	9.62%

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Includes the full-time employee's salary.

[c]Average value, not initial investment cost.

[d]Program value plus interest paid within the model less the land charge (Table 3); a standard charge for operator labor of $6,000; the full-time employee's salary of $6,000, when included; and the fixed costs, other than interest of machinery, etc.

[e]See Table 3.

difference between the non-land capital requirements of the solutions with and without cattle feeding narrows to $23,812 at the medium price level and $13,356 at the high price level. This is due to decreases in the number of cattle fed and smaller increases in the size of the beef cow herd in the solutions with cattle feeding.

The total amount of non-land capital utilized is increased by $69,143 at the medium cattle price level with cattle feeding when a full-time employee is added, due mainly to increased investment in feeder cattle and cattle feeding facilities. At the high cattle price level, non-land capital increases by $90,340 without cattle feeding, and by $121,378 with cattle feeding, when a full-time employee is added. The increased size of the cow herd is responsible for the increased investment in the first case, while the added capital is required for both the calf producing and cattle feeding enterprises in the second case.

Labor requirements

Tables 34 and 35 present the labor requirements for the key solutions for the grain farm without and with cattle feeding, respectively.

Labor availability is not a limiting factor in the solutions at the low and medium price levels without cattle feeding. There are fairly high shadow prices in April and May at the high price level with no cattle feeding. However, when a full-time employee is added, there is again excess labor availability, either operator and full-time employee or hourly part-time, in all months, and total labor utilized only increases by 1420 hours.

TABLE 34. Labor required on the grain farm: solutions with no cattle feeding.

Cattle price level	Low		Medium		High		High	
Full-time employee	No		No		No		Yes	
Forage harvesting equipment[a]	OB		OSFW		CB,CFH		CB,CFH	
	Labor furnished by operator (and full-time employee, if included)[b]							
	Hours	(Shadow price[c])	Hours	(Shadow price[c])	Hours	(Shadow price[c])	Hours	(Shadow price[c])
January	107		136		207		292	
February	125		144		213		296	
March	143		165		241	(2.99)	329	
April	292		294	(1.80)	294	(5.24)	559	(2.60)
May	279	(2.60)	279	(2.60)	279	(15.95)	484	
June	282		289	(2.60)	289	(2.60)	514	(2.60)
July	130		179		225		371	
August	147		179		288		442	
September	151		171		250		355	
October	283		280		290	(2.60)	391	
November	231		292	(1.80)	218		330	
December	120		146		171		210	
Total	2,290		2,554		2,965		4,573	

		Hourly part-time labor hired		
April	--	--	112	51
May	18	38	80	--
June	12	6	78	42
July	1	--	2	4
August	--	--	--	--
September	--	--	--	--
October	--	--	13	--
November	--	--	--	--
Total	31	44	285	97
Total hours required	2,321	2,598	3,250	4,670

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Includes overhead labor.

[c]The value of an additional hour of operator (or full-time employee) labor, expressed in dollars per hour.

TABLE 35. Labor required on the grain farm: solutions with cattle feeding allowed

Cattle price level	Low		Medium		High		Medium		High	
Full-time employee	No		No		No		Yes		Yes	
Forage harvesting equipment[a]	CB,CFH		CB,CFH		OSFW,CFH		CB,CFH		CB,CFH	
	Labor furnished by operator (and full-time employee, if included)[b]									
	Hours	(Shadow price[c])	Hours	(Shadow price[c])	Hours	(Shadow price[c])	Hours	(Shadow price[c])	Hours	(Shadow price[c])
January	185		190		213		309		396	
February	203		215		215	(5.15)	318		402	
March	221		227		241	(5.15)	340		430	
April	294	(2.60)	294	(2.60)	294	(5.15)	404		559	(2.60)
May	279	(6.59)	279	(17.86)	279	(15.75)	494		544	(2.60)
June	289	(2.60)	289	(2.60)	289	(2.60)	438		514	(2.60)
July	212		221		271		348		475	
August	213		228		299	(1.22)	330		466	
September	207		213		284		310		390	
October	244		254		290	(2.60)	208		289	
November	289		252		292	(5.15)	422		517	
December	197		196		215	(17.19)	309		350	
Total	2,833		2,858		3,179		4,230		5,332	

			Hourly part-time labor hired		
April	60	100	112	--	30
May	80	80	80	--	27
June	51	53	71	2	69
July	--	--	--	--	3
August	--	--	--	--	--
September	--	--	--	--	--
October	--	--	19	--	--
November	--	--	96	--	--
Total	191	233	378	2	129
Total hours required	3,024	3,091	3,557	4,232	5,461

[a]See Table 10 for explanation of abbreviations and equipment which is included.

[b]Includes overhead labor.

[c]The value of an additional hour of operator (or full-time employee) labor, expressed in dollars per hour.

Labor availability is critical in May in the solutions at the low and medium price levels with cattle feeding. Competition between the livestock enterprises and crop planting for labor is a limiting factor in these solutions. All available labor is used during February through May and November and December in the solution at the high price level with no full-time employee. Labor is not a limiting factor at either the medium or high cattle price levels with cattle feeding when a full-time employee is included.

Beef cow-calf enterprise costs and returns

Beef cow-calf unit budgets derived from the key solutions for the grain farm without and with cattle feeding are presented in Tables 36 and 37, respectively.

Fixed costs per unit are high in both solutions at the low cattle price level; because of the small size of the cow herd forage equipment fixed costs are the major factor. This is especially true in the solution without cattle feeding because all of the alternatives were relatively costly. As noted in footnote d of Table 36, substitution of custom baling for ownership of a baler, probably the most practical forage equipment choice for this situation, would reduce forage equipment fixed costs by $17.53 per cow-calf unit, with a net reduction in total costs of $13.38 per unit.

Forage equipment fixed costs per unit are also relatively high at the medium cattle price level without cattle feeding, where the costs of a stack-forming wagon are spread over 104 cow-calf units.

TABLE 36. Beef cow-calf unit budgets for the grain farm: solutions with no cattle feeding[a]

Cattle price level	Low	Medium	High[b]	High
Full-time employee	No	No	No	Yes
Forage harvesting equipment[c]	OB	OSFW	CB,CFH	CB,CFH
Total receipts[d]	$109.85	$145.90	$180.40	$180.40
Expenses:				
Variable costs:				
Cash expenses (Table D.3)	$21.07	$21.07	$21.07	$21.07
Corn grain	2.35	2.35	3.36	2.35
Variable forage growing and harvesting costs	22.32	22.57	27.04	27.54
Variable feeding costs	.26	--	2.18	2.86
Interest on short-term operating capital	1.84	1.83	2.14	2.15
Total variable costs	$47.84	$47.82	$55.79	$55.97
Return over variable costs	$62.01	$97.27	$124.61	$124.43
Fixed costs:				
Livestock facilities and equipment (Table 5)	$3.60	$3.60	$3.89	$3.60
Forage equipment	32.31[e]	17.16	3.77	2.03
Beef cow share of basic machinery[f]	13.12(9)	14.09(31)	14.01(74)	9.69(95)
Feed storage facilities	2.57	--	5.45	6.40
Real estate taxes	10.31	8.85	9.53	9.06
Total fixed costs	$61.91	$43.70	$36.65	$30.78
Return over fixed and variable costs	$.10	$53.57	$87.96	$93.65

Land required per cow calf unit (Acres):				
Class I	.--	.35	.63	.67
Class II	.60	.35	.15	.08
Class III	.90	.29	.12	.06
Class IV	.24	.07	.03	.01
Total investment in land	$567.00	$487.00	$525.00	$499.00
5.5 percent return to land value	$31.17	$26.79	$28.86	$27.44
Eight percent return to investment in livestock (Table D.4)	20.33	24.68	29.38	29.38
Total return to investment in land and livestock	$51.50	$51.79	$58.24	$56.82
Residual return to labor	$-51.40	$2.10	$29.72	$36.83
Labor required (hours):				
Non-feed labor (Table D.2)	3.49	3.49	3.47	3.49
Feeding labor	1.26	.84	1.51	1.89
Feed production labor	1.19	1.52	1.02	1.16
Total	5.94	5.85	6.00	6.54
Labor income (per hour)	$-8.65	$.36	$4.95	$5.63

[a]A cow-calf unit includes one cow, .9 calf, .17 replacement heifer, and .04 bull.

[b]Weighted average of spring and fall calving cows.

[c]See Table 10 for explanation of abbreviations and equipment which is included.

[d]Assumes sale of .45 steer calf (441 pounds), .28 heifer calf (412 pounds), and .15 cull cow (1018 pounds) at the prices shown in Table 9.

[e]No solutions were run with custom baling alone. Substituting custom baling for ownership of a baler would reduce forage equipment fixed costs to $17.53 and increase variable forage harvesting costs by $4.15 per cow unit. The net result would be a $13.38 increase in residual return to labor to -$38.02 or -$6.40 per hour.

[f]Allocated to the beef cow herd on the basis of the percentage of total tractor hours which were required for feed production, feeding, and choring. The figure in parentheses is the percentage of basic machinery fixed costs which is charged to the beef cow herd in each solution.

TABLE 37. Beef cow-calf unit budgets for the grain farm: solutions with cattle feeding allowed[a]

Cattle price level	Low	Medium	High[b]	Medium	High
Full-time employee	No	No	No	Yes	Yes
Forage harvesting equipment[c]	CB,CFH	CB,CFH	OSFW,CFH	CB,CFH	CB,CFH
Total receipts[d]	$109.85	$145.09	$180.40	$145.09	$180.40
Expenses:					
Variable costs:					
Cash expenses (Table D.3)	$21.07	$21.07	$21.07	$21.07	$21.07
Corn grain	2.35	2.35	4.14	2.35	2.57
Variable forage growing and harvesting costs	25.82	23.32	24.09	25.42	27.75
Variable feeding costs	.50	1.14	1.44	2.50	2.86
Interest on short term operating capital	1.98	1.91	2.02	2.05	2.17
Total variable costs	$51.72	$49.79	$52.76	$53.39	$56.42
Return over variable costs	$58.13	$95.30	$127.64	$91.70	$123.98
Fixed costs:					
Livestock facilities and equipment (Table 5)	$3.60	$3.60	$4.37	$3.60	$3.67
Beef cow share of forage equipment[e]	16.83	8.20	10.56	8.40	2.05
Beef cow share of basic machinery[f]	8.23(6)	9.65(16)	10.32(41)	9.43(15)	7.66(47)
Feed storage facilities	2.61	3.24	3.38	5.72	6.30
Real estate taxes	10.22	8.94	8.86	8.63	8.87
Total fixed costs	$41.49	$33.63	$37.49	$35.78	$28.55
Return over fixed and variable costs	$16.64	$61.67	$90.15	$55.92	$95.43
Land required per cow-calf unit (Acres):					
Class I	--	.21	.52	.16	.60
Class II	.61	.49	.20	.51	.13
Class III	.87	.39	.16	.41	.10
Class IV	.23	.10	.04	.10	.02

Total investment in land	$562.00	$493.00	$488.00	$475.00	$489.00
5.5 percent return to land value	$30.90	$27.09	$26.85	$26.11	$26.88
Eight percent return to investment in livestock (Table D.4)	20.33	24,68	29.38	24.68	29.38
Total return to land and livestock	$51.23	$51.77	$56.23	$50.79	$56.26
Residual return to labor	$-34.59	$9.90	$33.92	$5.13	$39.17
Labor required (hours):					
Nonfeed labor (Table D.2)	3.49	3.44	3.44	3.49	3.49
Feeding labor	1.10	1.11	1.19	1.72	1.89
Feed production labor	.88	.81	1.11	.95	1.13
Total	5.47	5.41	5.74	6.16	6.51
Labor income (per hour)	$-6.32	$1.83	$5.91	$ .83	$6.02
Cost of interfarm transfer of feeder calves saved due to feeding of home-raised calves (per cow-calf unit)[g]	$9.73	$11.95	$14.16	$11.95	$14.16

[a]A cow-calf unit includes one cow, .9 calf, .17 replacement heifer, and .04 bull.

[b]Weighted average of spring and fall calving cows.

[c]See Table 10 for explanation of abbreviations and equipment which is included.

[d]Assumes sale of .45 steer calf (441 pounds), .28 heifer calf (412 pounds), and .15 cull cow (1018 pounds) at the prices shown in Table 9. This represents the opportunity cost of home-raised calves fed on the farm where they are produced.

[e]Allocated between the beef cow herd and the cattle feeding enterprise on the basis of the proportions of forages consumed.

[f]Allocated to the beef cow herd on the basis of the percentage of total tractor hours which were required for feed production, feeding, and choring. The figure in parentheses is the percentage of basic machinery fixed costs which is charged to the beef cow herd in each solution.

[g]The opportunity cost of home-raised calves fed on the farm subtracted from the cost of purchasing similar calves, divided by the number of cow-calf units.

Total variable and fixed costs, not including a return to investment in land and livestock or a labor charge, for the solutions at the medium and high price levels without a full-time employee without cattle feeding, at the medium price level with a full-time employee, and at the high price level without a full-time employee with cattle feeding, fall between $89.17 and $92.44, a range of $3.27.

Per unit costs for the solution at the medium cattle price level without a full-time employee with cattle feeding are the lowest of any of the key solutions for the grain farm. Harvested forage feeding in this solution was limited to about one-half a ton of baled mixed hay and 2.5 tons of silage, and the major feed source in December and January was cornstalk grazing, as shown in Table E.16.

Total variable and fixed costs per unit in the solutions at the high cattle price level with a full-time employee are between five and six dollars lower than in the corresponding solutions without a full-time employee, mainly due to lower forage equipment and basic machinery fixed costs.

Land investment per cow-calf unit is highest at the low cattle price level, $567 and $562 per unit in the solutions without and with cattle feeding, respectively. Land investment per unit falls within a $50 range for the rest of the key solutions for the grain farm as the decreasing acreage of Classes II, III, and IV land is offset by an increasing acreage of Class I land per cow-calf unit as the size of the cow herd increases. Total land costs (taxes plus a 5.5% return on land investment) in these solutions vary from $34.74, with an investment of

$475, to $38.39, with an investment of $525, a difference of $3.65 per cow-calf unit.

Labor requirements per cow-calf unit are highest in the solutions with a full-time employee, due mainly to higher feeding labor requirements for silage feeding. Feed production labor requirements are lowest for the solutions at the low and medium cattle price levels in which all forages are custom harvested and cornstalk grazing provides the major feed supply in December and January. They are highest at the medium cattle price level without cattle where almost the entire winter feed supply is harvested with a stack-forming wagon. Labor income, after all costs plus a return to investment in land and livestock have been paid, is negative or very low except at the high cattle price level.

Because all home-raised calves are fed out in the solutions with cattle feeding (Table 27), the maximum possible savings of inter-farm transfer costs are realized. These savings, allocated on a per cow-calf unit basis, are noted in Table 37.

SUMMARY AND CONCLUSIONS

This study explores the role of feeder calf and forage production on the organization of Iowa farms. Models were developed to represent a forage producing farm and a grain producing farm. The model farms were made up of different proportions of the same soils and were defined to be of equal value, rather than equal acreage. Linear programming was utilized to determine the optimum crop and livestock program for each farm in each of several situations. These situations were defined by the following variables: three cattle price levels, whether or not a full-time employee was included, and whether or not cattle feeding was allowed. For each situation on both farms, a set of solutions involving different forage harvesting equipment combinations was run. All of the linear programming solutions were outlined in Tables 12 and 13. From each set of solutions the solution with the highest return to operator labor and management was selected as the key solution which was analyzed in more detail. The discussion which follows summarizes the results.

Swine were allowed to compete in all solutions up to a maximum of 40 litters. Cattle feeding, when it was allowed, was limited to a total of 500 head. Corn grain and soybeans were the only crops which could be sold. Corn grain was the only feed, with the exception of mineral and protein supplements, which could be purchased. Grain prices and hog prices were held constant.

The beef cow herd played a major role in the organization of the forage farm at all price levels. The size of the cow herd varied from 211 head at the low price level with cattle feeding, to 498 head at the high cattle price level with a full-time employee without cattle feeding. Increases in the cattle price level had a relatively greater effect on the number of beef cows on the grain farm than on the forage farm. The size of the cow herd on the grain farm was limited to around 33 head at the low price level, but expanded to 440 head at the high price level with a full-time employee without cattle feeding.

The relative stability of the solutions on the forage farm would be a more manageable situation for the farm operator faced with fluctuating cattle prices. On the other hand, the operator's labor and management returns were more variable on the forage farm due to changing cattle prices because his income was more dependent on cattle sales. Crop prices and hog prices were held constant so they were not a factor.

Fall calving cows were competitive with spring calving at the high cattle price level on the grain farm, comprising about one-fourth of the total beef cow herd in the solution without a full-time employee, with cattle feeding. However, their competitive position may have been improved because competition for fall labor was reduced because grain and silage were custom harvested. On the other hand, fall calving may have been more competitive if there had been a price advantage for fall calves. The models assumed seasonally constant prices. These results indicate that fall calving should be explored more carefully, especially for cow herds on grain producing farms.

The cattle feeding enterprise was more competitive with the beef cow herd on the grain farm than the crop farm. On the grain farm the number of cattle fed decreased as the size of the cow herd increased, in the solutions without a full-time employee. The addition of cattle feeding caused a relatively greater decrease in the size of the cow herd on the grain farm than on the forage farm. On the grain farm cattle feeding shifted from mostly purchased calves at the low price level to mostly home-raised calves at the high price level without a full-time employee. Cattle feeding was basically limited to home-raised calves on the forage farm in the solutions without a full-time employee. The inclusion of a cattle feeding enterprise increased operator labor and management returns more on the grain farm than on the forage farm. With the restriction placed on swine numbers in this study, cattle feeding appeared to be a key element in the organization of the grain farm, just as the beef cow herd is a basic part of the operation of the forage farm. However, a sure profit was built into cattle feeding by the fixed feeder to slaughter price margins assumed.

The swine enterprise was more secure from competition from the beef cow herd and cattle feeding on the grain farm. The restriction placed on swine numbers limited the amount of profit in the key solutions in all situations except at the high price level, without a full-time employee, with cattle feeding on the forage farm. Had the restrictions on swine numbers been relaxed, swine probably would have had a greater tendency to drive beef cows out of the solutions on the grain farm. However, on the forage farm swine in large numbers probably would have entered the

solutions only at the lower price levels and when a full-time employee was included.

When a full-time employee was included but cattle feeding was not allowed, the size of the beef cow herd was expanded on both farms so that the entire farm was producing feed for the cow herd at the high cattle price level. The forage farm carried a cow-calf unit on 1.32 acres in this situation, while each .86 acre supported a cow-calf unit in the corresponding solution for the grain farm.

The cattle feeding enterprise was expanded to the maximum 500 head, when allowed, in the solutions for both farms when a full-time employee was included. The addition of cattle feeding again caused a greater reduction in the size of the cow herd on the grain farm than on the forage farm. It was necessary to purchase corn grain to expand the livestock feeding operation beyond the farm's feed producing capabilities. This was most important on the forage farm where the cattle feeding enterprise shifted completely to baled hay and corn grain feeding which utilized a higher proportion of corn grain.

With the restrictions placed on swine numbers, the cattle feeding enterprise was necessary to justify a full-time employee when measured by the returns to operator labor and management. The total labor utilized increased by only 1200 to 1400 hours when a full-time employee was added and cattle feeding was not allowed, but increased by 1900 to 2200 hours in the corresponding situations with cattle feeding on both farms. A full-time man could be employed on either farm without reducing operator labor and management returns below the standard $6,000

charge for operator labor at the medium price level, if cattle feeding was included in the farm operation. Therefore, a two-man operation, such as a father-son partnership, would be a workable alternative on the land base represented by either model farm.

Generally, labor availability was the most limiting factor determining the size of the livestock operation on both farms. In the solutions without cattle feeding, labor was most limiting during the calving season on the forage farm, and during the planting season on the grain farm. When cattle feeding was included, labor for livestock chores during the winter became more critical. Labor availability during the harvest season was not limiting in these solutions because grain was custom harvested in all solutions, and silage was custom harvested in all of the key solutions. Ownership of harvesting equipment probably would have shown a more realistic fall labor picture.

No restraints were placed on capital availability in this study, but capital requirements of the linear programming solutions were estimated. Total capital requirements were higher on the forage farm than in corresponding solutions for the grain farm in all cases. Most of the difference was related to the investment in the beef cow herd.

The basic cropping programs and the shifts made in crop production to accommodate the larger size of the beef cow herd were similar in corresponding solutions for the two model farms. The maximum acreage of corn grain and soybeans were raised on Class I and Class II land at the low cattle price level on both farms, with the exception of the land required to produce corn silage for the cattle feeding enterprise. The

remainder of the Class II land produced alfalfa-bromegrass, which because of its shorter stand life allowed the maximum acreage of row crops. Class III land produced a combination of forages of which the largest share was birdsfoot trefoil and fertilized Kentucky bluegrass.

In the solutions without a full-time employee at the medium and high price levels, some Class I land was shifted to forage production for the beef cow herd. This included forage sorghum and sorghum-sudangrass plus some alfalfa-bromegrass on the grain farm. Class II land on both farms was shifted from alfalfa-bromegrass and row crops to bromegrass. Class III land was shifted from a combination of forages to alfalfa-bromegrass on the forage farm, but remained mostly in Kentucky bluegrass on the grain farm.

Class I land shifted completely to the production of forages for the beef cow herd in the solutions with a full-time employee at the high price level on both farms. The only exception is the solution for the grain farm with cattle feeding in which 149 acres of corn silage were produced on Class I land, mostly for the cattle feeding enterprise. Some alfalfa-bromegrass was produced on Class I land on the grain farm, while forage sorghum and sorghum-sudangrass were produced on Class II and III land in the corresponding solutions on the forage farm. Forage production on Class II and III land was similar to that in the corresponding solutions without a full-time employee. An exception is the large acreage of birdsfoot trefoil-orchardgrass on Class III land in the solution with a full-time employee without cattle feeding at the high price level on the forage farm.

Labor availability, especially for livestock chores during the winter, had an impact on the forage harvesting equipment combinations which were involved in the key solutions without a full-time employee for the forage farm. In the solutions with a full-time employee, the key solutions shifted to baled hay and custom silage harvesting equipment combinations and there was a large increase in forage sorghum silage feeding per cow-calf unit. The increased availability of labor during the winter allowed the shift from stacked hay to silage as the major harvested forage for the cow herd.

The solutions involving the baler and stack-forming wagon equipment combinations were competitive on the grain farm with no full-time employee. Because the beef cow herd was smaller on this farm, the level of forage equipment fixed costs was a more critical factor in the selection of the key solutions. The level of silage feeding for the beef cow herd also increased on this farm when a full-time employee was added.

The forage species and management combinations on the two farms were similar. Table 38 compares the beef cow herd forage systems in corresponding solutions for the two model farms. The consistency in the forage systems appears to be valid, and not reflections of particular species and management combinations having unduly favorable input-output coefficients, because the forage systems shifted as the demand for forage production increased. This consistency of forage systems is an important factor in terms of application of these results to other farm situations.

TABLE 38. Comparison of the forage systems for the beef cow herd in corresponding solutions for the forage farm and the grain farm, without cattle feeding[a]

Land Class	Species and management[c]	Percent of land class[b] Forage farm	Grain farm
	A. Low cattle price level		
Cl. II	Sdg/G	16.7	16.7
	Alf-Br/H1,G	26.4	28.6
	Alf-Br/H2,G	--	2.3
	Alf-Br/H3,G	6.9	2.5
Cl. III	Sdg/G	5.0	1.7
	Alf-Br/H1,G	15.3	7.0
	Br/240N,H2,G	10.2	--
	BFT seeding	3.1	3.6
	BFT/H,G	27.5	29.6
	KBG/60N,3SG	30.5	53.3
	B. Medium cattle price level		
Cl. I	SS/AG	--	7.5
	Sdg/G	--	1.4
	Alf-Br/H3,G	--	2.9
Cl. II	FS/H,G	18.9	--
	Sdg/G	14.7	14.3
	Alf-Br/H1,G	25.3	--
	Alf-Br/H2,G	--	19.3
	Alf-Br/H3,G	--	20.2
	Br/240N,3SG	12.6	13.6
	Br/240N,H1,G	5.5	--
	Br/240N,H2,G	--	7.0
Cl. III	Sdg/G	14.5	3.4
	Alf-Br/H1,G	35.0	--
	Alf-Br/H2,G	23.0	13.6
	BFT/H,G	.3	--
	KBG/60N,3SG	12.6	83.0

[a]Breakdown of the forage system for the beef cow herd by species and management, expressed as a percentage of the total land in each land class, based on tables in Appendix E. Does not include cornstalks harvested or grazed.

[b]Forage farm: Cl. I-97 acres, Cl. II-161 acres, Cl. III-310 acres. Grain farm: Cl. I-312 acres, Cl. II-39 acres, Cl. III-31 acres.

[c]See Table B.4 for an explanation of abbreviations.

TABLE 38. Continued

Land Class	Species and management	Percent of land class Forage farm	Grain farm
	C. High cattle price level		
Cl. I	FS/H,G	--	25.0
	SS/AG	7.0	13.4
	Sdg/G	--	4.0
	Alf-Br/RG	--	2.2
	Alf-Br/H2,G	--	5.9
Cl. II	FS/H,G	16.7	--
	Sdg	12.4	10.0
	Alf-Br/H1,G	32.5	--
	Br/240N,3SG	24.1	90.0
	Br/240N,H1,G	13.1	--
	Br/240N,H2,G	1.3	--
Cl. III	FS/H,G	1.4	--
	SS/AG	1.8	--
	Sdg/G	16.1	20.0
	Alf-Br/RG	--	80.0
	Alf-Br/H1,G	29.5	--
	Alf-Br/H2,G	35.0	--
	KBG/60N,3SG	16.2	
	D. High cattle price level, with full-time employee		
Cl. I	Corn silage	11.7	7.2
	FS/H,G	88.3	55.3
	SS/AG	--	28.4
	Sdg/G	--	3.0
	Alf-Br/RG	--	3.5
	Alf-Br/H2,G	--	2.5
Cl. II	FS/H	36.1	--
	Sdg/G	13.2	12.2
	Alf-Br/H1,G	19.4	--
	Alf-Br/H2,G	--	17.4
	Br/240N,3SG	31.2	70.3

TABLE 38. Continued

Land Class	Species and management	Percent of land class	
		Forage farm	Grain farm
Cl. III	FS/H,G	9.3	--
	SS/AG	2.9	--
	Sdg/G	6.9	20.0
	Alf-Br/H1,G	27.6	--
	Alf-Br/H2,G	--	80.0
	BFT seeding	5.3	--
	BFT/CG	48.0	--

The differences in the forage combinations utilized by the beef cow herd were largely related to the differences in the soil resources between the two farms. As the size of the cow herd increased, it was necessary to shift a higher proportion of Class I land to forage production on the grain farm. More annual forages were produced on Class II and III land on the forage farm.

The cows on the grain farm were more dependent on annual forages. For this reason, as indicated by the shadow prices of TDN and crude protein, protein was more frequently limiting on the grain farm. Energy production was more often a limiting factor on the forage farm. In the solution at the high cattle price level with a full-time employee on the grain farm, cattle feeding did not shift entirely to the baled hay and corn grain feeding activities to free more land for forage production for the cow herd, as it did in the corresponding solution for the forage farm. Labor was not limiting in this solution. Allowing purchase of a less expensive protein supplement or of baled hay might have allowed expansion of the cow herd in this situation. Protein supplement was

available for the cow herd at a cost of eighteen cents per pound of crude protein. The highest shadow price for crude protein in any solution was 12.9 cents per pound.

Feeding of grain to the cow herd was limited to the small amount required for the bulls and replacement heifers. Shadow prices for TDN ranged up to 3.1 cents per pound and were above the cost of TDN in corn grain (2.7 cents per pound), in solutions for both farms at the higher cattle price levels. Energy was most limiting in the winter and especially during the calving season. These results indicate that feeding of corn grain should be considered as an alternative to meet the cows' energy requirements during critical periods.

Creep feeding of spring calves did not enter any of the key solutions for either farm. Creep feeding was allowed as an alternative way of partially meeting the total energy requirements of the cow-calf unit in the late summer and fall, and was not specifically associated with an added weight increase for the calves. The costs and benefits of creep feeding need to be considered more carefully, especially for those areas of the state where lack of rainfall limits pasture production in the late summer season.

Annual forages become increasingly important as the size of the cow herd and the demand for forage production increased. The forage programs for the beef cow herd on both farms at the high cattle price level, especially when a full-time employee was added, were built around forage sorghum silage and regrowth grazing. Forage sorghum silage was utilized instead of corn silage, which actually yields more TDN per acre

(Table B.6), because of the importance of the regrowth grazing in November and December. Corn silage was fed to the cow herd in several solutions during the calving season when energy requirements were most critical. Alternately, grazed sorghum-sudangrass was utilized in some solutions, especially on the grain farm, as a major feed source in July, August, and September.

When they were available, cornstalks were utilized in the winter feeding program. Fairly large acreages of Class I land were reserved for cornstalk grazing rather than fall plowed in the key solutions at the low and medium cattle price levels on the grain farm. However, labor was not limiting in April when spring plowing was completed. Cornstalks were stacked in the key solutions for the forage farm, allowing Class I land to be fall plowed. April labor availability was more critical on this farm.

Alfalfa-bromegrass was the perennial forage species mixture most frequently grown for hay harvest. As the size of the cow herd increased, alfalfa-bromegrass was replaced by bromegrass on Class II land. Bromegrass was fertilized with 240 pounds of nitrogen and three-season grazed. Birdsfoot trefoil-orchardgrass and fertilized permanent bluegrass played important roles in the pasture program on Class III land at the low and medium cattle price levels. They were replaced by alfalfa-bromegrass as the size of the cow herd and demand for forage production increased. It would seem more likely that alfalfa-bromegrass would be grown on the rotated Class II land and bromegrass, with its longer stand life grown on the Class III land. Probably, the higher level of production on

Class II land was necessary to justify the high fertilizer cost of the heavily fertilized bromegrass (Table B.1).

Production costs per cow-calf unit did not change greatly, although they were, in general, slightly lower on the forage farm. Total costs per cow-calf unit, including land costs but not including a labor charge, were generally in the $130 to $140 range. Labor income from the beef cow enterprise was favorable only at the high cattle price level.

Land investment and land costs per cow-calf unit were reduced as the size of the cow herd increased because of more intensive use of forage producing land. This effect was greater on the forage farm because increased forage production on the grain farm was more dependent on shifting Class I land from grain to forages. Reduced land costs were offset by higher capital costs due to increased investment in livestock, and higher variable forage production costs.

The linear programming solutions obtained in this study apply only to farms having the specific combination of resources represented by the model farms. However, general observations can be drawn which can be applied to similar types of farms in other areas of Iowa.

The solutions were limited by assumptions which represented artificial restraints on the organization of the farms. This included the limits on swine numbers and cattle feeding, and on buying and selling of forages. The models further departed from reality because there were no capital restraints and because grain, and in most cases silage, were custom harvested. This last assumption had an important effect on labor availability in the fall, especially on the grain farm.

The value of the study lies in the forage and feeder calf production information which was collected, and in the general observations about the role of the beef cow herd in the organization of Iowa farms. The linear programming solutions indicated that beef cows would be an important part of the optimum organization of forage producing farms, and could play a major role on grain producing farms if price relationships were favorable.

Both energy and protein requirements of the beef cow were considered in developing forage systems for the cow herd. The solutions indicated that similar forage species and management systems would be utilized on the same land classes on both types of farms. Species and management systems shifted on both rotated and semi-permanent forage producing land as greater forage production was demanded. The consistency between farms of the forage systems indicates that forage management programs could be developed for similar soil types which could be applied on farms having different combinations of soil resources.

The results of this study point to areas which should receive more emphasis in future research. The potential for fall calving and split-season calving beef cow herds needs to be studied more carefully, especially for grain producing farms. Forage systems built around forage sorghum silage and regrowth grazing also deserve more thorough testing. In future studies, capital restrictions in relation to the capital investment required for the beef cow herd should probably be considered. The need for more study of forage harvesting, storing, and feeding systems, with emphasis on labor requirements as well as costs, was also indicated.

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APPENDIX A: MACHINERY AND EQUIPMENT COSTS

The machinery fixed and variable costs used in this study are presented in Tables A.1 through A.8. These costs were based on the following assumptions:

A. Fixed costs.

1. Straight line depreciation was used. The remaining value of each machine at the end of its estimated life was calculated as a percent of initial list price according to the following schedule:

At the end of year	Remaining Value[a]			
	Tractors	Forage harvesters, balers	Mower-conditioners	All other machines
	(% of initial list price)			
8	34.9	21.1	23.7	22.6
9	32.1	18.6	20.9	20.0
10	29.5	16.5	18.4	17.7
11	27.2	14.6	16.2	15.7
12	--	--	--	14.0

[a]From Bowers (7)

2. Taxes, shelter, insurance, and interest on investment (TSII) were assumed to total eight percent of initial list price. Interest on investment was assumed to equal eight percent of average value or approximately five percent of initial list price. Hadley, Parsons, and Doster (13) estimated taxes plus shelter plus insurance at three percent of initial list price.

B. Variable costs.

1. Tractor fuel costs were adapted from James (22).

a. 4 plow diesel tractor:

4 gallons per hour x $.179 per gallon = $.72 per hour.

b. 3 plow gas tractor:

4.2 gallons per hour x $.216 per gallon = $.91 per hour.

2. Tractor lubrication costs were assumed to equal 15 percent of fuel costs; lubrication costs for other machinery was assumed to be included in repair and maintenance costs.

3. Repair and maintenance costs for all machines were based on the estimated total accumulated repair costs per $1000 initial list price (TAR/$1000 ILP) presented by Bowers (7). Repair and maintenance costs are presented in Tables A.3 and A.6.

TABLE A.1. Initial investment and annual fixed costs of the basic machinery set, forage farm

Machine	Initial Investment[a]	Estimated Life (years)	Value Remaining at End of Est. Life	Depreciation	TSII[b]	Total Annual Fixed Costs	Average Value
Tractor, 4 plow diesel	$9000	10	$2655	$635	$720	$1355	$5825
Tractor, 3 plow gas	6600	10	1947	465	528	933	4275
Plow, 4-16"	1200	12	168	86	96	182	684
Disk, 14 ft. tandem	1300	12	182	93	104	197	742
Harrow, 30' w/cart	650	12	91	47	52	99	368
Planter, 4 row-38"	1800	12	252	129	144	273	1026
Cultivator, 4 row-38"	1090	10	193	90	87	177	640
Rotary hoe, 4 row-38"	690	8	156	67	55	122	422
Stalk chopper, 12 ft.	1560	12	218	112	125	237	888
Grain drill, 11 ft.	1560	12	218	112	125	237	888
Cultipacker, 11 ft.	260	12	36	19	21	40	146
Wagons, 150 bu. (3)	1500	12	210	108	120	228	852
Elevator, 48 ft.	1040	12	146	75	83	158	590
Manure loader	850	10	150	70	68	138	500
Manure spreader	990	10	175	82	79	161	580
	$30,090					$4597	$18,126

[a]From Background information for use with Crop-Opt system, FM-1627 (3), Iowa Department of Revenue, Property Tax Division (21), Ayres (1), Ayres (2), and Harvesting, storing, processing feeds for beef cattle (14).

[b]Taxes, Shelter, Insurance, Interest.

TABLE A.2. Initial investment and annual fixed costs for the basic machinery set, grain farm

Machine	Initial Investment[a]	Estimated Life (years)	Value Remaining at End of Est. Life	Depreciation	TSII[b]	Total Annual Fixed Costs	Average Value
Tractor, 4 plow diesel	$9000	10	$2655	$635	$720	$1355	$5825
Tractor, 3 plow gas	6600	10	1947	465	528	993	4275
Plow, 4-16"	1200	9	240	107	96	203	720
Disk, 14 ft. tandem	1300	9	260	116	104	220	780
Harrow, 30' w/cart	650	10	115	54	52	106	333
Planter, 4 row-38"	1800	8	407	174	144	318	1104
Cultivator, 4 row-38"	1090	8	246	106	87	193	668
Rotary hoe, 4 row-38"	690	6	199	82	55	137	445
Stalk chopper, 12 ft.	1560	12	218	112	125	237	888
Grain drill, 11 ft.	1560	12	218	112	125	237	888
Cultipacker, 11 ft.	260	12	36	19	21	40	146
Wagons, 150 bu. (3)	1500	12	210	108	120	228	852
Elevator, 40 ft.	1040	12	146	75	83	158	590
Manure loader	850	10	150	70	68	138	500
	$30,090					$4724	$18,594

[a]From Background information for use with Crop-Opt system, FM 1627 (3), Iowa Department of Revenue, Property Tax Division (21), Ayres (1), and Harvesting, storing, processing feeds for beef cattle (14).

[b]Taxes, Shelter, Insurance, Interest.

TABLE A.3. Repair costs for the basic machinery set

Machine	Estimated Total Use (hours)	TAR/ $1000 ILP[a]	Total Life Repair Costs	Average Repair Costs per Hour
Tractor, 4 plow diesel	6000	$474	$4266	$ .71
Tractor, 3 plow gas	4000	248	1673	.41
Plow, 4-16"	900	1005	1206	1.34
Disk, 14 ft. tandem	900	219	285	.32
Harrow, 30' w/cart	300	47	31	.10
Planter, 4 row-38"	600	327	589	.98
Cultivator, 4 row-38"	1000	387	422	.42
Rotary hoe, 4 row-38"	400	246	170	.43
Stalk chopper, 12 ft.	900	176	275	.31
Grain drill, 11 ft.	300	106	165	.55
Cultipacker, 11 ft.	300	47	12	.04
Wagons, 150 bu. (3)	600	162	84	.14
Elevator, 40 ft.	600	368	383	.64
Manure loader	1000	141	120	.12
Manure spreader	750	90	89	.12

[a]Total accumulated repair cost per $1000 initial list price from Bowers (7).

TABLE A.4. Basic machinery set operating costs

Operation	Tractor Used[a]	Variable cost per hour of operation				Acres per Hour	Operating cost per Acre
		Fuel and Lube	Tractor Repair	Implement Repair	Total Cost per Hour		
Plow	4P	$ .83	$ .71	$1.34	$2.88	2.1	$1.37
Disk	4P	.83	.71	.32	1.86	6.3	.30
Harrow	4P	.83	.71	.10	1.64	12.5	.13
Plant	3P	1.04	.41	.98	2.43	4.3	.57
Cultivate	4P	.83	.71	.42	1.96	4.3	.46
Rotary hoe	4P	.83	.71	.43	1.97	9.1	.22
Chop stalks (or clip pastures, etc.)	4P	.83	.71	.31	1.85	4.1	.45
Drill grain or grass seed (cultipacker pulled behind drill)	3P	1.04	.41	.59	2.04	3.3	.62
Haul grain (2 wagons pulled at a time)	4P	.83	.71	.28	1.82		
Operate elevator	3P	1.04	.41	.64	2.09		
Load manure (or silage from bunker silo)	3P	1.04	.41	.12	1.57		
Spread manure	4P	.83	.71	.12	1.66		

[a]4P - 4 plow diesel; 3P - 3 plow gas.

TABLE A.5. Initial investment and annual fixed costs for forage harvesting and handling equipment

Machine	Initial Investment[a]	Estimated Life (years)	Value Remaining at end of Est. Life	Depreciation	TSII[b]	Total Annual Fixed Costs	Average Value
Mower-conditioner	$2950	10	$543	$241	$236	$477	$1745
Baler, PTO, twine	2375	10	392	198	190	388	1385
Flat rack	600	12	84	43	48	91	342
Forage harvester:							
base unit	3725	10	615	311	298	609	2170
row crop head	1350	10	223	113	108	221	785
windrow pickup	670	10	111	56	54	110	390
flail pickup	1675	10	276	140	134	274	975
Self-unloading forage wagon	2300	10	407	189	184	373	1355
Forage blower	1060	10	188	87	85	172	625
Stock-farming wagon, 3 T.	7990	10	1318	667	639	1306	4655
Feeder-mixer wagon, 100 bu. (for silage rations)	1500	10	266	123	120	243	885
Feeder-mixer wagon, 65 bu. (for grain rations)	600	10	106	49	48	97	355

[a]From Ayres (1), Background information for use with Crop-Opt system, FM 1627 (3), Iowa Department of Revenue, Property Tax Division (21), and Harvesting, storing, processing feeds for beef cattle (14).

[b]Taxes, Shelter, Insurance, Interest.

TABLE A.6. Repair costs for forage harvesting and handling equipment

Machine	Estimated Total Use (hours)	TAR/ $1000 ILP[a]	Total Life Repair Costs	Average Repair Costs per hour
Mower-conditioner	750	$548	$1617	$2.16
Baler	750	280	665	.89
Flat-rack	600	162	97	.16
Forage harvester:				
base unit	1000	835	3110	3.11
row crop head	500	339	458	.92
windrow pickup	500	339	227	.46
flail pickup	500	339	568	1.14
Self-unloading forage wagon	1000	387	890	.89
Forage blower	500	69	73	.14
Stack-forming wagon	1000	198	1582	1.58
Feeder mixer wagon, 100 bu.	1500	643	964	.64
Feeder mixer wagon, 65 bu.	1500	643	386	.26

[a]Total accumulated repair cost per $1000 initial list price from Bowers (7).

TABLE A.7. Forage harvesting and handling equipment operating costs

Operation	Tractor Used[a]	Variable cost per hour of operation: Fuel and Lube	Tractor Repair	Implement Repair	Total Cost per Hour	Acres per Hour	Operating cost per Acre
Mow and condition hay	3P	$1.04	$ .41	$2.16	$3.61	3.5	$1.03
Bale hay (rack pulled behind baler)	4P	.83	.71	1.05	2.59[b]		
Haul baled hay	3P	1.04	.41	.16	1.61		
Chop silage (forage wagon pulled behind forage harvester):							
corn or forage sorghum	4P	.83	.71	4.92	6.46		
haylage	4P	.83	.71	4.46	6.00		
Stalklage	4P	.83	.71	5.14	6.68		
Haul and unload silage	3P	1.04	.41	.89	2.34		
Blow silage	4P	.83	.71	.14	1.68		
Stack hay or cornstalks	4P	.83	.71	1.58	3.12		
Feed silage rations[c]	4P	.83	.71	.64	2.18		
Feed grain rations[c]	3P	1.04	.41	.26	1.71		

[a] 4P - 4 plow diesel; 3P - 3 plow gas.

[b] Twine cost not included; estimated twine cost is 1.5¢ per bale or 60¢ per ton of hay.

[c] To feed lot cattle only.

TABLE A.8. Custom rates[a]

Operation	Unit	Rate[b]
Combine soybeans	acre	$ 6.00
Combine corn	acre	8.00
Bale hay and load on rack pulled behind baler	bale (50 lbs.)	.12[c]
Chop, haul, and unload corn or forage sorghum silage	acre	15.00
Fertilizer application:		
dry (bulk blend)	acre	.80
anhydrous ammonia	acre	1.65

[a]Source: Howell, Winterboer, and Kamal-Abdou (19).

[b]Rates include machine, power, fuel, and operator.

[c]Includes twine cost (1.5¢ per bale) and labor for loading bales on the rack.

APPENDIX B: CROP PRODUCTION COSTS, RESOURCE REQUIREMENTS AND YIELDS

TABLE B.1. Fertilizer requirements and costs per acre for grain and forage production[a]

Crop	Nitrogen		Phosphorus (P_2O_5)		Potassium (K_2O)		Application Cost	Total Cost
	(lbs.)	Cost[b]	(lbs.)	Cost[b]	(lbs.)	Cost[b]		
				Class I Land				
Soybeans	--	--	(30)	$2.49	(20)	$ .92	$ .92	$ 4.21
Corn-grain	(160)	$7.84	(60)	4.98	(60)	2.76	2.45	18.03
Corn-silage	(160)	7.84	(60)	4.98	(80)	3.68	2.45	18.95
Forage sorghum-silage and graze	(160)	7.84	(60)	4.98	(80)	3.68	2.45	18.95
Forage sorghum-graze only	(160)	7.84	(60)	4.98	(60)	2.76	2.45	18.03
Sorghum-sudan grass	(160)	7.84	(60)	4.98	(60)	2.76	2.45	18.03
Alfalfa-brome seeding			(50)	4.15	(40)	1.84	.80	6.79
Standing alfalfa-brome			(40)	3.32	(40)	1.84	.80	5.96
				Class II Land				
Soybeans		100 lbs. 0-20-10 applied with planter						3.00
Corn-grain	(120)	5.88	(50)	4.15	(40)	1.84	2.45	14.32
Corn-silage	(120)	5.88	(50)	4.15	(60)	2.76	2.45	15.24
Forage sorghum-silage and graze	(120)	5.88	(50)	4.15	(60)	2.76	2.45	15.24
Forage sorghum-graze only	(120)	5.88	(50)	4.15	(40)	1.84	2.45	14.32
Sorghum-sudan grass	(120)	5.88	(50)	4.15	(40)	1.84	2.45	14.32
Alfalfa-brome or brome seeding			(50)	4.15	(40)	1.84	.80	6.79
Standing alfalfa-brome			(40)	3.32	(40)	1.84	.80	5.96
Standing brome-120N	(120)	10.56	(40)	3.32	(20)	.92	.80	15.60
Standing brome-240N	(240)	21.12	(40)	3.32	(20)	.92	1.60	26.96
Birdsfoot trefoil-orchardgrass seeding			(40)	3.32	(40)	1.84	.80	5.96

Standing birdsfoot trefoil-orchardgrass			(30)	2.49	(20)	.92	.40	3.81
Kentucky bluegrass-60N	(60)	5.28	(20)	1.66	(10)	.46	.80	8.20
				Class III Land				
Corn-grain	(80)	3.92	(40)	3.32	(40)	1.84	2.45	11.53
Forage sorghum-silage and graze	(80)	3.92	(40)	3.32	(60)	2.76	2.45	12.45
Forage sorghum-graze only	(80)	3.92	(40)	3.32	(40)	1.84	2.45	11.53
Sorghum-sudangrass	(80)	3.92	(40)	3.32	(40)	1.84	2.45	11.53
Alfalfa-brome or brome seeding			(50)	4.15	(40)	1.84	.80	6.79
Standing alfalfa-brome			(40)	3.32	(40)	1.84	.80	5.96
Standing brome-120N	(120)	10.56	(40)	3.32	(20)	.92	.80	15.60
Standing brome-240N	(240)	21.12	(40)	3.32	(20)	.92	1.60	26.96
Birdsfoot trefoil-orchardgrass seeding			(40)	3.32	(40)	1.84	.80	5.96
Standing birdsfoot trefoil-orchardgrass			(30)	2.49	(20)	.92	.40	3.81
Kentucky bluegrass-60N	(60)	5.28	(20)	1.66	(10)	.46	.80	8.20

[a] Sources: Voss (40), Van Horn et al. (37), James (22).

[b] Note: The fertilizer prices used were: nitrogen (anhydrous ammonia) - 4.9¢/lb., nitrogen (ammonium nitrate or urea for use on pastures) - 8.8¢/lb., phosphorus - 8.3¢/lb. (P_2O_5), and potassium - 4.6¢/lb. (K_2O). Custom application of fertilizer was assumed.

TABLE B.2. Grain production variable costs, labor requirements, and per acre yields

	Class I Land			Class II Land			Class III Land	
	Soybeans	Corn grain harvested in: October	November	Soybeans	Corn grain harvested in: October	November	Corn grain harvested in: October	November
Variable costs per acre:								
Seed	$ 4.80	$ 7.20	$ 7.20	$ 4.80	$ 6.00	$ 6.00	$ 6.00	$ 6.00
Fertilizer	4.21	18.03	18.03	3.00	14.32	14.32	11.53	11.53
Lime	2.75	2.75	2.75	3.67	3.67	3.67	3.67	3.67
Insecticide and herbicide	5.20	6.50	6.50	5.20	6.50	6.50	6.50	6.50
Non-harvest power and machine costs[a]	2.20	3.81	3.81	2.20	3.81	3.81	3.81	3.81
Harvest costs	6.14	8.54	8.53	6.11	8.44	8.43	8.35	8.34
Corn drying		11.52	11.22		9.60	9.35	7.68	7.48
Total variable costs per acre	$25.30	$58.35	$58.04	$24.98	$52.34	$52.08	$47.54	$47.33
Labor required (hours/acre)[b]	1.22	2.45	2.44	1.22	2.39	2.39	2.33	2.33
Net yield (bushels per acre after harvest losses)	42.3	115.2	112.2	34.8	96.0	93.5	76.8	74.8

[a]Plowing costs charged to corn grain and not to soybeans.

[b]Does not include labor furnished by custom operator.

TABLE B.3. Forage production variable costs and labor requirements, not including harvest

Crop	Variable costs:						
	Seed	Fertilizer	Lime	Insecticide and Herbicide	Variable Power and Machine Costs	Total Variable Costs	Labor Required (hours)
				Class I Land			
Corn-silage	$7.20	$18.95	$2.75	$6.50	$3.81	$39.21	1.75
Forage sorghum-silage and graze	2.20	18.95	2.75		3.80	27.70	1.76
Forage sorghum-graze only	2.20	18.03	2.75		3.80	26.78	1.76
Sorghum-sudangrass	5.50	18.03	2.75		3.61	29.89	1.72
Alfalfa-brome seeding[a]	12.64	6.79	2.75		2.87	25.05	1.31
Standing alfalfa-brome[b]		5.96	2.75			8.71	
				Class II Land			
Corn-silage	6.00	15.24	3.67	6.50	3.81	35.22	1.75
Forage sorghum-silage and graze	2.20	15.24	3.67		3.80	24.91	1.76
Forage sorghum-graze only	2.20	14.32	3.67		3.80	23.99	1.76
Sorghum-sudangrass	5.50	14.32	3.67		3.61	27.10	1.72
Alfalfa-brome seeding[a]	12.64	6.79	3.67		2.87	25.97	1.31
Standing alfalfa-brome[b]		5.96	3.67			9.63	
Brome seeding[a]	9.54	6.79	3.67		2.87	22.87	1.31
Standing brome-120N[b,c]		15.60	3.67			19.27	
Standing brome-240N[b,c]		26.96	3.67			30.63	
Birdsfoot trefoil-orchardgrass seeding[a]	10.60	5.96	3.67		4.22	24.45	2.06
Standing Birdsfoot trefoil-orchardgrass		3.81	3.67			7.48	
Kentucky bluegrass-60N[c]		8.20	3.67		.45	12.32	.25
Kentucky bluegrass-unimproved					.45	.45	.25

			Class III Land			
Forage sorghum-silage and graze	$2.20	$12.45	$3.67	$3.80	$22.12	1.76
Forage sorghum-graze only	2.20	11.53	3.67	3.80	21.20	1.76
Sorghum-sudangrass	5.50	11.53	3.67	3.61	24.31	1.72
Alfalfa-brome seeding[a]	12.64	6.79	3.67	2.87	25.05	1.31
Standing alfalfa-brome[b]		5.96	3.67		9.63	
Brome seeding[a]	9.54	6.79	3.67	2.87	22.87	1.31
Standing brome-120N[b,c]		15.60	3.67		19.27	
Standing brome-240N[b,c]		26.96	3.67		30.63	
Birdsfoot trefoil-orchardgrass seeding[a]	10.60	5.96	3.67	4.22	24.45	2.06
Standing birdsfoot trefoil-orchardgrass		3.81	3.67		7.48	
Kentucky bluegrass-60N[c]		8.20	3.67	.45	12.32	.25
Kentucky bluegrass-unimproved				.45	.45	.25
			Class IV Land			
Kentucky bluegrass-unimproved				.23	.23	.13

[a]Stand life after seeding year assumed: alfalfa-brome - Cl. I land 2 years, Cl. II land 2 or 4 years, Cl. III land 4 years; brome - 9 years; birdsfoot trefoil - 9 years.

[b]In addition to these costs, clipping may be required one or two times per season depending on the management system; clipping requires .25 hour and costs $.45 per acre.

[c]Level of nitrogen application.

TABLE B.4. Abbreviations used to describe forage production activities

	Species
Alf-Br	Alfalfa-brome mixture
Br	Brome
BFT	Birdsfoot trefoil (grown with orchardgrass)
KBG	Kentucky bluegrass (permanent pasture)
Sdg	Alfalfa-brome or brome seeding (oats grown as a cover crop and grazed)
FS	Forage sorghum
SS	Sorghum-sudangrass hybrid
Cs	Cornstalks
	Management
G	Graze (as available)
CG	Continuous graze
RG	Rotational graze
AG	Alternate graze
3SG	3 season graze (graze in early Spring through early summer, then save for fall grazing)
3SG(E)	3 season graze with earlier fall grazing
Sp	Stockpile (delay grazing to save for later use)
H	Harvest
1, 2, 3	Cuttings or growths harvested (if not included, assume only one cutting harvested)
60N, 120N, 240N	Pounds of nitrogen applied to brome or Kentucky bluegrass

TABLE B.5. Monthly TDN and crude protein (CP) yields per acre available for grazing[a]

Species/management		(Pounds of TDN and CP)												Total
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
						Class I Land								
Alf-Br/RG	TDN					874	1120	874	737	291	674			4570
	CP					271	347	271	229	90	209			1417
Alf-Br/H1,G	TDN						X	977	823	291	794			2885
	CP						X	303	255	90	246			894
Alf-Br/H2,G	TDN						X	X	823	291	794			1908
	CP						X	X	255	90	246			591
Alf-br/H3,G	TDN						X	X	X		794			794
	CP						X	X	X		246			246
Sdg/G	TDN						1223	349	440		297	257		2566
	CP						245	70	88		59	51		513
SS/AG	TDN							1646	1915	1618		307		5486
	CP							395	459	389		74		1317
SS/Sp	TDN										881	1796	734	3704
	CP										123	251	103	518
FS/Sp	TDN	662	176	117	117							1676	1548	4296
	CP	73	19	13	13							184	170	472
FS/H,G	TDN								X			440	902	1342
	CP								X			48	99	147
CS/G	TDN	166		33									265	464
	CP	13		2									21	36

Class II Land

Alf-Br/RG	TDN		766	983	766	646	257	594			4012
	CP		238	305	238	200	80	184			1245
Alf-Br/H1,G	TDN			X	863	726	257	697			2543
	CP			X	267	225	80	216			788
Alf-Br/H2,G	TDN			X	X	726	257	697			1680
	CP			X	X	225	80	216			521
Alf-Br/H3,G	TDN			X	X	X		697			697
	CP			X	X	X		216			216
Br/120N,CG	TDN	80	983	983	554	389	520	263			3772
	CP	25	305	305	171	120	161	81			1168
Br/120N,3SG	TDN	80	983	983	309			417	566	160	3498
	CP	25	305	305	96			129	57	16	933
Br/120N,3SG(E)	TDN	80	983	983			411	309	269	160	3195
	CP	25	305	305			128	96	27	16	902
Br/120N,H2,G	TDN		X		X			417	566	160	1143
	CP		X		X			129	57	16	199
Br/240N,3SG	TDN	126	1389	1234	892			337	886	491	5355
	CP	39	431	383	277			104	89	49	1372
Br/240N,H1,G	TDN		X				417	629	886	491	2423
	CP		X				129	195	89	49	461
Br/240N,H2,G	TDN		X		X			337	886	491	1714
	CP		X		X			104	89	49	242
Sdg/G	TDN			1074	309	387		257	223		2250
	CP			215	62	78		51	45		451
BFT/CG	TDN		154	1114	1023	777	491	257			3816
	CP		56	401	368	280	177	93			1375
BFT/Sp	TDN			583	1377	823	491	257			3611
	CP			210	496	296	177	121			1300

[a]Sources: Wedin (41), National Research Council (27).

TABLE B.5. Continued

Species/management		(Pounds of TDN and CP)												Total
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
BFT/H1,G	TDN						X	497	777	652	315			2240
	CP						X	179	280	234	113			806
KBG/CG	TDN					493	493	219	133	258	133			1729
	CP					109	109	48	29	57	29			378
KBG/60N,CG	TDN					796	918	366	154	488	488			3210
	CP					175	202	80	34	107	107			705
KBG/60N,3SG	TDN				78	914	1066			769	385	314		3526
	CP				17	201	234			169	85	70		776
SS/AG	TDN							1337	1556	1316		249		4458
	CP							321	374	315		59		1069
SS/Sp	TDN	238									717	1460	596	3011
	CP	33									101	205	83	422
FS/Sp	TDN	537	143	94	94							1361	1257	3486
	CP	59	16	10	10							150	138	383
FS/H,G	TDN								X			387	793	1180
	CP								X			42	87	129
Cs/G	TDN	142		28									225	395
	CP	11		2									18	31
						Class III Land								
Alf-Br/RG	TDN					560	714	560	469	189	434			2926
	CP					174	222	174	145	58	135			908
Alf-Br/H1,G	TDN						X	629	562	189	514			1858
	CP						X	194	163	58	160			575
Alf-Br/H2,G	TDN						X	X	526	189	514			1229
	CP						X	X	163	58	160			381

Alf-Br/H3,G	TDN							514			514
	CP							160			160
Br/120N,CG	TDN	57	720	720	406	286	377	189			2755
	CP	18	223	223	126	89	117	58			854
Br/120N,3SG	TDN	57	720	720	223			303	411	114	2548
	CP	18	223	223	69			94	41	11	679
Br/120N,3SG(E)	TDN	57	720	720			303	223	411	114	2548
	CP	18	223	223			94	69	41	11	679
Br/120N,H2,G	TDN		X		X			303	411	114	828
	CP		X		X			94	41	11	146
Br/240N,3SG	TDN	91	1006	897	625			246	640	360	3892
	CP	29	312	278	202			77	64	37	999
Br/240N,H1,G	TDN		X				303	457	640	360	1760
	CP		X				94	142	64	37	337
Br/240N,H2,G	TDN		X		X			246	640	360	1246
	CP		X		X			77	64	36	178
Sdg/G	TDN			783	223	280		189	166		1641
	CP			157	45	56		38	33		329
BFT/CG	TDN		109	812	743	566	360	189			2779
	CP		39	293	267	203	129	67			998
BFT/Sp	TDN			423	1000	600	360	189			2572
	CP			152	360	216	129	67			924
BFT/H1,G	TDN			X	360	566	474	229			1629
	CP			X	129	203	170	82			584
KBG/CG	TDN		360	360	160	97	189	97			1263
	CP		79	79	35	22	41	22			278
KBG/60N,CG	TDN		583	669	269	114	354	354			2343
	CP		128	147	59	25	78	78			515
KBG/60N,3SG	TDN	57	669	777			560	280	229		2572
	CP	13	147	171			123	62	50		566

TABLE B.5. Continued

Species/management		(Pounds of TDN and CP)												Total
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
SS/AG	TDN							1054	1225	1036		197		3215
	CP							253	294	248		47		842
SS/Sp	TDN	187									565	1150	470	2372
	CP	26									79	161	64	330
FS/Sp	TDN	424	113	74	74							1072	990	2747
	CP	47	13	8	8							118	109	303
FS/H,G	TDN								X			281	577	858
	CP								X			31	64	95
Cs/G	TDN	110		22									177	309
	CP	9		2									14	25
						Class IV Land								
KBG/CG	TDN					223	223	97	57	120	57			777
	CP					49	49	22	13	26	13			172

TABLE B.6. Harvested forage yields[a]

Species/management	Harvest Method[b]	Potential dry matter available (lbs.)	Harvest loss (%)	Dry matter harvested (lbs.)	TDN		Crude protein		Moisture (%)	Tons harvested moisture basis
					%[c]	(lbs.)	%[c]	(lbs.)		
				Class I Land						
Alf-Br/H1,G	BH	4862	17.4	4016	56	(2249)	16.2	(651)	15	2.36
	STK	4862	15.0	4133	56	(2314)	16.2	(670)	15	2.43
	Hlg	4862	8.0	4473	56	(2505)	16.2	(725)	50	4.47
Alf-Br/H2,G	BH	7251	17.4	5989	56	(3354)	16.2	(970)	15	3.52
	STK	7251	15.0	6163	56	(3451)	16.2	(998)	15	3.63
	Hlg	7251	8.0	6671	56	(3736)	16.2	(1081)	50	6.67
Alf-Br/H3,G	BH	9261	17.4	7650	56	(4284)	16.2	(1239)	15	4.50
	STK	9261	15.0	7872	56	(4408)	16.2	(1275)	15	4.63
	Hlg	9261	8.0	8520	56		16.2	(1380	50	8.50
FS/H,G	Sil	13,725	2.0	13,451	58	(7802)	6.3	(847)	65	19.22
Corn	Sil	12,000	2.0	11,760	70	(8232)	8.4	(988)	65	16.80
Cs	Sil	5522	55.0	2485	51	(1267)	4.4	(109)	50	2.49
	STK	5522	50.0	2761	51	(1408)	4.4	(121)	35	2.12
				Class II Land						
Alf-Br/H1,G	BH	4277	17.4	3533	56	(1978)	16.2	(572)	15	2.08
	STK	4277	15.0	3635	56	(2036)	16.2	(589)	15	2.14
	Hlg	4277	8.0	3935	56	(2204)	16.2	(637)	50	3.94
Alf-Br/H2,G	BH	6379	17.4	5269	56	(2951)	16.2	(854)	15	3.10
	STK	6379	15.0	5422	56	(3036)	16.2	(878)	15	3.19
	Hlg	6379	8.0	5869	56	(3287)	16.2	(951)	50	5.87
Alf-Br/H3,G	BH	8146	17.4	6729	56	(3768)	16.2	(1090)	15	3.96
	STK	8146	15.0	6924	56	(3877)	16.2	(1122)	15	4.07
	Hlg	8146	8.0	7494	56	(4197)	16.2	(1214)	50	7.49

Br/120N,H2,G	BH	5710	17.4	4716	58	(2735)	12.1	(571)	15	2.77
	STK	5710	15.0	4854	58	(2815)	12.1	(587)	15	2.86
	Hlg	5710	8.0	5253	58	(3047)	12.1	(636)	50	5.25
Br/240N,H1,G	BH	6797	17.4	5614	58	(3256)	12.1	(679)	15	3.30
	STK	6797	15.0	5777	58	(3351)	12.1	(699)	15	3.40
	Hlg	6797	8.0	6253	58	(3627)	12.1	(757)	50	6.25
Br/240N,H2,G	BH	8865	17.4	7322	58	(4247)	12.1	(886)	15	4.31
	STK	8865	15.0	7535	58	(4370)	12.1	(912)	15	4.43
	Hlg	8865	8.0	8156	58	(4730)	12.1	(987)	50	8.16
BFT/H1,G	BH	3062	17.4	2529	56	(1416)	16.2	(410)	15	1.49
	STK	3062	15.0	2603	56	(1458)	16.2	(422)	15	1.53
	Hlg	3062	8.0	2817	56	(1578)	16.2	(456)	50	2.82
FS/H,G	Sil	12,078	2.0	11,836	58	(6865)	6.3	(746)	65	16.91
Corn	Sil	10,204	2.0	10,000	70	(7000)	8.4	(840)	65	14.29
Cs	Sil	4603	55.0	2071	51	(1056)	4.4	(91)	50	2.07
	STK	4603	50.0	2302	51	(1174)	4.4	(101)	35	1.77
				Class III Land						
Alf-Br/H1,G	BH	3111	17.4	2570	56	(1439)	16.2	(416)	15	1.51
	STK	3111	15.0	2644	56	(1481)	16.2	(428)	15	1.56
	Sil	3111	8.0	2862	56	(1603)	16.2	(464)	50	2.86
Alf-Br/H2,G	BH	4641	17.4	3833	56	(2146)	16.2	(621)	15	2.26
	STK	4641	15.0	3945	56	(2209)	16.2	(639)	15	2.32
	Sil	4641	8.0	4270	56	(2391)	16.2	(692)	50	4.27

[a] Sources: Wedin (41), Ayres (2), Vetter and Weber (38), Vetter, Weber, and Gay (39), Silage production and use (29), and Baumgardt and Smith (4).

[b] Harvest methods: BH = baled hay, STK = stack, Hlg = haylage, Sil = silage.

[c] Percent of dry matter harvested.

TABLE B.6. Continued

Species/management	Harvest Method[a]	Potential dry matter available (lbs.)	Harvest loss (%)	Dry matter harvested (lbs.)	TDN		Crude protein		Moisture (%)	Tons harvested moisture basis
					%[b]	(lbs.)	%[b]	(lbs.)		
Alf-Br/H3,G	BH	5926	17.4	4895	56	(2741)	16.2	(793)	15	2.88
	STK	5926	15.0	5037	56	(2821)	16.2	(816)	15	2.96
	Sil	5926	8.0	5452	56	(3053)	16.2	(883)	50	5.45
Br/120N,H2,G	BH	4153	17.4	3430	58	(1989)	12.1	(415)	15	2.02
	STK	4153	15.0	3530	58	(2047)	12.1	(427)	15	2.08
	Sil	4153	8.0	3821	58	(2216)	12.1	(462)	50	3.82
Br/240N,H1,G	BH	4942	17.4	4082	58	(2368)	12.1	(494)	15	2.40
	STK	4942	15.0	4201	58	(2437)	12.1	(508)	15	2.47
	Hlg	4942	8.0	4547	58	(2637)	12.1	(550)	50	4.55
Br/240N,H2,G	BH	6448	17.4	5326	58	(3089)	12.1	(644)	15	3.13
	STK	6448	15.0	5481	58	(3179)	12.1	(663)	15	3.22
	Hlg	6448	8.0	5932	58	(3441)	12.1	(718)	50	5.93
BFT/H1,G	BH	2228	17.4	1840	56	(1030)	16.2	(298)	15	1.08
	STK	2228	15.0	1894	56	(1061)	16.2	(307)	15	1.11
	Hlg	2228	8.0	2050	56	(1148)	16.2	(332)	50	2.05
FS/H,G	Sil	8786	2.0	8610	58	(4994)	6.3	(542)	65	12.30
Cs	Sil	3682	55.0	1657	51	(854)	4.4	(73)	50	1.66
	STK	3682	50.0	1841	51	(939)	4.4	(81)	55	1.42

APPENDIX C: COSTS AND RESOURCE REQUIREMENTS OF HARVESTED FORAGE SYSTEMS

TABLE C.1. Description of harvested forage systems for the beef cow herd

Forage	Harvest	Storage[a]	Removal from storage	Transportation to feeding area	Feeding
Baled hay	Own or custom baler	Pole type hay shed	Removed by hand	Tractor and flat rack	Bales placed on ground by hand
Stacked hay	Own stack-forming wagon	Stacks placed at end of field where harvested and fed in place; electric fence protects stacks yet to be used			Electric fence moved, and portable collapsible feeding racks placed around fresh stacks as needed; cows self-feed from stacks
Haylage	Own forage harvester with windrow pickup	Concrete stave silo	Mechanical silo unloader	Tractor and self-unloading forage wagon	Unloaded into feed bunks
Corn silage	Own or custom forage harvester	Concrete stave silo or bunker silo	Mechanical silo unloader Tractor and manure loader	Tractor and self-unloading forage wagon	Unloaded into feed bunks
Forage sorghum	Own or custom forage harvester	Bunker silo	Tractor and manure loader	Tractor and self-unloading forage wagon	Unloaded into feed bunks
Stalklage	Own forage harvester with flail pickup	Bunker silo	Tractor and manure loader	Tractor and self-unloading forage wagon	Unloaded into feed bunks

Stacked corn	Own stack-forming wagon	Stacks placed at end of field where harvested and fed in place; electric fence protects stacks yet to be used	Electric fence moved and portable, collapsible racks placed around fresh stacks as needed; cows self-feed from stacks

[a]Costs of storage facilities are presented in Tables 6 and 7.

TABLE C.2. Forage harvesting equipment capacities, variable costs, and labor requirements

Machine	Baler	Stack-forming wagon	
Forage harvested	Baled hay	Stacked hay	Stacked cornstalks
Machine field capacity[a] (tons/hr.)	6	5	3
Dry matter content of forage (%)	85	85	65
Machine field capacity (dry matter tons/hr.)	5.1	4.3	2.0
Variable costs per hour-harvest[b]	$ 6.19	$ 3.12	$ 3.12
Variable costs-supporting:[c]			
mowing-conditioning	3.68	2.98	
hauling	.77		
unloading and storing	1.05	1.02[d]	1.71[d]
Total variable costs per hour of harvest machine operation	$11.69	$ 7.12	$ 4.83
Variable costs per ton of dry matter	$ 2.29	$ 1.66	$ 2.42
- Labor requirements in hours -			
Labor required per hour-harvest	2.0	1.0	1.0
Labor required-supporting:[c]			
mowing-conditioning	1.0	.8	
hauling	.5		
unloading and storing	1.0	.1[d]	.2[d]
Total labor required per hour of harvest machine operation	4.5	1.9	1.2
Labor required per ton of dry matter	.88	.44	.60

[a]From Harvesting, storing, processing feeds for beef cattle (14) and Ayres (2).

[b]Includes twine cost, 1.5¢/bale or 60¢ per ton.

[c]Variable costs and labor requirements for mowing and conditioning, hauling, unloading, and storing the forage processed by the harvesting machine per hour.

[d]Cost and labor requirements of setting up electric fence around stacks.

[e]Not including labor furnished by custom operator.

Forage harvester			Custom harvest	
Haylage	Corn or forage sorghum silage	Stalklage	Baled hay	Corn or forage sorghum silage
9.8	20	4.7	6	20
50	35	50	85	35
4.9	7.0	2.4	5.1	7.0
$ 6.00	$ 6.46	$ 6.68	$28.80[b]	$18.90
3.17			3.68	
.54	1.05	.26	.77	
.96	2.88	.69	1.05	1.09
$10.67	$10.39	$ 7.63	$34.30	$19.99
$ 2.18	$ 1.48	$ 3.18	$ 6.73	$ 2.86
	- Labor requirements in hours -			
1.0	1.0	1.0		
.9			1.0	
.3	.6	.1	.5	
.4	1.8	.4	1.0	.9
2.6	3.4	1.5	2.5[e]	.9[e]
.53	.49	.63	.49[e]	.13[e]

TABLE C.3. Labor requirements and machinery and equipment variable costs for feeding harvested forages to the beef cow herd[a]

Forage[b]	Per ton fed, moisture basis		Per ton of dry matter fed	
	Labor required (hr.)	Machinery and equipment variable cost	Labor required (hr.)	Machinery and equipment variable cost
Baled hay	1.00	$ .21	1.18	$ .25
Stacked hay	.27	--	.32	--
Haylage	.32	.44	.64	.88
Corn silage (stored in concrete stave silo)	.26	.33	.74	.94
Corn or forage sorghum silage (stored in bunker silo)	.25	.42	.71	1.20
Stalklage	.39	.61	.78	1.22
Stacked cornstalks	.27	--	.42	--

[a]Sources: Harvesting, storing, processing feeds for beef cattle (14), and Suter (32).

[b]Includes removal from storage and transportation to feeding area.

TABLE C.4. Forage dry matter losses through harvest, storage, and feeding[a]

Forage	Storage facility	Harvest loss	Storage loss	Feeding loss
		(% of dry matter available in the field)		
Baled hay	hay shed	17.4	4.4	6.0[b]
Stacked hay	none	15.0	11.8	21.5[c]
Haylage	concrete stave silo	8.0	11.4	3.0
Corn silage	concrete stave silo	2.0	8.0	3.0
Corn or forage sorghum silage	bunker silo	2.0	15.3	3.0
Stacked cornstalks	none	50.0	10.0	25.0
stalklage	bunker silo	55.0	15.0	5.0

[a]Sources: Harvesting, storing processing feeds for beef cattle (14) and Ayres (2).

[b]Feeding waste is only 3% for baled hay fed to feedlot cattle in racks. 6% waste is for bales fed to cows on the ground.

[c]The actual feeding waste for stacked hay, which is fed in collapsible racks is 6.5%; the additional 15% represents consumption in excess of the cows' requirements, based on the results of feeding experiments conducted at Purdue University, as reported by Smith et al. (30).

APPENDIX D: LIVESTOCK PRODUCTION COSTS AND RESOURCE REQUIREMENTS

TABLE D.1. TDN and crude protein requirements of the feeder calf producing activities

	Pounds per cow-calf unit												Total
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Spring calving:													
TDN per day	9.7	9.8	10.2	12.7	15.5	16.0	17.1	18.1	18.6	19.1	8.5	9.3	
TDN per month	302	274	315	381	481	480	531	562	558	591	285	289	5049
Crude protein per day	1.28	1.37	1.44	1.81	2.39	2.57	2.65	2.72	2.73	2.73	1.31	1.28	
Crude protein per month	39.8	38.3	44.5	54.4	74.2	77.0	82.3	84.2	81.8	84.5	39.2	39.8	740.0
Fall calving:													
TDN per day	15.0	14.4	13.5	19.4	10.4	10.4	10.4	10.8	13.0	15.4	15.4	14.7	
TDN per month	465	404	417	281	321	311	321	334	391	476	465	455	4641
Crude protein per day	2.32	2.22	2.11	1.32	1.38	1.38	1.46	1.53	1.89	2.39	2.50	2.36	
Crude protein per month	72.0	62.2	65.4	39.5	42.8	41.5	45.4	47.5	56.7	774.2	75.1	72.1	694.4

Note: In addition to the above requirements, corn grain is assumed to be fed in the following amounts per cow-calf unit.

Spring calving: 1.5 bu. to the replacement heifer and .6 bu. to the bull;
Fall calving: 1.6 bu. to the replacement heifer and .8 bu. to the bull and 10.1 bu. creep fed to the calves.

[a]Sources: Maddox (25), Gay and Zmolek (11).

[b]Cow-calf unit = 1 cow, .9 calf, .17 replacement heifer, and .04 bull.

TABLE D.2. Estimated feeder calf production labor requirements, not including labor for feeding harvested forages

	(Hours per cow-calf unit)[a]												Total
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Spring calving[b]	.21	.21	.21	.46	.37	.35	.32	.28	.28	.27	.32	.21	3.49
Fall Calving	.25	.25	.35	.25	.20	.20	.20	.25	.45	.35	.30	.25	3.30

[a]Cow-calf unit = 1 cow, .9 calf, .17 replacement heifer, and .04 bull.

[b]Adapted from Worden (44) and Bortfield et al. (6).

TABLE D.3. Feeder calf production variable costs[a]

	$/cow-calf unit
Salt (40 lbs. x $.03)	$ 1.20
Mineral (40 lbs. x $.08)	3.20
Veterinary and medical	6.60
Marketing of cull cow ($.70/cwt.)	1.07
Variable power and machine cost	2.00[b]
Depreciation of bull	5.00
Miscellaneous	2.00
	$21.07

[a]Sources: Howell and Stoneberg (18) and James (22).

[b]Add $.20 per cow-calf unit in fall calving activity for processing of creep feed.

TABLE D.4. Capital invested in livestock, feeder calf production

	Cattle price level		
	Low	Medium	High
Beef cow, 1050 lbs. x 125% of cull cow price	$204.75	$252.00	$299.25
.17 replacement heifer, 700 lbs. x fed heifer price	30.05	37.19	44.33
.04 bull	19.36	21.52	23.68
Total investment per cow-calf unit	$254.16	$308.55	$367.26
8% interest on investment	$ 20.33	$ 24.68	$ 29.38

TABLE D.5. Total feed requirements of cattle feeding activities[a]

	Ration (identified by % of total ration dry matter)[b]			
	30% corn grain 70% corn silage	60% corn grain 20% corn silage 20% mixed haylage	60% corn grain 40% mixed haylage	Variable corn grain and mixed baled hay[c]
Steers (450 to 1050 lbs.)				
Corn grain (bushels)	28.4	54.0	59.6	66.1
Corn silage (tons)	4.46	1.23		
Mixed haylage (tons)		.86	1.93	
Mixed baled hay (tons)				.47
36% natural protein based supplement (lbs.)	67	63	47	64
50% urea based supplement (lbs.)	140			9
Total supplement cost	$10.25	$ 3.71	$ 2.77	$ 4.19
Heifers (420 to 880 lbs.)				
Corn grain (bushels)	22.3	42.3	45.5	51.6
Corn silage (tons)	3.50	.96	1.45	
Mixed haylage (tons)		.67		
Mixed baled hay (tons)				.38
36% natural protein based supplement (lbs.)	58	54	37	55
50% urea based supplement (lbs.)	104			7
Total supplement cost	$ 7.97	$ 3.19	$ 2.18	$ 3.57

[a]Source: Geasler (12).

[b]The same requirements were assumed for both spring and fall calves.

[c]Percent of dry matter supplied by corn grain increases from 70% to 85% through the feeding period.

TABLE D.6. Cattle feeding labor requirements[a]

Ration:	Steer Calves			
	30% corn grain 70% corn silage	60% corn grain 20% corn silage 20% haylage	60% corn grain 40% haylage	corn grain and baled hay
		(hr./head)		
Spring calves				
Nov.	.38	.35	.57	.33
Dec.	.36	.33	.35	.31
Jan.	.36	.33	.35	.31
Feb.	.36	.33	.35	.31
Mar.	.36	.33	.35	.31
Apr.	.31	.28	.30	.26
May	.31	.28	.30	.26
June	.31	.28	.30	.26
July	.39	.38	.38	.37
Aug.	.29	.29	.29	.29
Total	3.43	3.18	3.34	3.01
Fall calves				
Apr.	.38	.35	.37	.33
May	.32	.29	.31	.27
June	.31	.28	.30	.26
July	.31	.28	.30	.26
Aug.	.60	.57	.59	.55
Sept.	.31	.28	.30	.26
Oct.	.31	.28	.30	.26
Nov.	.31	.28	.30	.26
Dec.	.39	.38	.38	.37
Total	3.24	2.99	3.15	2.82

[a] Sources: Johnson and Nodland (24) and Harvesting, storing, processing feeds for beef cattle (14).

Heifer calves			
30% corn grain 70% corn silage	60% corn grain 20% corn silage 20% haylage	60% corn grain 40% haylage	Corn grain and baled hay
(hr./head)			
.37	.33	.35	.32
.35	.31	.33	.30
.35	.31	.33	.30
.35	.31	.33	.30
.35	.31	.33	.30
.30	.26	.28	.25
.30	.26	.28	.25
.09	.08	.09	.08
.25	.25	.25	.25
.25	.25	.25	.25
2.96	2.67	2.82	2.60
.37	.33	.35	.32
.31	.27	.29	.26
.30	.26	.28	.25
.30	.26	.28	.25
.59	.55	.57	.54
.30	.26	.28	.25
.30	.26	.28	.25
.31	.30	.31	.30
2.78	2.49	2.64	2.42

TABLE D.7. Cattle feeding variable costs[a]

	Steers	Heifers
	($/head)[b]	
Salt and mineral	$ 2.20	$ 1.65
Bedding ($20/ton)	3.00	2.40
Veterinary and medical	4.00	3.00
Marketing costs ($.70/cwt.)	7.13	5.92
Variable power and machine cost	1.34	1.14
Miscellaneous	.50	.50
	$18.17	$14.61

[a]Sources: Howell and Stoneberg (18) and Wisconsin farm enterprise budgets: cattle feeding (43).

[b]The same costs were assumed for both spring and fall calves.

TABLE D.8. Capital invested in livestock, cattle feeding[a]

	Cattle price level		
	Low	Medium	High
Steer calves:			
Average investment per head fed[b]	$134.75	$178.86	$222.99
x 8% x .69[c] = interest on investment	7.44	9.87	12.31
Heifer calves:			
Average investment per head fed[b]	$112.72	$153.93	$195.21
x 8% x .61[c] = interest on investment	5.50	7.51	9.53

[a]The investment and interest costs were assumed to be the same for both spring and fall calves.

[b]The investment presented here is the average of the cost of purchased calves and the opportunity cost of home-raised calves, increased by 1.5% to allow for death loss.

[c]Steer calves are on feed .69 year and heifers are on feed .61 year.

TABLE D.9. Description of swine production activities[a]

	Winter-Summer Farrowing Activity	Spring-Fall Farrowing Activity
Farrowing months	December June	March September
Month of sale and price per cwt. of 220 lb. butchers[b]	June, $24.20 December, $22.55	September, $22.15 March, $20.80
Pigs weaned per litter	7.52	7.61
% death loss after weaning	2.55	2.87
Sales per sow	13.66-220 lb. butchers 1-400 lb. sow	13.78-220 lb. butchers 1-400 lb. sow
Total lbs. pork sold	3405	3432
Feed required:		
Corn grain	200.2 bu.	207.1 bu.
Purchased complete feeds	642 lbs.	615 lbs.
Supplements	2353 lbs.	2361 lbs.
Salt and mineral	35 lbs.	39 lbs.
Total cost of purchased feeds	$187.46	$187.16
Total feed fed	14,241 lbs.	14,613 lbs.
Feed efficiency (lbs. feed fed per lb. pork sold)	4.18	4.26

[a]Source: James and Trede (23).

[b]Butcher prices assumed are the average interior Iowa and southern Minnesota prices for the indicated months from 1965 to 1972, U.S. Department of Agriculture, Consumer and Marketing Service (34).

TABLE D.10. Swine production labor requirements[a]

	(Hours per sow and two litters)												Total
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Winter-summer farrowing	2.2	2.2	2.2	1.9	2.0	2.7	2.0	1.4	1.2	1.6	2.6	3.5	25.5
Spring-fall farrowing	2.4	3.2	3.5	2.2	2.0	1.5	1.5	2.0	2.7	2.1	1.9	1.8	26.8

[a]Source: James and Trede (23).

TABLE D.11. Swine production variable costs[a]

	Winter-Summer Farrowing Activity	Spring-Fall Farrowing Activity
	(costs per sow and two litters)	
Bedding	$ 6.70	$ 4.20
Veterinary and medical	27.00	21.00
Variable power and machine cost	5.75	6.50
Boar cost	4.50	4.50
Miscellaneous	3.00	3.00
Total	$46.95	$39.20

[a]Source: Howell and Stoneberg (18).

TABLE D.12. Capital invested in livestock, swine production

	Winter-Summer Farrowing Activity	Spring-Fall Farrowing Activity
Sow (at market value)	$71.60	$72.20
.5 replacement gilt (220 lbs.)	24.81	22.88
1/30 boar x $300	10.00	10.00
Total investment	$106.41	$105.08
8% interest on investment	$ 8.51	$ 8.41

APPENDIX E: FORAGE SYSTEMS FOR THE BEEF COW HERD FROM KEY SOLUTIONS

TABLE E.1. Forage system TDN and crude protein (CP) balance sheet: forage farm, low cattle price level, no cattle feeding, own stack-forming wagon

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
			(000 lbs.)				
TDN		220.20	66.50	60.33	69.36	83.90	105.92
Crude protein			8.76	8.43	9.80	11.98	16.34
Supplied by - Grazing:[a]		Acres					
Sdg/G(II)	TDN	26.83					
	CP						
Alf-Br/H1,G(II)	TDN	42.54					
	CP						
Alf-Br/H3,G(II)	TDN	11.12					
	CP						
Sdg/G(III)	TDN	15.48					
	CP						
Alf-Br/H1,G(III)	TDN	47.84					
	CP						
Br/240N,H2, G(III)	TDN	31.68					
	CP						
BFT/H1,G(III)	TDN	85.86					
	CP						
KBG/60N,3SG(III)	TDN	94.58				5.39	63.27
	CP					1.23	13.90
KBG/CG(IV)	TDN	77.00					17.17
	CP						3.77
Harvested Feed:							
Stacked mixed hay	TDN	269.50	66.50	15.89	57.21	34.51	
	CP		19.20	4.59	16.52	9.97	
Stacked grass hay	TDN	89.77				44.00	25.48
	CP					9.21	5.33
Stacked corn-stalks	TDN	188.41		44.45	12.15		
	CP			3.85	1.05		
Excess available	TDN						
	CP		10.44	--	7.77	8.43	6.66
Shadow price	TDN	¢/lb.	1.6	1.6	1.6	1.7	1.7
	CP	¢/lb.					

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
				(000 lbs.)			
TDN	105.70	116.93	123.75	123.87	130.14	62.76	63.64
CP	16.96	18.12	18.54	18.01	18.61	8.63	8.76
TDN	28.09	8.29	10.38		6.90	5.98	
CP	5.77	1.66	2.09		1.37	1.21	
TDN		36.71	30.88	10.93	29.65		
CP		11.36	9.57	3.40	9.19		
TDN					7.75		
CP					2.40		
TDN	12.12	3.45	4.33		2.93	2.57	
CP	2.43	.70	.87		.59	.51	
TDN		30.09	25.16	9.04	24.59		
CP		9.28	7.80	2.77	7.65		
TDN					7.79	20.28	11.40
CP					2.44	2.03	1.17
TDN		30.91	48.60	40.70	19.66		
CP		11.08	17.43	14.60	7.04		
TDN	73.49			52.96	26.481	21.66	
CP	16.17			11.63	5.86	4.73	
TDN	17.17	7.47	4.39	9.24	4.39		
CP	3.77	1.69	1.00	2.00	1.00		
TDN						12.27	15.19
CP						3.54	4.39
TDN							
CP							
TDN							37.04
CP							3.20
TDN	25.17						
CP	11.18	17.64	20.22	16.39	18.93	3.39	
TDN		1.2	.4	1.5	.4	1.7	1.6
CP							

TABLE E.2. Forage system TDN and crude protein (CP) balance sheet: forage farm, medium cattle price level, no cattle feeding, own stack-forming wagon and custom silage harvesting

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
TDN		276.3	83.44	75.71	87.03	105.27	132.90
CP			11.00	10.58	12.30	15.03	20.50
Supplied by-Grazing:[a]		Acres					
FS/H,G(II)	TDN	30.35					
	CP						
Sdg/G(II)	TDN	23.59					
	CP						
Alf-Br/H1,G(II)	TDN	40.69					
	CP						
Br/240N,3SG(II)	TDN	20.36				2.57	28.28
	CP					.79	8.78
Br/240N,H1,G(II)	TDN	8.83					
	CP						
Sdg/G(III)	TDN	44.94					
	CP						
Alf-Br/H1,G(III)	TDN	108.58					
	CP						
Alf-Br/H2,G(III)	TDN	71.19					
	CP						
BFT/H,G(III)	TDN	1.04					
	CP						
KBG/60N,3SG(III)	TDN	39.08				2.23	26.14
	CP					.51	5.74
KBG/CG(IV)	TDN	77.00					17.17
	CP						3.77
Harvested feed:		Tons					
Stacked mixed hay	TDN	372.66	64.28	12.92	22.87	80.03	61.31
	CP		18.56	3.73	6.61	23.11	17.71
Stacked grass hay	TDN	26.43				20.46	
	CP					4.28	
FS silage	TDN	435.27		62.80	6.17		
	CP			6.85	.67		
Stacked corn-stalks	TDN	155.28	19.17		57.99		
	CP		1.66		5.02		
Excess available	TDN						
	CP		9.22			13.66	15.50
Shadow price	TDN	¢/lb.	1.7	1.7	1.7	2.3	1.9
	CP	¢/lb.					

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	132.62	146.72	155.28	154.18	163.29	78.75	79.85
CP	21.28	22.74	23.26	22.60	23.35	10.83	11.00
TDN							24.07
CP						1.27	2.64
TDN	25.34	7.29	9.13		6.06	5.26	
CP	5.07	1.46	1.84		1.20	1.06	
TDN		35.12	29.54	10.46	28.36		
CP		10.86	9.16	3.26	8.79		
TDN	25.12	18.16			6.86	18.04	10.00
CP	7.80	5.64			2.12	1.81	1.00
TDN				3.68	5.55	7.82	4.34
CP				1.14	1.72	.79	.43
TDN	35.19	10.02	12.58		8.49	7.46	
CP	7.06	2.02	2.52		1.71	1.48	
TDN		68.30	57.11	20.52	55.81		
CP		21.06	17.70	6.30	17.37		
TDN			37.45	13.45	36.59		
CP			11.60	4.13	11.39		
TDN		.37	.59	.49	.24		
CP		.13	.21	.18	.09		
TDN	30.37			21.88	10.94	8.95	
CP	6.68			4.81	2.42	1.95	
TDN	17.17	7.47	4.39	9.24	4.39		
CP	3.77	1.69	1.00	2.00	1.00		
TDN			4.50			19.47	13.37
CP			1.30			5.62	3.86
TDN							
CP							
TDN				74.45			28.08
CP				8.13			3.06
TDN							
CP							
TDN	.57						
CP	9.10	20.12	22.07	7.35	24.46	3.15	
TDN		1.3	1.8	1.7	1.7	1.8	1.7
CP							

TABLE E.3. Forage system TDN and crude protein (CP) balance sheet: forage farm, high cattle price level, no cattle feeding, own stack-forming wagon and custom silage harvesting

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
TDN		337.1	101.80	92.37	106.19	128.44	162.15
CP			13.42	12.91	15.00	18.34	25.01
Supplied by-Grazing:[a]		Acres					
SS/AG(I)	TDN	6.79					
	CP						
FS/H,G(II)	TDN	26.83					
	CP						
Sdg/G(II)	TDN	19.95					
	CP						
Alf-Br/H1,G(II)	TDN	52.27					
	CP						
Br/240N,3SG(II)	TDN	38.77				4.89	53.85
	CP					1.51	16.71
Br/240N,H1,G(II)	TDN	21.11					
	CP						
Br/240N,H2,G(II)	TDN	2.07					
	CP						
FS/H,G(III)	TDN	4.40					
	CP						
SS/AG(III)	TDN	5.57					
	CP						
Sdg/G(III)	TDN	49.95					
	CP						
Alf-Br/H1,G(III)	TDN	91.36					
	CP						
Alf-Br/H2,G(II)	TDN	108.44					
	CP						
KBG/60N,3SG(III)	TDN	50.28				2.87	33.64
	CP					.65	7.39
KBG/CG(IV)	TDN	77.00					17.17
	CP						3.77
Harvested feeds:		Tons					
Stacked mixed hay	TDN	446.19	59.85	72.08	84.82	65.53	32.36
	CP		17.28	20.82	24.49	18.92	9.34
Stacked grass hay	TDN	71.24				55.14	
	CP					11.54	

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	161.81	179.00	189.45	188.10	199.23	96.07	97.42
CP	25.96	27.74	28.38	27.47	28.48	13.21	13.42
TDN		11.18	13.00	10.99		2.08	
CP		2.68	3.12	2.64		.50	
TDN						10.38	21.28
CP						1.13	2.33
TDN	21.43	6.16	7.72		5.13	4.49	
CP	4.29	1.24	1.56		1.02	.90	
TDN		45.11	37.95	13.43	36.43		
CP		13.96	11.76	4.18	11.29		
TDN	47.84	34.58			13.07	34.35	19.04
CP	14.85	10.74			4.03	3.45	1.90
TDN				8.80	13.29	18.70	10.37
CP				2.72	4.12	1.88	1.03
TDN					.70	1.83	1.02
CP					.22	.18	.10
TDN						1.24	2.54
CP						.14	.28
TDN		5.87	6.82	5.77		1.10	
CP		1.41	1.64	1.38		.26	
TDN	39.11	11.14	13.99		9.44	8.29	
CP	7.84	2.25	2.80		1.90	1.65	
TDN		57.47	48.06	17.27	46.96		
CP		17.72	14.89	5.30	14.62		
TDN			57.04	20.50	55.74		
CP			17.68	6.29	17.35		
TDN	39.07			28.16	14.08	11.51	
CP	8.60			6.18	3.12	2.51	
TDN	17.17	7.47	4.39	9.24	4.39		
CP	3.77	1.69	1.00	2.00	1.00		
TDN						2.12	16.99
CP						.61	4.91
TDN							
CP							

TABLE E.3. Continued

			Jan.	Feb.	Mar.	Apr.	May
		Tons					
Forage sorghum silage	TDN	430.60	41.94	2.03			25.11
	CP		4.58	.22			2.74
Stacked corn-stalks	TDN	79.67		18.24	21.35		
	CP			1.58	1.85		
Excess available	TDN						
	CP		8.44	9.71	11.34	14.28	14.94
Shadow price	TDN	¢/lb.	2.6	2.6	2.6	2.9	2.6
	CP	¢/lb.					

	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
TDN			.46	73.93			26.19
CP			.05	8.07			2.86
TDN							
CP							
TDN	2.81						
CP	13.39	23.95	26.12	13.19	30.19		
TDN		1.8	2.3	2.1	1.9	.8	2.0
CP						5.8	1.3

TABLE E.4. Forage system TDN and crudt protein (CP) balance sheet: forage farm, with full-time employee, medium cattle price level, no cattle feeding, custom baling and custom silage harvesting

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
TDN		340.2	102.74	93.21	107.16	129.62	163.64
CP			13.54	13.03	15.14	18.51	25.24
Supplies by-Grazing:[a]		Acres					
Cs/G(I)	TDN	11.68	1.94		.39		
	CP		.15		.02		
FS/H1,G(I)	TDN	36.82					
	CP						
FS/H1,G(II)	TDN	48.98					
	CP						
Sdg/G(II)	TDN	26.83					
	CP						
Alf-Br/H1,G(II)	TDN	53.67					
	CP						
Cs/G(III)	TDN	45.13	4.96		.99		
	CP		.41		.09		
Sdg/G(III)	TDN	45.13					
	CP						
Alf-Br/RG(III)	TDN	73.14					40.96
	CP						12.73
Alf-Br/H1,G(III)	TDN	107.38					
	CP						
KBG/60N,3SG(III)	TDN	39.21				2.23	26.23
	CP					.51	5.76
KBG/CG(IV)	TDN	77.00					17.17
	CP						3.77
Harvested feeds:		Tons					
Baled mixed hay	TDN	262.59	34.90	15.85	105.78	22.72	
	CP		10.10	4.59	30.61	6.57	
Forage sorghum silage	TDN	1,301.79	60.94	77.37		104.66	79.27
	CP		6.65	8.44		11.42	8.65
Excess Available	TDN						
	CP		3.77		15.58		5.67
Shadow price	TDN	¢/lb.	2.0	2.0	2.0	2.1	2.0
	CP	¢/lb.				.5	

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	163.30	180.65	191.19	189.83	201.06	96.96	98.32
CP	26.20	28.00	28.64	27.83	28.75	13.34	13.54
TDN							3.10
CP							.25
TDN						16.20	33.21
CP						1.77	3.65
TDN						18.96	38.84
CP						2.06	4.26
TDN	28.82	8.29	10.38		6.90	5.98	
CP	5.77	1.66	2.09		1.37	1.21	
TDN		46.32	38.96	13.79	37.41		
CP		14.33	12.08	4.29	11.59		
TDN							7.99
CP							.63
TDN	35.34	10.06	12.64		8.53	7.49	
CP	7.09	2.03	2.53		1.71	1.49	
TDN	52.22	40.96	34.30	13.82	31.74		
CP	16.24	12.73	10.61	4.24	9.87		
TDN		67.54	56.48	20.29	55.19		
CP		20.83	17.50	6.23	17.18		
TDN	30.47			21.96	10.98	8.98	
CP	6.70			4.82	2.43	1.96	
TDN	17.17	7.47	4.39	9.24	4.39		
CP	3.77	1.69	1.00	2.00	1.00		
TDN						39.34	16.43
CP						11.39	4.76
TDN			34.03	110.72	45.92		
CP			3.71	12.08	5.01		
TDN							1.25
CP	13.37	25.271	20.88	5.83	21.41	6.54	
TDN	.9	1.4	2.0	2.0	2.0	2.0	
CP							7.0

TABLE E.5. Forage system TDN and crude protein (CP) balance sheet: forage farm, with full-time employee, high cattle price level, no cattle feeding, own baler and custom silage harvesting

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
TDN		498.3	150.49	136.53	156.96	189.85	239.68
CP			19.83	19.08	22.17	27.11	36.97
Supplied by-Grazing:[a]		Acres					
FS/H,G(I)	TDN	85.69					
	CP						
FS/H,G(II)	TDN	58.14					
	CP						
Sdg/G(II)	TDN	21.24					
	CP						
Alf-Br/Hl,G(II)	TDN	31.31					
	CP						
Br/240N,3SG(II)	TDN	50.31				6.34	69.88
	CP					1.96	21.68
FS/H,G(III)	TDN	28.76					
	CP						
SS/AG(III)	TDN	9.13					
	CP						
Sdg/G(III)	TDN	21.36					
	CP						
Alf-Br/Hl,G(III)	TDN	85.43					
	CP						
BFT/CG(III)	TDN	148.79					16.22
	CP						5.80
KBG/CG(IV)	TDN	77.00					17.17
	CP						3.77
Harvested feed:		Tons					
Baled mixed hay	TDN	186.26	65.81	23.22	27.98	23.77	
	CP		19.04	6.72	8.10	6.88	
Corn silage	TDN	161.45				76.69	
	CP					9.20	
Forage sorghum silage	TDN	2,528.54	84.68	113.32	128.98	83.06	136.41
	CP		9.24	12.37	14.08	9.06	14.89
Excess available	TDN						
	CP		8.45				9.17
Shadow price	TDN	¢/lb.	2.5	2.5	2.5	2.8	2.5
	CP	¢/lb.				2.2	

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	239.18	264.60	280.05	278.05	294.50	142.02	144.01
CP	38.37	41.01	41.96	40.76	42.11	19.53	19.83
TDN						37.70	77.29
CP						4.11	8.48
TDN						22.50	46.11
CP						2.44	5.06
TDN	22.81	6.56	8.22		5.46	4.74	
CP	4.57	1.32	1.66		1.08	.96	
TDN		27.02	22.73	8.05	21.82		
CP		8.36	7.04	2.50	6.76		
TDN	62.08	44.88			16.95	44.57	24.70
CP	19.27	13.94			5.23	4.48	2.47
TDN						8.08	16.59
CP						.89	1.84
TDN		9.62	11.18	9.46		1.80	
CP		2.31	2.68	2.26		.43	
TDN	16.72	4.76	5.98		4.04	3.55	
CP	3.35	.96	1.20		.81	.70	
TDN		53.74	44.94	16.15	43.91		
CP		16.57	13.93	4.95	13.67		
TDN	120.82	110.55	84.22	53.56	28.12		
CP	43.60	39.73	30.20	19.19	9.97		
TDN	17.17	7.47	4.39	9.24	4.39		
CP	3.77	1.69	1.00	2.00	1.00		
TDN						19.07	6.86
CP						5.52	1.98
TDN							
CP							
TDN			98.39	181.60	169.80		
CP			10.74	19.82	18.53		
TDN							27.54
CP	36.19	43.87	26.49	9.96	14.94		
TDN	1.9	2.3	2.5	2.5	2.5	.8	
CP						5.9	8.6

TABLE E.6. Forage system TDN and crude protein (CP) balance sheet: forage farm, low cattle price level, cattle feeding allowed, own stack-forming wagon and custom silage harvesting

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
TDN		210.9	63.69	57.79	66.43	80.35	101.44
CP			8.39	8.08	9.39	11.47	15.65
Supplied by-Grazing:[a]		Acres					
Sdg/G(II)	TDN	26.83					
	CP						
Alf-Br/H1,G(II)	TDN	24.21					
	CP						
Alf-Br/H3,G(II)	TDN	29.45					
	CP						
Sdg/G(III)	TDN	12.63					
	CP						
Alf-Br/H1,G(III)	TDN	34.24					
	CP						
Br/240N,3SG(III)	TDN	15.14				1.38	15.23
	CP					.44	4.72
Br/240N,H2,G(III)	TDN	21.47					
	CP						
BFT/H1,G(III)	TDN	114.18					
	CP						
KBG/60N,3SG(III)	TDN	74.33				4.24	49.73
	CP					.97	10.93
KBG/CG(IV)	TDN	77.00					17.17
	CP						3.77
Harvested feed:		Tons					
Stacked mixed hay	TDN	309.64	17.26	41.58	66.44	74.74	7.75
	CP		4.99	12.01	19.19	21.58	2.24
Stacked grass hay	TDN	60.82					11.56
	CP						2.42
Stacked corn-stalks	TDN	126.03	46.43	16.21			
	CP		4.02	1.40			
Excess available	TDN						
	CP		.62	5.33	9.80	11.52	8.43
Shadow price	TDN	¢/lb.	1.7	1.7	1.7	1.7	1.8
	CP	¢/lb.					

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	101.23	111.99	118.53	117.68	124.64	60.11	60.95
CP	16.24	17.36	17.76	17.25	17.82	8.27	8.39
TDN	28.09	8.29	10.38		6.90	5.98	
CP	5.77	1.66	2.09		1.37	1.21	
TDN		20.89	17.58	6.22	16.87		
CP		6.46	5.45	1.94	5.23		
TDN					20.53		
CP					6.36		
TDN	9.89	2.82	3.54		2.39	2.10	
CP	1.98	.57	.71		.48	.42	
TDN		21.54	18.01	6.47	17.60		
CP		6.64	5.58	1.99	5.48		
TDN	13.58	9.87			3.72	9.69	5.45
CP	4.21	3.06			1.17	.97	.56
TDN					5.28	13.74	7.73
CP					1.65	1.37	.79
TDN		41.10	64.63	54.12	26.15		
CP		14.73	23.18	19.41	9.36		
TDN	57.75			41.62	20.81	17.02	
CP	12.71			9.14	4.61	3.72	
TDN	17.17	7.47	4.39	9.24	4.39		
CP	3.77	1.69	1.00	2.00	1.00		
TDN						11.58	12.26
CP						3.34	3.54
TDN							35.51
CP							7.43
TDN							
CP							
TDN	25.25						
CP	12.20	17.45	20.25	17.23	18.89	2.76	3.93
TDN		1.4	.3	1.6		1.7	1.8
CP							

TABLE E.7. Forage system TDN and crude protein (CP) balance sheet: forage farm, medium cattle price level, cattle feeding allowed, own stack-forming wagon and custom silage harvesting

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
TDN		231.5	69.91	63.43	72.92	88.20	111.35
CP			9.21	8.87	10.30	12.59	17.18
Supplied by-Grazing:[a]		Acres					
FS/H,G(II)	TDN	6.11					
	CP						
Sdg/G(II)	TDN	25.36					
	CP						
Alf-Br/H2,G(II)	TDN	41.47					
	CP						
Alf-Br/H3,G(II)	TDN	6.30					
	CP						
Br/240N,3SG(II)	TDN	.75				.09	1.04
	CP					.03	.32
Br/240N,H2,G(II)	TDN	12.51					
	CP						
Sdg/G(III)	TDN	25.98					
	CP						
Alf-Br/H1,G(III)	TDN	77.72					
	CP						
Alf-Br/H2,G(III)	TDN	5.58					
	CP						
Br/240N,3SG(III)	TDN	46.31				4.21	46.59
	CP					1.34	14.45
BFT/H1,G(III)	TDN	61.31					
	CP						
KBG/60N,3SG(III)	TDN	53.50				3.05	35.79
	CP					.70	7.86
KBG/CG(IV)	TDN	77.00					17.17
	CP						3.77
Harvested feed:		Tons					
Stacked mixed hay	TDN	317.00	24.92	25.67	66.80	77.83	10.75
	CP		7.19	7.41	19.29	22.47	3.10
Stacked grass hay	TDN	48.78		37.76			
	CP			7.90			
Forage sorghum silage	TDN	87.59					
	CP						

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	111.12	122.93	130.10	129.18	136.82	65.98	66.90
CP	17.83	19.05	19.49	18.94	19.56	9.07	9.21
TDN						2.36	4.85
CP						.26	.53
TDN	27.24	7.84	9.81		6.52	5.66	
CP	5.45	1.57	1.98		1.29	1.14	
TDN			30.11	10.66	28.90		
CP			9.33	3.32	8.96		
TDN					4.39		
CP					1.36		
TDN	.93	.67			.25	.66	.37
CP	.29	.21			.08	.07	.04
TDN					4.22	11.08	6.14
CP					1.30	1.11	.61
TDN	20.34	5.79	7.27		4.91	4.31	
CP	4.08	1.17	1.45		.99	.86	
TDN		48.89	40.88	14.69	39.95		
CP		15.08	12.67	4.51	12.44		
TDN			2.94	1.05	2.87		
CP			.91	.32	.89		
TDN	41.54	30.19			11.39	29.64	16.67
CP	12.87	9.35			3.57	2.96	1.71
TDN		22.07	34.70	29.06	14.04		
CP		7.91	12.45	10.42	5.03		
TDN	41.57			29.96	14.98	12.25	
CP	9.15			6.58	3.32	2.68	
TDN	17.17	7.47	4.39	9.24	4.39		
CP	3.77	1.69	1.00	2.00	1.00		
TDN							31.15
CP							9.00
TDN							
CP							
TDN				34.51			
CP				3.77			

TABLE E.7. Continued

			Jan.	Feb.	Mar.	Apr.	May
		Tons					
Stacked corn-stalks	TDN	124.42	44.99		6.12	3.01	
	CP		3.89		.57	.26	
Excess available	TDN						
	CP		1.87	6.44	9.56	12.21	12.32
Shadow price	TDN	¢/lb.	2.2	3.0	2.2	2.2	2.3
	CP	¢/lb.					

	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
TDN							7.71
CP							.67
TDN	37.67						
CP	17.78	17.93	20.30	11.98	20.67		3.35
TDN		1.4	.7	1.9	.4	1.6	2.2
CP							

TABLE E.8. Forage system TDN and crude protein (CP) balance sheet: forage farm, high cattle price level, cattle feeding allowed, own stack-forming wagon and custom silage harvesting

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
TDN		279.5	84.41	76.58	88.04	106.49	134.44
CP			11.12	10.70	12.44	15.20	20.74
Supplied by-Grazing:[a]		Acres					
FS/H,G(II)	TDN	21.46					
	CP						
Sdg/G(II)	TDN	20.89					
	CP						
Alf-Br/H2,G(II)	TDN	43.68					
	CP						
Br/240N,3SG(II)	TDN	43.56				5.49	60.50
	CP					1.70	18.77
Br/240N,H1,G(II)	TDN	9.95					
	CP						
Sdg/G(III)	TDN	37.67					
	CP						
Alf-Br/H1,G(III)	TDN	118.40					
	CP						
Alf-Br/H2,G(III)	TDN	32.28					
	CP						
BFT/H,G(III)	TDN	35.50					
	CP						
KBG/60N,3SG(III)	TDN	40.59				2.31	27.15
	CP					.53	5.97
KBG/CG(IV)	TDN	77.00					17.17
	CP						3.77
Harvested feeds:		Tons					
Stacked mixed hay	TDN	386.03	30.91	53.54	38.40	98.71	25.94
	CP		8.93	15.46	11.09	28.50	7.49
Stacked grass hay	TDN	29.78		23.05			
	CP			4.82			
Forage sorghum silage	TDN	307.76	1.55		49.66		3.68
	CP		.17		5.42		.40
Stacked corn-stalks	TDN	104.54	51.96				
	CP		4.50				
Excess available	TDN						
	CP		2.48	9.58	4.07	15.53	15.66
Shadow price	TDN	¢/lb.	2.6	3.1	2.6	2.8	2.6
	CP	¢/lb.					

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	134.16	148.41	157.08	155.96	165.18	79.66	80.78
CP	21.52	23.00	23.53	22.86	23.62	10.96	11.12
TDN						8.31	17.02
CP						.90	1.87
TDN	22.44	6.46	8.08		5.37	4.66	
CP	4.49	1.30	1.63		1.07	.94	
TDN			31.71	11.23	30.44		
CP			9.83	3.49	9.43		
TDN	53.75	38.86			14.68	38.59	21.39
CP	16.68	12.07			4.53	3.88	2.13
TDN				4.15	6.26	8.82	4.89
CP				1.28	1.94	.89	.49
TDN	29.50	8.40	10.55		7.12	6.25	
CP	5.91	1.70	2.11		1.43	1.25	
TDN		74.47	62.28	22.38	60.86		
CP		22.97	19.30	6.87	18.94		
TDN			16.98	6.10	16.59		
CP			5.26	1.87	5.16		
TDN		12.78	20.09	16.82	8.13		
CP		4.58	7.21	6.04	2.91		
TDN	31.54			22.73	11.37	9.30	
CP	6.94			4.99	2.52	2.03	
TDN	17.17	7.47	4.39	9.24	4.39		
CP	3.77	1.69	1.00	2.00	1.00		
TDN						3.75	37.50
CP						1.08	10.83
TDN							
CP							
TDN			3.02	63.33			
CP			.33	6.91			
TDN							
CP							
TDN	20.24						
CP	16.27	21.31	23.14	10.59	25.31		4.20
TDN		1.5	2.2	2.0	1.6	.3	2.7
CP						7.2	

TABLE E.9. Forage system TDN and crude protein (CP) balance sheet: forage farm, with full-time employee, medium cattle price level, cattle feeding allowed, own baler and custom silage harvesting

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
TDN		339.9	102.65	93.13	107.07	129.50	163.49
CP			13.53	13.02	15.13	18.49	25.22
Supplied by-[a]		Acres					
Grazing:							
FS/H,G(II)	TDN	61.37					
	CP						
Sdg/G(II)	TDN	22.05					
	CP						
Alf-Br/Hl,G(II)	TDN	34.54					
	CP						
Br/240N,3SG(II)	TDN	19.28				2.43	26.78
	CP					.75	8.31
Br/240N,Hl,G(II)	TDN	23.76					
	CP						
Cs/G(III)	TDN	11.35	1.25		.25		
	CP		.10		.02		
FS/H,G(III)	TDN	16.77					
	CP						
SS/AG(III)	TDN	9.51					
	CP						
Sdg/G(III)	TDN	36.08					
	CP						
Alf-Br/Hl,G(III)	TDN	144.32					
	CP						
BFT/CG(III)	TDN	13.96					1.52
	CP						.54
KBG/60N,3SG(III)	TDN	76.45				4.36	51.15
	CP					.99	11.24
KBG/CG(IV)	TDN	77.00					17.17
	CP						3.77
Harvested feeds:		Tons					
Baled mixed hay	TDN	208.94	71.47	59.55	20.63	18.60	
	CP		20.68	17.23	5.97	5.38	
Baled grass hay	TDN	75.12			34.01		
	CP				7.08		
Forage sorghum silage	TDN	1,054.84	29.94	33.59	52.19	104.13	66.89
	CP		3.27	3.67	5.70	11.36	7.30

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	163.15	180.49	191.02	189.66	200.88	96.87	98.23
CP	26.17	27.97	28.62	27.80	28.72	13.32	13.53
TDN						23.75	48.67
CP						2.58	5.34
TDN	23.68	6.81	8.53		5.67	4.92	
CP	4.74	1.37	1.72		1.12	.99	
TDN		29.81	25.08	8.88	24.07		
CP		9.22	7.77	2.76	7.46		
TDN	23.79	17.20			6.50	17.08	9.47
CP	7.38	5.34			2.01	1.72	.94
TDN				9.91	14.95	21.05	11.67
CP				3.07	4.63	2.11	1.16
TDN							2.01
CP							.16
TDN						4.71	9.68
CP						.52	1.07
TDN		10.02	11.65	9.85		1.87	
CP		2.41	2.80	2.36		.45	
TDN	28.25	8.05	10.10		6.82	5.99	
CP	5.66	1.62	2.02		1.37	1.19	
TDN		90.78	75.91	27.28	74.18		
CP		28.00	23.52	8.37	23.09		
TDN	11.34	10.37	7.90	5.03	2.64		
CP	4.09	3.73	2.83	1.80	.94		
TDN	59.40			42.81	21.41	17.51	
CP	13.07			9.40	4.74	3.82	
TDN	17.17	7.47	4.39	9.24	4.39		
CP	3.77	1.69	1.00	2.00	1.00		
TDN							16.75
CP							4.85
TDN					35.62		
CP					7.42		
TDN			47.48	76.70	4.66		
CP			5.18	8.37	.51		

TABLE E.9. Continued

			Jan.	Feb.	Mar.	Apr.	May
		Tons					
Excess available	TDN CP		10.52	7.88	3.64		5.94
Shadow price	TDN CP	¢/lb. ¢/lb.	2.2	2.2	2.2	2.2 .7	2.2

	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
TDN CP	12.54	25.41	18.22	10.33	25.57	.06	
TDN CP	.9	1.8	2.2	2.2	2.2	2.0	.3 6.3

TABLE E.10. Forage system TDN and crude protein (CP) balance sheet: forage farm, with full-time employee, high cattle price, cattle feeding allowed, own baler and custom silage harvesting

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
TDN		439.8	132.82	120.51	138.54	167.56	211.54
CP			17.50	16.84	19.57	23.93	32.63
Supplied by-Grazing:[a]		Acres					
FS/H,G(I)	TDN	24.91					
	CP						
SS/AG(I)	TDN	41.67					
	CP						
FS/H,G(II)	TDN	35.10					
	CP						
Sdg/G(II)	TDN	19.70					
	CP						
Alf-Br/H1,G(II)	TDN	42.06					
	CP						
Br/240N,3SG(II)	TDN	47.26				5.95	65.64
	CP					1.84	20.37
Br/240N,H1,G(II)	TDN	16.86					
	CP						
FS/H,G(III)	TDN	37.05					
	CP						
Sdg/G(III)	TDN	30.46					
	CP						
Alf-Br/H1,G(III)	TDN	35.11					
	CP						
Alf-Br/H2,G(III)	TDN	86.72					
	CP						
BFT/CG(III)	TDN	59.29					6.46
	CP						2.31
KBG/60N,3SG(III)	TDN	54.79				3.12	36.65
	CP					.71	8.05
KBG/CG(IV)	TDN	77.00					17.17
	CP						3.77
Harvested feeds:		Tons					
Baled mixed hay	TDN	98.49	8.86	20.49	20.98	13.88	
	CP		2.56	5.93	6.07	4.02	
Baled grass hay	TDN	53.33	19.81				
	CP		4.12				

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	211.10	233.53	247.17	245.41	259.92	125.34	127.10
CP	33.86	36.20	37.03	35.98	37.16	17.24	17.50
TDN						10.96	22.47
CP						1.20	2.47
TDN		68.59	79.80	67.42		12.79	
CP		16.46	19.13	16.21		3.08	
TDN						13.58	27.83
CP						1.47	3.05
TDN	21.16	6.09	7.62		5.06	4.39	
CP	4.24	1.22	1.54		1.00	.89	
TDN		36.30	30.54	10.81	29.32		
CP		11.23	9.46	3.36	9.08		
TDN	58.32	42.16			15.93	41.87	23.20
CP	18.10	13.09			4.92	4.21	2.32
TDN				7.03	10.60	14.94	8.28
CP				2.17	3.29	1.50	.83
TDN						10.41	21.38
CP						1.15	2.37
TDN	23.85	6.79	8.53		5.76	5.06	
CP	4.78	1.37	1.71		1.16	1.01	
TDN		22.08	18.47	6.64	18.05		
CP		6.81	5.72	2.04	5.62		
TDN			45.61	16.39	44.57		
CP			14.14	5.03	13.88		
TDN	48.14	44.05	33.56	21.34	11.21		
CP	17.37	15.83	12.04	7.65	3.97		
TDN	42.57			30.68	15.34	12.55	
CP	9.37			6.74	3.40	2.74	
TDN	17.17	7.47	4.39	9.24	4.39		
CP	3.77	1.69	1.00	2.00	1.00		
TDN							23.94
CP							6.93
TDN				29.63			
CP				6.17			

TABLE E.10. Continued

			Jan.	Feb.	Mar.	Apr.	May
		Tons					
Corn silage	TDN	434.38			61.72	144.61	
	CP				7.41	17.35	
Forage sorghum silage	TDN		104.15	100.02	55.84		85.62
	CP		11.37	10.92	6.09		9.34
Excess available	TDN						
	CP		.55				11.21
Shadow price	TDN	¢/lb.	2.5	2.5	2.6	2.8	2.5
	CP	¢/lb.		.4	1.4	7.1	

	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
TDN							
CP							
TDN			18.65	46.23	99.69		
CP			2.04	5.05	10.11		
TDN						1.21	
CP	23.77	31.50	29.75	20.44	20.27		.47
TDN	1.4	2.0	2.6	2.5	2.5		2.5
CP						5.9	

TABLE E.11. Forage system TDN and crude protein (CP) balance sheet: grain farm, low cattle price level, no cattle feeding, own baler

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
TDN		32.4	9.78	8.88	10.21	12.34	15.58
CP			1.29	1.24	1.44	1.78	2.40
Supplied by-Grazing:[a]		Acres					
Cs/G(I)	TDN	51.97	8.63		1.72		
	CP		.68		.10		
Cs/G(II)	TDN	9.75	1.38		.27		
	CP		.11		.02		
Sdg/G(II)	TDN	6.50					
	CP						
Alf-Br/H1,G(II)	TDN	11.15					
	CP						
Alf-Br/H2,G(II)	TDN	.89					
	CP						
Alf-Br/H3,G(II)	TDN	.96					
	CP						
Cs/G(III)	TDN	1.56	.17		.03		
	CP		.01		--		
Sdg/G(III)	TDN	.54					
	CP						
Alf-Br/H1,G(III)	TDN	2.17					
	CP						
BFT/H,G(III)	TDN	9.17					
	CP						
KBG/60N,3SG(III)	TDN	16.53				.94	11.06
	CP					.21	2.43
KBG/CG(IV)	TDN	8.00					1.78
	CP						.39
Harvested feeds:		Tons					
Baled mixed hay	TDN	41.10	1.70	8.87	8.18	11.39	2.73
	CP		.49	2.57	2.37	3.30	.79
Excess available	TDN		2.10				
	CP			1.33	1.05	1.75	1.21
Shadow price	TDN	¢/lb.		1.9	1.9	1.9	2.2
	CP	¢/lb.	6.6				

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	15.55	17.20	18.21	18.03	19.15	9.23	9.36
CP	2.49	2.67	2.73	2.65	2.74	1.27	1.29
TDN							13.77
CP							1.09
TDN							2.19
CP							.18
TDN	6.98	2.01	2.52		1.67	1.45	
CP	1.40	.40	.51		.33	.29	
TDN		9.62	8.09	2.87	7.77		
CP		2.98	2.51	.89	2.41		
TDN			.65	.23	.62		
CP			.20	.07	.19		
TDN					.67		
CP					.21		
TDN							.28
CP							.02
TDN	.42	.12	.15		.10	.09	
CP	.08	.02	.03		.02	.02	
TDN		1.36	1.14	.41	1.12		
CP		.42	.35	.13	.35		
TDN		3.30	5.19	4.35	2.10		
CP		1.18	1.86	1.56	.75		
TDN	12.84			9.26	4.63	3.79	
CP	2.83		2.03	1.02	.83		
TDN	1.78	.78	.46	.96	.46		
CP	.39	.18	.10	.21	.10		
TDN						3.90	
CP						1.13	
TDN	6.47						6.88
CP	2.21	2.51	2.83	2.24	2.64	1.00	
TDN		1.4	.7	1.7	.5	1.9	
CP							.6

TABLE E.12. Forage system TDN and crude protein (CP) balance sheet: grain farm, medium cattle price level, no cattle feeding, own stack-forming wagon

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
TDN		103.9	31.38	28.47	32.73	39.59	49.98
CP			4.14	3.98	4.62	5.65	7.71
Supplied by-Grazing:[a]		Acres					
SS/AG(I)	TDN	23.95					
	CP						
Sdg/G(I)	TDN	4.42					
	CP						
Alf-Br/H3,G(I)	TDN	8.84					
	CP						
Sdg/G(II)	TDN	5.58					
	CP						
Alf-Br/H2,G(II)	TDN	7.51					
	CP						
Alf-Br/H3,G(II)	TDN	7.88					
	CP						
Br/240N,3SG(II)	TDN	12.86				1.62	17.86
	CP					.50	5.54
Br/240N,H1,G(II)	TDN	2.73					
	CP						
Sdg/G(III)	TDN	1.06					
	CP						
Alf-Br/H2,G(III)	TDN	4.22					
	CP						
KBG/60N,3SG(III)	TDN	25.72				1.47	17.21
	CP					.33	3.78
KBG/CG(IV)	TDN	8.00					1.78
	CP						.39
Harvested feeds:		Tons					
Stacked mixed hay	TDN	93.98	7.02	7.49	8.86	8.20	6.80
	CP		2.03	2.16	2.56	2.37	1.96
Stacked grass hay	TDN	8.16					6.32
	CP						1.32
Stacked corn-stalks	TDN	226.88	24.35	20.97	23.87	28.30	
	CP		2.11	1.81	2.06	2.45	
Excess available	TDN						
	CP						5.28
Shadow price	TDN		0.1	0.1	0.1	.2	2.8
	CP		9.2	9.2	9.2	9.1	

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	49.87	55.17	58.39	57.98	61.40	29.61	30.03
CP	8.00	8.55	8.75	8.50	8.78	4.07	4.14
TDN		39.42	45.86	38.75		7.35	
CP		9.46	10.99	9.32		1.77	
TDN	5.41	1.54	1.94		1.31	1.14	
CP	1.08	.31	.39		.26	.23	
TDN					7.02		
CP					2.17		
TDN	5.99	1.72	2.16		1.43	1.24	
CP	1.20	.35	.44		.28	.25	
TDN			5.45	1.93	5.23		
CP			1.69	.60	1.62		
TDN					5.49		
CP					1.70		
TDN	15.87	11.47			4.33	11.39	6.31
CP	4.93	3.56			1.34	1.14	.63
TDN				1.14	1.72	2.42	1.34
CP				.35	.53	.24	.13
TDN	.83	.24	.30		.20	.18	
CP	.17	.05	.06		.04	.03	
TDN			2.22	.80	2.17		
CP			.69	.24	.68		
TDN	19.98			14.40	7.20	5.89	
CP	4.40			3.16	1.59	1.29	
TDN	1.78	.78	.46	.96	.46		
CP	.39	.18	.10	.21	.10		
TDN					24.83		7.10
CP					7.17		2.05
TDN							
CP							
TDN							15.27
CP							1.32
TDN							
CP	4.17	5.36	5.61	5.38	8.70	.88	
TDN	1.2	2.0	1.1	2.3	2.7	1.0	.1
CP							9.2

TABLE E.13. Forage system TDN and crude protein (CP) balance sheet: grain farm, high cattle price level, no cattle feeding, custom baling and custom silage harvesting

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
TDN		227.6	68.74	62.36	71.69	86.72	109.48
CP			9.06	8.72	10.13	12.38	16.89
Fall calving	TDN	21.8	10.14	8.81	9.09	6.13	7.00
	CP		1.57	1.36	1.43	.86	.93
Total requirements	TDN	249.4	78.88	71.17	80.78	92.85	116.48
	CP		10.63	10.08	11.56	13.24	17.82
Supplied by-							
Grazing[a]		Acres					
FS/H,G(I)	TDN	77.99					
	CP						
SS/AG(I)	TDN	41.90					
	CP						
Sdg/G(I)	TDN	12.61					
	CP						
Alf-Br/RG(I)	TDN	6.75					5.90
	CP						1.83
Alf-Br/H2,G(I)	TDN	18.46					
	CP						
Sdg/G(II)	TDN	3.90					
	CP						
Br/240N,3SG(II)	TDN	35.10				4.42	48.75
	CP					1.37	15.13
Sdg/G(III)	TDN	6.20					
	CP						
Alf-Br/RG(III)	TDN	24.80					13.89
	CP						4.32
KBG/CG(IV)	TDN	8.00					1.78
	CP						.39
Harvested feeds:		Tons					
Baled mixed hay	TDN	62.14	11.21	12.79	15.19	12.33	
	CP		3.24	3.70	4.40	3.57	
Forage sorghum silage	TDN	1,269.75	67.65	58.37	65.59	76.07	46.13
	CP		7.38	6.37	7.16	8.30	5.03
Excess available	TDN						
	CP						8.88
Shadow prices	TDN	¢/lb.	1.6	1.6	1.7	1.7	3.2
	CP	¢/lb.	5.7	5.7	6.5	7.1	

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	109.25	120.86	127.91	127.00	134.51	64.87	65.78
CP	17.53	18.73	19.16	18.72	19.23	8.92	9.06
TDN	6.78	7.00	7.28	8.52	10.38	10.14	9.92
CP	.90	.99	1.04	1.24	1.62	1.64	1.57
TDN	116.03	127.86	135.19	135.52	144.89	75.01	75.70
CP	18.43	19.72	20.20	19.96	20.85	10.56	10.63
TDN						34.31	70.35
CP						3.74	7.72
TDN		68.97	80.24	67.79		12.86	
CP		16.55	19.23	16.30		3.10	
TDN	15.42	4.40	5.55		3.75	3.24	
CP	3.09	.88	1.10		.74	.64	
TDN	7.56	5.90	4.97	1.96	4.55		
CP	2.34	1.87	1.55	.61	1.41		
TDN			15.19	5.37	14.66		
CP			4.71	1.66	4.54		
TDN	4.19	1.21	1.51		1.00	.87	
CP	.84	.24	.30		.20	.18	
TDN	43.31	31.31			11.83	31.10	17.23
CP	13.44	9.72			3.65	3.12	1.72
TDN	4.85	1.38	1.74		1.17	1.03	
CP	.97	.28	.35		.24	.20	
TDN	17.71	13.89	11.63	4.69	10.76		
CP	5.51	4.32	3.60	1.44	3.35		
TDN	1.78	.78	.46	.96	.46		
CP	.39	.18	.10	.21	.10		
TDN							4.10
CP							1.19
TDN	21.18		13.88	54.72	96.69		
CP	2.31		1.51	5.97	10.55		
TDN						8.40	15.98
CP	10.46	14.32	12.25	6.23	3.93	.42	
TDN	2.3	2.1	2.2	2.2	2.3		
CP							11.1

TABLE E.14. Forage system TDN and crude protein (CP) balance sheet: grain farm, high cattle price level, with full-time employee, no cattle feeding, custom baling and custom silage harvesting

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
TDN		463.0	139.83	126.86	145.85	176.40	222.70
CP			18.43	17.73	20.60	25.19	34.35
Supplied by-Grazing:[a]		Acres					
FS/H,G(I)	TDN	172.56					
	CP						
SS/AG(I)	TDN	88.72					
	CP						
Sdg/G(I)	TDN	9.38					
	CP						
Alf-Br/RG(I)	TDN	10.84					9.47
	CP						2.94
Alf-Br/H2,G(I)	TDN	7.92					
	CP						
Sdg/G(II)	TDN	4.76					
	CP						
Alf-Br/H2,G(II)	TDN	6.83					
	CP						
Br/240N,3SG(II)	TDN	27.41				3.45	38.07
	CP					1.07	11.81
Sdg/G(III)	TDN	6.20					
	CP						
Alf-Br/H2,G(III)	TDN	24.80					
	CP						
KBG/CG(IV)	TDN	8.00					1.78
	CP						.39
Harvested feeds:		Tons					
Baled mixed hay	TDN	100.68	17.57	21.57	26.00	19.86	1.60
	CP		5.08	6.24	7.52	5.75	.46
Corn silage	TDN	322.28				153.08	
	CP					18.37	
Forage sorghum silage	TDN	2,809.36	122.25	105.29	119.84		171.76
	CP		13.34	11.49	13.08		18.75
Excess available	TDN						
	CP						
Shadow price	TDN	¢/lb.	1.8	1.8	1.8	1.8	1.8
	CP	¢/lb.	6.4	6.4	6.4	7.3	6.4

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	222.24	245.85	260.21	258.35	273.63	131.96	133.81
CP	35.65	38.10	38.98	37.87	39.12	18.15	18.43
TDN						75.93	155.65
CP						8.28	17.08
TDN		146.03	169.90	143.55		27.24	
CP		35.04	40.72	34.51		6.57	
TDN	11.47	3.27	4.13		2.79	2.41	
CP	2.30	.66	.83		.55	.48	
TDN	12.14	9.47	7.99	3.15	7.31		
CP	3.76	2.94	2.48	.98	2.27		
TDN			6.52	2.30	6.29		
CP			2.02	.71	1.95		
TDN	5.11	1.47	1.84		1.22	1.06	
CP	1.02	.30	.37		.24	.21	
TDN			4.96	1.76	4.76		
CP			1.54	.55	1.48		
TDN	33.82	24.45			9.24	24.29	13.46
CP	10.50	7.59			2.85	2.44	1.34
TDN	4.85	1.38	1.74		1.17	1.03	
CP	.97	.28	.35		.24	.20	
TDN			13.04	4.69	12.75		
CP			4.04	1.44	3.97		
TDN	1.78	.78	.46	.96	.46		
CP	.39	.18	.10	.21	.10		
TDN					3.51		
CP					1.01		
TDN							
CP							
TDN	153.05	58.99	49.63	101.94	224.13		
CP	16.70	6.44	5.42	11.13	24.46		
TDN							35.30
CP		15.33	18.89	11.66		.03	
TDN	2.5	2.5	2.5	2.5	1.8	.1	
CP	1.2				6.4		7.1

TABLE E.15. Forage system TDN and crude protein (CP) balance sheet: grain farm, low cattle price level, cattle feeding allowed, custom baling and custom silage harvesting

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
TDN		34.4	10.39	9.43	10.84	13.11	16.55
CP			1.37	1.32	1.53	1.87	2.55
Supplied by-Grazing:[a]		Acres					
Cs/G(I)	TDN	50.24	8.34		1.66		
	CP		.65		.10		
Cs/G(II)	TDN	7.94	1.13		.22		
	CP		.09		.02		
FS/H,G(II)	TDN	1.81					
	CP						
Sdg/G(II)	TDN	6.50					
	CP						
Alf-Br/Hl,G(II)	TDN	13.00					
	CP						
Cs/G(III)	TDN	1.01	.11		.02		
	CP		.01		--		
Sdg/G(III)	TDN	.45					
	CP						
Alf-Br/Hl,G(III)	TDN	1.79					
	CP						
BFT/SP(III)	TDN	1.89					
	CP						
BFT/H,G(III)	TDN	3.21					
	CP						
KBG/60N,3SG(III)	TDN	22.08				1.26	14.77
	CP					.29	3.25
KBG/CG(IV)	TDN	8.00					1.78
	CP						.39
Harvested feeds:		Tons					
Baled mixed hay	TDN	31.79	2.14	9.43	8.94	1.62	
	CP		.62	2.73	2.59	.47	
Forage sorghum silage	TDN	25.98				10.24	
	CP					1.12	
Excess available	TDN		1.33				
	CP			1.41	1.18		1.09
Shadow price	TDN	¢/lb.		1.6	1.6	1.9	1.6
	CP	¢/lb.	5.5				

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	16.51	18.27	19.33	19.20	20.33	9.80	9.94
CP	2.65	2.83	2.90	2.81	2.91	1.35	1.37
TDN							13.31
CP							1.06
TDN							1.79
CP							.14
TDN						.70	1.44
CP						.08	.16
TDN	6.98	2.01	2.52		1.67	1.45	
CP	1.40	.40	.51	.33	.29		
TDN		11.22	9.44	3.34	9.06		
CP		3.47	2.93	1.04	2.81		
TDN							.18
CP							.01
TDN	.35	.10	.13		.09	.07	
CP	.07	.02	.03		.02	.01	
TDN		1.13	.94	.34	.92		
CP		.35	.29	.10	.29		
TDN	.80	1.89	1.13	.68	.36		
CP	.29	.68	.41	.24	.13		
TDN		1.16	1.82	1.52	.74		
CP		.41	.65	.55	.26		
TDN	17.16			12.36	6.18	5.06	
CP	3.78			2.72	1.37	1.10	
TDN	1.78	.78	.46	.96	.46		
CP	.39	.18	.10	.21	.10		
TDN			2.92		.88	2.52	
CP			.84		.25	.73	
TDN							
CP							
TDN	10.56						6.78
CP	3.28	2.68	2.86	2.05	2.65	.86	
TDN		1.0	1.6	1.6	1.6	1.6	
CP							5.2

TABLE E.16. Forage system TDN and crude protein (CP) balance sheet: grain farm, medium cattle price level, cattle feeding allowed, custom baling and custom silage harvesting

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
TDN		78.3	23.65	21.45	24.66	29.83	37.66
CP			3.12	3.00	3.48	4.26	5.81
Supplied by-Grazing:[a]		Acres					
Cs/G(I)	TDN	81.84	13.59		2.70		
	CP		1.06		.16		
FS/H,G(I)	TDN	6.15					
	CP						
SS/AG(I)	TDN	10.72					
	CP						
FS/H,G(II)	TDN	6.03					
	CP						
Sdg/G(II)	TDN	5.43					
	CP						
Alf-Br/H1,G(II)	TDN	19.31					
	CP						
Br/240N,3SG(II)	TDN	5.42				.68	7.53
	CP					.21	2.34
KBG/60N,3SG(II)	TDN	2.82				.22	2.58
	CP					.05	.57
KBG/60N,3SG(III)	TDN	31.00				1.77	20.74
	CP					.40	4.56
KBG/CG(IV)	TDN	8.00					1.78
	CP						.39
Harvested feeds:		Tons					
Baled mixed hay	TDN	38.43	5.30	20.46	5.13	3.51	
	CP		1.53	5.92	1.48	1.02	
Corn silage	TDN	10.63					5.05
	CP						.61
Forage sorghum silage	TDN	186.53	4.77	1.00	16.84	23.66	
	CP		.52	.11	1.84	2.58	
Excess available	TDN						
	CP			3.03			2.66
Shadow price	TDN	¢/lb.	2.1	2.1	2.1	2.2	3.2
	CP	¢/lb.				.7	

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	37.58	41.58	44.00	43.69	46.28	22.32	22.63
CP	6.03	6.44	6.59	6.40	6.62	3.07	3.12
TDN							21.69
CP							1.72
TDN						2.71	5.55
CP						.30	.61
TDN		17.65	20.53	17.34		3.29	
CP		4.23	4.92	4.17		.79	
TDN						2.33	4.78
CP						.25	.52
TDN	5.83	1.68	2.10		1.40	1.21	
CP	1.17	.34	.42		.28	.24	
TDN		16.66	14.02	4.96	13.46		
CP		5.16	4.34	1.54	4.17		
TDN	6.69	4.83			1.83	4.80	2.66
CP	2.08	1.50			.56	.48	.27
TDN	3.01			2.17	1.09	.89	
CP	.66			.48	.24	.20	
TDN	24.09			17.36	8.68	7.10	
CP	5.30			3.81	1.92	1.55	
TDN	1.78	.78	.46	.96	.46		
CP	.39	.18	.10	.21	.10		
TDN							
CP							
TDN							
CP							
TDN			6.92	.91	19.39		
CP			.76	.10	2.12		
TDN	3.82						12.05
CP	3.57	4.97	3.95	3.91	2.77	.74	
TDN		1.7	2.1	2.1	2.1	1.5	
CP							1.3

TABLE E.17. Forage system TDN and crude protein (CP) balance sheet: grain farm, high cattle price level, cattle feeding allowed, own stack-forming wagon and custom silage harvesting

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
Spring calving	TDN	143.6	43.37	39.35	45.23	54.71	69.07
	CP		5.72	5.50	6.39	7.81	10.66
Fall calving	TDN	43.9	20.41	17.74	18.31	12.34	14.09
	CP		3.16	2.73	2.87	1.73	1.88
Total requirements	TDN	187.50	63.78	57.09	63.54	67.05	83.16
	CP		8.88	8.23	9.26	9.54	12.54
Supplied by-Grazing:[a]		Acres					
FS/H,G(I)	TDN	40.17					
	CP						
SS/AG(I)	TDN	25.70					
	CP						
Sdg/G(I)	TDN	11.15					
	CP						
Alf-Br/H2,G(I)	TDN	22.29					
	CP						
Sdg/G(II)	TDN	3.90					
	CP						
Br/240N,3SG(II)	TDN	35.10				4.42	48.75
	CP					1.37	15.13
Sdg/G(III)	TDN	1.47					
	CP						
Alf-Br/H2,G(III)	TDN	5.88					
	CP						
KBG/60N,3SG(III)	TDN	23.65				1.35	15.82
	CP					.31	3.48
KBG/CG(IV)	TDN	8.00					1.78
	CP						.39
Harvested feeds:		Tons					
Stacked mixed hay	TDN	83.06	10.67	15.26	18.07	7.10	
	CP		3.08	4.41	5.22	2.05	
Forage sorghum silage	TDN	645.00	53.13	9.14	4.87	50.09	16.82
	CP		5.80	1.00	.53	5.47	1.84
Stacked corn-stalks	TDN	155.78		32.70	40.62	4.11	
	CP			2.83	3.51	.36	
Excess available	TDN						
	CP						8.30
Shadow price	TDN		1.6	2.0	2.0	2.0	3.1
	CP		5.4	4.6	4.6	4.6	--

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	68.93	76.25	80.70	80.13	84.87	40.93	41.50
CP	11.06	11.82	12.09	11.75	12.13	5.63	5.72
TDN	13.65	14.09	14.66	17.16	20.90	20.41	19.97
CP	1.82	1.99	2.08	2.49	3.26	3.30	3.17
TDN	82.58	90.34	95.36	97.29	105.77	61.34	61.47
CP	12.88	13.81	14.17	14.24	15.39	8.93	8.89
TDN						17.67	36.23
CP						1.93	3.98
TDN		42.30	49.22	41.58		7.89	
CP		10.15	11.80	10.00		1.90	
TDN	13.64	3.89	4.91		3.31	2.87	
CP	2.73	.78	.98		.66	.57	
TDN			18.34	6.49	17.70		
CP			5.02	2.01	5.48		
TDN	4.19	1.21	1.51		1.00	.87	
CP	.84	.24	.30		.20	.18	
TDN	43.31	31.31			11.83	31.10	17.23
CP	13.44	9.27			3.65	3.12	1.72
TDN	1.15	.33	.41		.28	.24	
CP	.23	.07	.08		.06	.05	
TDN			3.09	1.11	3.02		
CP			.96	.34	.94		
TDN	18.38			13.24	6.62	5.42	
CP	4.04			2.91	1.47	1.18	
TDN	1.78	.78	.46	.96	.46		
CP	.39	.18	.10	.21	.10		
TDN							11.03
CP							3.19
TDN	.15	10.54	17.44	33.92	61.57		
CP	.02	1.15	1.90	3.70	6.72		
TDN							
CP							
TDN						4.72	3.02
CP	8.81	8.03	6.97	4.93	3.89		
TDN	2.3	2.1	2.2	2.1	2.3		
CP						3.6	12.9

TABLE E.18. Forage system TDN and crude protein (CP) balance sheet: grain farm, medium cattle price level, with full-time employee, cattle feeding allowed, custom baling and custom silage harvesting

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
				(000 lbs.)			
Requirements:							
TDN		75.1	22.68	20.58	23.66	28.61	36.12
CP			2.99	2.88	3.34	4.09	5.57
Supplied by-Grazing:[a]		Acres					
FS/H,G(I)	TDN	12.10					
	CP						
FS/H,G(II)	TDN	16.94					
	CP						
Sdg/G(II)	TDN	5.86					
	CP						
Alf-Br/RG(II)	TDN	.44					.34
	CP						.12
Alf-Br/Hl,G(II)	TDN	10.00					
	CP						
Br/240N,3SG(II)	TDN	5.76				.73	8.00
	CP					.22	2.48
SS/AG(III)	TDN	2.82					
	CP						
BFT/CG(III)	TDN	25.36					2.76
	CP						.99
KBG/CG(IV)	TDN	8.00					1.78
	CP						.39
Harvested feeds:		Tons					
Baled mixed hay	TDN	19.91	2.86	3.50	4.22	4.54	
	CP		.83	1.01	1.22	1.31	
Forage sorghum silage	TDN	439.83	19.84	17.09	19.45	23.37	23.37
	CP		2.17	1.87	2.12	2.55	2.54
Excess available	TDN						
	CP						.95
Shadow price	TDN	¢/lb.	2.0	2.0	2.0	2.0	2.1
	CP	¢/lb.	1.4	1.4	1.4	1.4	

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	36.05	39.88	42.21	41.91	44.38	21.40	21.70
CP	5.78	6.18	6.32	6.14	6.35	2.94	2.99
TDN						5.32	10.91
CP						.58	1.20
TDN						6.56	13.43
CP						.71	1.47
TDN	6.29	1.81	2.27		1.51	1.31	
CP	1.26	.36	.46		.30	.26	
TDN	.43	.34	.28	.11	.26		
CP	.13	.10	.09	.04	.08		
TDN		8.63	7.26	2.57	6.97		
CP		2.67	2.25	.80	2.16		
TDN	7.11	5.14			1.94	5.10	2.83
CP	2.11	1.60			.60	.51	.28
TDN		2.97	3.45	2.92		.56	
CP		.71	.83	.70		.13	
TDN	20.59	18.84	14.35	9.13	4.79		
CP	7.43	6.77	5.15	3.27	1.70		
TDN	1.78	.78	.46	.96	.46		
CP	.39	.18	.10	.21	.10		
TDN						2.58	.13
CP						.75	.04
TDN		1.39	14.16	26.24	28.49		
CP		.15	1.54	2.86	3.11		
TDN							5.60
CP	5.64	6.36	4.10	1.74	1.70		
TDN	1.6	2.1	2.1	2.1	2.1	1.2	
CP							8.2

TABLE E.19. Forage system TDN and crude protein (CP) balance sheet: grain farm, high cattle price level, with full-time employee, cattle feeding allowed, custom baling and custom silage harvesting

		No. of cows	Jan.	Feb.	Mar.	Apr.	May
Requirements:				(000 lbs.)			
Spring calving	TDN	283.9	85.74	77.79	89.43	108.17	136.56
	CP		11.30	10.87	12.63	15.44	21.07
Fall calving	TDN	5.9	2.72	2.36	2.44	1.64	1.88
	CP		.42	.36	.38	.23	.25
Total requirements	TDN	289.8	88.46	80.15	91.87	109.81	138.44
	CP		11.72	11.23	13.01	15.67	21.32
Supplied by-Grazing:[a]		Acres					
FS/H,G(I)	TDN	107.50					
	CP						
SS/AG(I)	TDN	55.13					
	CP						
FS/H,G(II)	TDN	.44					
	CP						
Sdg/G(II)	TDN	5.36					5.76
	CP						1.15
Alf-Br/H2,G(II)	TDN	12.01					
	CP						
Br/240N,3SG(II)	TDN	21.20				2.67	29.45
	CP					.83	9.14
Sdg/G(III)	TDN	5.49					
	CP						
Alf-Br/H2,G(III)	TDN	21.96					
	CP						
BFT/CG(III)	TDN	3.20					.35
	CP						.12
KBG/CG(IV)	TDN	8.00					1.78
	CP						.39
Harvested feeds:		Tons					
Baled mixed hay	TDN	59.91	11.46	13.81	16.58	11.76	
	CP		3.32	4.00	4.80	3.40	
Corn silage	TDN					95.37	
	CP					11.44	
Forage sorghum silage	TDN	1,756.42	76.98	66.33	75.27		106.84
	CP		8.40	7.24	8.21		11.66
Excess available	TDN						
	CP						
Shadow price	TDN	¢/lb.	2.0	2.0	2.0	2.1	2.7
	CP	¢/lb.	6.2	6.2	6.2	6.9	1.5

[a]The grazing activities are designated by "Species/management (land class)". Explanation of abbreviations for species and management alternatives are presented in Table B.4.

	June	July	Aug.	Sept. (000 lbs.)	Oct.	Nov.	Dec.
TDN	136.27	150.75	159.55	158.42	167.78	80.91	82.05
CP	21.86	23.36	23.90	23.22	23.99	11.13	11.30
TDN	1.82	1.88	1.95	2.29	2.78	2.72	2.66
CP	.24	.27	.28	.33	.43	.44	.42
TDN	138.09	152.63	161.50	160.71	170.56	83.63	84.71
CP	22.10	23.63	24.18	23.55	24.42	11.57	11.72
TDN						47.30	96.97
CP						5.16	10.64
TDN		90.74	105.57	89.20		16.92	
CP		21.78	25.30	21.45		4.08	
TDN						.17	.35
CP						.02	.04
TDN	5.76	1.66	2.07		1.38	1.20	
CP	1.15	.33	.42		.27	.24	
TDN			8.72	3.09	8.37		
CP			2.70	.96	2.59		
TDN	26.16	18.91			7.14	18.78	10.41
CP	8.12	5.87			2.20	1.89	1.04
TDN	4.30	1.22	1.54		1.04	.91	
CP	.86	.25	.31		.21	.18	
TDN			11.55	4.15	11.29		
CP			3.58	1.27	3.51		
TDN	2.60	2.38	1.81	1.15	.60		
CP	.94	.85	.65	.41	.21		
TDN	1.78	.78	.46	.96	.46		
CP	.39	.18	.10	.21	.10		
TDN							
CP							
TDN							
CP							
TDN	97.48	36.93	29.77	62.14	140.28		
CP	10.64	4.03	3.25	6.78	15.31		
TDN						1.65	23.02
CP		8,55	2k,68	6,53			
TDN	2.5	2.7	2.7	2.7	2.6		
CP	2.8				.7	5.9	6.2