BEEF HOUSING ECONOMICS

FOR FARM-FEEDLOTS

by:

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Farm-feedlot operators in the northern Corn Belt express a continuing interest in various housing systems for feeder cattle. Factors such as reduced feed requirements, faster weight gains, reduced labor requirements, control of feedlot runoff, reduced bedding needs, and improved waste handling favor confinement housing. However, is the greater investment required for confinement feeding facilities justified?

Previous research results (2, 7, 14, 15, 17) showed that confinement feeding could be justified under certain circumstances, but production cost and cattle price relationships have changed significantly since those studies were made. This report incorporates price relationships expected to prevail from the present to the early 1980's and examines the probable income effect on both crop and feeding enterprises of four alternative housing systems. Each system has capacity for feeding 500 head of cattle on a 500 acre farm, and each is examined under two levels of labor availability and two levels of management. The labor requirements in waste handling and the nutrient composition of the manure differ with each system. The effect of these differences on crop and beef production and on net farm income are taken into account in a computer analysis.

A profit-maximizing linear programming model is used to compare the four housing systems by computer. Determining the most profitable beef feeding system requires three major steps, (1) determining the quantity of available resources, (2) budgeting resource requirements (land, labor field days, storage space, cash costs) and expected income for each crop and cattle feeding enterprise, and (3) solving for the combination of enterprises which maximizes net revenue within the limits of available resources. The last step is accomplished by using a computer program designed to systematically solve the mathematical statements developed (see 1, 15).

The following sections describe the housing systems, provide beef enterprise performance and waste handling data, specify the crop enterprises, and summarize the fixed costs for each farm-feedlot system. The linear programming results are discussed in the final section.

Alternative Systems

The four alternative housing systems specified in table 1 can be described as follows:

Open lots have 250 square feet of lot surface per animal including two earthen mounds having 25 square feet of mound surface per animal (17). Each mound is topped by a long windbreak fence--the mound and fence are at right angles to prevailing winds. A 10 feet wide concrete apron is constructed next to wooden fenceline feedbunks. Four row wire rope fencing surrounds the lot and divides it, so that two groups of 250 head may be fed. A runoff control device is included.

The partially paved conventional drylot includes a pole frame barn with an open front (southern or eastern exposure) and with 17 square feet per head of bedded area (packed earth floor). Cattle are fed in fenceline bunks with a concrete apron similar to the open lot. Only 100 square feet of lot space per animal is subject to runoff, allowing construction of a smaller runoff control device. Concrete aprons, a concrete walkway and bedded shelter allow the cattle to avoid the muddy lot surface during wet weather.

Table 1. Specifications and Investment Costs for Feedlot Facility Components, 1976, 500 Head Capacity Lots.[1]

Item	Open Lot	Conventional Drylot	Manure Scrape Unit	Slotted Floor Unit
		Specifications		
Building space/head (sq.ft.)	---	17 bedded	17 bedded	17
Bunk space/head (ft.)	1	1	.75	.75
Building dimensions (ft.xft.)	---	40x215	2(40x190)	40x375
Lot space/head (sq.ft.)	250	100	---	---
Lot dimension (ft.xft.)	250x500	200x250	---	---
Mounds (ft.xft.xft.)	2(6x54x200)	---	---	---
Windbreak fence (ft.)	400	---	---	---
Concrete dimension (ft.xft.)	10x500	10x700	80x190	24x375 (slats)
Pit (ft.xft.xft.)	---	---	---	8x24x375
Fence (ft.)	1,250	440	160	72
All weather driveway (ft.xft.)	16x550	16x550	16x400	16x400
		Investment Costs		
Total facility investment[2]	$20,500	$50,000	$66,000	$95,000
Avg. investment cost/head[2]	$41	$100	$132	$190
Annual costs[3]	$2,357	$5,750	$7,590	$10,925

[1] Does not include feed storage, feed delivery, or feed processing equipment. Runoff control device is not included, see table 11. Investment estimates are based on 1974-75 costs as reported in (18).

[2] For alternative estimates, see (2). Inflation has raised these costs 15 to 20 percent by late 1976 and will, no doubt, increase them more in the future.

[3] Assumes 11.5 percent annual cost. Annual straight line depreciation for 20 years is 5 percent plus 4.5 percent for interest (9 percent multiplied by half the value); plus 2 percent for repairs, taxes and insurance.

The <u>manure scrape</u> unit includes two open front pole-frame barns (each measuring 40 by 190 feet) with solid concrete floors and 17 square feet of bedded area per animal. This unit does not include an outdoor lot or runoff control device. The fenceline feedbunk is located along the open side of the buildings, which have a southern or eastern exposure. The floor slopes away from the feed bunk at 1 inch per foot for 6 feet 8 inches to a flat 10 feet wide center alley. The area available per head in the center alley and feeding area is 13 square feet when 17 square feet is allowed per head in the bedded area. The concrete under the bedded area is also sloped to facilitate drainage of some liquid into the scrape alley. Two buildings are needed because one 375 feet long barn would be difficult to scrape without additional gates and cross alleys.

In each of the above facilities, solid waste is handled with tractor front-end loaders and conventional spreaders. The concrete aprons and the manure scrape alley are cleaned every 10 days. Some operators may use a two-week cleaning schedule.

The <u>slotted floor</u> unit (40 by 375 feet) is also open to the south and provides 17 square feet of slotted floor per head. The slotted floor area is 24 feet wide, and the fenceline feedbunk and driveway take the remaining 16 feet. The concrete pit is 8 feet deep. (Some operators may prefer a 10 foot pit depth for greater storage capacity but this, of course, costs more.) The pit is divided into 40 foot sections by cross walls for effective agitation, because no area of the pit should be further than 30 feet from the discharge of the manure pump during agitation. The cross walls may also serve to brace outer walls. Sections of slats are removable to permit the pump to be lowered to a shallow sump in each smaller pit. After agitation, the liquid waste is pumped into tractor-drawn tank wagons to be distributed on cropland.

Each of the four facilities includes plumbing and waterers on concrete bases. Working corral facilities are similar for each unit, except in the slotted floor building. Here the driveway serves as a holding area and chutes are the only additional expense. Fenceline feeding, rather than auger feeding, is used in each of the facilities simply because lot size may be expanded more readily. A portable grinder-mixer is used instead of more elaborate feed processing equipment. High moisture shelled corn is fed as it comes from the silo. Feed storage and processing investment is included in table 11.

Beef Feeding Enterprise

Feeding costs and returns, animal performance comparisons, and waste handling data are developed in this section.

<u>Cost and return</u>: Return over cash cost must be calculated for each feeding program considered in the linear program. Cash expenses (purchased feed, veterinarian fees, medicine, interest on purchase cost of cattle, and miscellaneous costs) are subtracted from the gross margin to give return over cash cost. The gross margin is calculated by subtracting purchase cost and death loss from sale value. Recent records and price projections by Minnesota Extension Economists indicate $43 (calves) and $48 (yearlings) per hundredweight gain are reasonable gross margin expectations for the above average southwestern Minnesota beef feeder. Table 2 reports the cost and return estimates used in this study.

Animal performance: Rates of gain and feed requirements are also listed in table 2. Rations are composed of corn silage as the roughage source and high moisture shelled corn as the energy source. One pound of protein supplement per head per day is fed to balance the ration. The proportion of silage to grain (wet weight) decreases sharply when the cattle reach 700 to 750 pounds on the high grain rations. A similar two-phase program is used in all programs, but higher proportions of concentrates are fed in both phases in the high grain rations. The amounts of feed listed in table 2 approximate on-farm requirements as reported by well-managed feedlots in southwestern Minnesota. Typically, average daily gain on high silage rations is at least 0.2 pound less per day than that obtained from high grain rations for both calves and yearlings (8,18). Cattle receiving higher forage rations for longer periods of time have historically been marketed at higher weights and thus remain in the feedlot for a longer period of time. (With the new grading system inaugurated in 1976 the amount of weight difference needed to grade will decline.) For all of the feeding programs, average daily gain is calculated on market to market weight basis and accounts for a two week inshrink recovery and a 3 percent outshrink.

The effect of shelter on average daily gain and feed conversion can vary considerably from one year to the next and between lots of different design and location. Most beef housing research in the northern Corn Belt indicates that the shelter-nonshelter difference is significant. Differences between covered confinement (scrape barn and slotted floor) and the conventional drylot are less significant. The reader may refer to Smith, et. al. (17, 18) and other housing studies reported in recent Minnesota Beef Cattle Reports; Pherson (15, pp. 71-73); and Boehlje and Trede (2) for additional information. Shelter appears to be more beneficial to cattle in the finishing phase than to lighter animals. Mud and cold possibly stress the heavier animals to the point that relatively more energy is used for body maintenance and less for fattening. Direct exposure to the hot summer sun also seems to reduce the gains of finishing cattle significantly. Death loss is not significantly affected by type of shelter, thus death loss does not bias average daily gain estimates.

These research results correspond with field observations. Feeders who own both open lots and confinement buildings claim they obtain best results by starting calves outside and finishing heavy cattle inside. Cattle in confinement buildings are quieter, more docile, not subjected to weather extremes, and generally cleaner and healthier, according to observations by Butchbaker (4). These factors lead to improved performance.

In this study, feed requirements are assumed to be 5 percent greater for calves and 10 percent greater for yearlings, when cattle are fed in open lots, as shown in table 2. Average daily gains are also assumed to be lower in the open lots.

Cattle feeding labor: In table 2, labor is expressed in total hours per head per feeding period for 350 to 700 head lots. The estimates include total labor for feeding, watering, maintenance, care and treatment of sick animals, feed grinding, manure disposal, and miscellaneous jobs. Some of these tasks include substantial fixed time components which lead to economies in labor in larger lots. This size effect is included by using lower per head labor requirements for larger lot sizes.

Table 2. Costs, Returns and Resources Used for Feeding Beef Cattle in Various Housing Systems.

Item Housing Systems:	Open Lot	Conventional Drylot	Scrape Barn	Slotted Floor

430 to 1,030 Pound Calf on High Grain Rations, November Purchase, One Lot per Year

Item	Open Lot	Conventional Drylot	Scrape Barn	Slotted Floor
Total gain, pounds	600	600	600	600
Average daily gain, pounds	2.1	2.2	2.3	2.3
Days in lot	290	275	260	260
Gross margin per head[1]/	$258.00	$258.00	$258.00	$258.00
Cash expense				
Feed: protein at $8/cwt.	23.20	22.00	20.80	20.80
salt, minerals at $4/cwt.	1.60	1.40	1.40	1.40
Veterinary and medicine	4.00	4.00	4.00	4.00
Interest: 9% x days ÷ 365 x purchase	15.37	14.58	13.78	13.78
Miscellaneous	3.50	3.50	3.50	3.50
Total cash cost per head	$ 47.67	$ 45.48	$ 43.48	$ 43.48
Return over cash cost	$210.33	$212.52	$214.52	$214.52
Raised feed: corn, bushels	64	60	60	60
corn, silage, tons	2	2	2	2
Bedding, tons[2]/	.4	.275	.275	---
Labor required, hours/head (350-700 hd.)	2.4	2.1	2.1	1.7

650 to 1,100 Pound Yearling on High Grain Rations, Feedlot Kept Filled to Capacity

Item	Open Lot	Conventional Drylot	Scrape Barn	Slotted Floor
Total gain, pounds	450	450	450	450
Average daily gain, pounds	2.25	2.5	2.5	2.5
Days in lot	200	180	180	180
Turnover--lots per year	1.8	2.0	2.0	2.0
Gross margin per head	$216.00	$216.00	$216.00	$216.00
Cash expense				
Feed: protein at $8/cwt.	16.00	14.40	14.40	14.40
salt, minerals at $4/cwt.	1.32	1.20	1.20	1.20
Veterinary and medicine	3.00	3.00	3.00	3.00
Interest: 9% x days ÷ 365 x purchase	14.42	12.98	12.98	12.98
Miscellaneous	3.00	3.00	3.00	3.00
Total cash cost per head	$ 37.74	$ 34.58	$ 34.58	$ 34.58
Return over cash cost	$178.26	$181.42	$181.42	$181.42
Annual return over cash cost	$320.87	$362.84	$362.84	$362.84
Raised feed: corn, bushels	60	55	55	55
corn, silage, tons	1.1	1	1	1
Bedding, tons per head	.25	.2	.2	---
Labor required, hours/head (350-700 hd.)	1.8	1.6	1.6	1.3

[1]/ Gross margin per head is (sell weight x laid-in price) minus (buy weight x net farm price) minus (death loss x buy weight x price) all divided by total weight gain.

Table 2. (Continued) Costs, Returns and Resources Used for Feeding Beef Cattle in Various Housing Systems.

Item Housing Systems:	Open Lot	Conventional Drylot	Scrape Barn	Slotted Floor
430 to 1,080 Pound Calf on High Silage Rations, November Purchase, One Lot per Year				
Total gain, pounds	650	650	650	650
Average daily gain, pounds	1.9	2.0	2.1	2.1
Days in lot	340	320	310	310
Gross margin per head	$279.50	$279.50	$279.50	$279.50
Cash expense				
Feed: protein at $8/cwt.	27.40	25.60	24.80	24.80
salt, minerals at $4/cwt.	2.00	1.80	1.80	1.80
Veterinary and medicine	4.00	4.00	4.00	4.00
Interest: 9% x days ÷ 365 x purchase	18.02	16.96	16.43	16.43
Miscellaneous (insurance, fuel)	3.50	3.50	3.50	3.50
Total cash cost per head	$ 54.72	$ 51.86	$ 50.53	$ 50.53
Return over cash cost	$224.78	$227.64	$228.97	$228.97
Raised feed: corn, bushels	44	40	40	40
corn, silage, tons	4.8	4.4	4.4	4.4
Bedding, tons	.5	.35	.35	---
Labor required, hours/head (350-700 hd.)	2.8	2.5	2.5	2.0
650 to 1,150 Pound Yearling on High Silage Rations, Feedlot Kept Filled to Capacity				
Total gain, pounds	500	500	500	500
Average daily gain, pounds	2.1	2.3	2.3	2.3
Days in lot	240	220	220	220
Turnover--lots per year	1.5	1.6	1.6	1.6
Gross margin per head	$240.00	$240.00	$240.00	$240.00
Cash expense				
Feed: protein at $8/cwt.	19.20	17.60	17.60	17.60
salt, mineral at $4/cwt.	1.44	1.33	1.33	1.33
Veterinary and medicine	3.00	3.00	3.00	3.00
Interest: 9% x days ÷ 365 x purchase	17.30	15.87	15.87	15.87
Miscellaneous (insurance, fuel)	3.00	3.00	3.00	3.00
Total cash cost per head	$ 43.94	$ 40.80	$ 40.80	$ 40.80
Return over cash cost	$196.06	$199.20	$199.20	$199.20
Annual return over cash cost	$294.09	$318.72	$318.72	$318.72
Raised feed: corn, bushels	44	40	40	40
corn, silage, tons	3.9	3.5	3.5	3.5
Bedding, tons	.3	.26	.26	---
Labor required, hours/head (350-700 hd.)	2.1	1.9	1.9	1.5

2/ Bedding is cobs in open lot and straw in other units. Yearlings in open lots are assumed to need the most bedding during winter and early spring; the estimate given is an average of total used per animal.

In the linear programming framework, labor available for cattle feeding must be specified for each period, when labor is expected to be a limiting resource. For example, in May, cattle feeding will compete with corn planting for labor. In January, it is not necessary to specify labor because the cropping activities do not compete at that time. In this study, the hours of labor used per head per day are held constant over the five spring time periods and six fall time periods considered. The estimates are: open lot, .007; dry-lot and manure scrape, .0065; and slotted floor, .0055 hours per head per day for the 350 to 700 head capacity size range. The manure loading, hauling, and spreading operation is handled as a separate activity. The scraping task (once every 10 days) and the bedding task (once every three to four days) in the solid waste handling systems are included. One can argue that additional labor is needed for silage rations because greater bulk is handled. For the purpose of this study, this increase was assumed to be negligible during the 11 periods considered.

Waste handling: Farm planners who are considering alternative housing systems want to know quantities of waste which must be removed. Precise estimates of quantity and quality of recoverable waste (feces, urine, bedding, waste feed, and waste water) are difficult to determine from the wide range of values reported in waste management literature. Rule-of-thumb estimates in the literature indicate that manure produced daily is approximately 6 percent of body weight or 60 pounds of manure per 1,000 pounds of live-weight. Farmers feeding high silage rations will probably find this figure appropriate, but recent research on high grain rations at the West Central Experiment Station, Morris, Minnesota resulted in approximately half of the manure accumulated that would be expected from feeding high silage rations. This observation is supported by results of other studies (10, 19, 20). Estimates of total and per day recoverable waste used in this study are reported in table 3.

In the linear programming model developed for this study, an accounting was made of the amount of waste on inventory at all times. Only the amounts on hand could be spread at times when land and labor were available for spreading. The assumption was made that each animal on feed produced the same amount of manure each day regardless of weight. This may appear to oversimplify the waste production-distribution question, but the Hegg and Larson (10) research and the Snapp and Neuman (19) estimates show no consistent pattern of manure production over the feeding period. Also, two-phase feeding programs, with higher proportions of roughage for light cattle and higher proportions of grain for finishing cattle, make the assumption of equal daily manure production more plausible. Readers may wish to compare this with Nordstedt, et al. (12), who used dynamic programming with waste production as a function of time.

Fertilizer elements per ton of waste vary according to time in storage, storage conditions, dry matter content, ration fed, and amount of bedding used. Availability of these nutrients to field crops depends primarily on the time of year waste is applied and the speed with which it is incorporated into the soil. Application of crop nutrients in the form of beef wastes reduce cash outlays for commercial fertilizer. Estimated analysis of wastes (as hauled) from the various waste handling systems is shown in table 4. The assumption in this study is that for each ton of manure hauled in the spring before the crop is planted, the following proportions of the nutrients will become available to plants:

Table 3. Estimated Recoverable Waste Production with Various Waste Handling-Housing Systems.

Type of Cattle	Ration	Open Lot	Conventional Drylot	Scrape Barn	Slotted Floor
		total tons per feeding period			
Calves	grain[1]	1.00	2.00	2.50	3.40
Calves	silage[2]	1.80	3.60	4.40	6.00
Yearlings	grain	.80	1.65	2.00	3.10
Yearlings	silage[2][3]	1.40	2.90	3.50	5.50
		pounds per day			
Calves	grain[1]	7.0	14.5	19.0	26.0
Calves	silage[2]	10.5	22.5	28.5	38.5
Yearlings	grain	8.0	18.5	22.0	34.0
Yearlings	silage[2]	11.5	26.5	32.0	50.0

[1] Original information is unpublished data obtained from Ralph Smith, Director, West Central Experiment Station, Morris, Minnesota. The basic data were adjusted by animal weights, total gain and length of feeding period reported in table 2.

[2] Original information is unpublished data obtained from Roy Black, Extension Agricultural Economist, Michigan State University. These data were adjusted by animal weight, total gain and length of feeding period reported in table 2.

[3] Silage rations for yearlings are assumed to produce about 1.75 as much total manure as grain rations, based on relationships observed in calf feeding programs.

75 percent of total N, 66 percent of P_2O_5, and 75 percent of K_2O (11, 12). Fall application reduces available N to 50 percent because of storage losses. This points out the desirability of timely application of manure in the spring.

The linear programming model specifies that adequate unplanted or harvested land must be available to spread up to 20 tons of solid waste and up to 40 tons of liquid waste per acre. Although the application rates are above average, they are feasible for most Minnesota soil conditions and the typically available farm machines. The practical farm manager would apply waste at rates indicated by soil tests, or at lighter rates to cover a greater acreage, and then balance nutrients with commercial fertilizer.

Table 4. Estimated Fertilizer Nutrients in Solid and Liquid Waste from Beef Cattle Fed Grain and Roughage Rations.

	Dry Matter	Total Nitrogen as N	Phosphorus as P_2O_5	Potassium as K_2O
	Percent	Commercial Fertilizer Equivalent pounds per ton		
Solid Wastes				
Grain rations	33			
Total		20.0	11.0	14.0
Spring spread		15.0	8.0	11.0
Fall spread		10.0	7.0	11.0
Silage rations				
Total		15.0	11.0	14.0
Spring spread		11.0	8.0	11.0
Fall spread		7.5	7.0	11.0
Liquid Wastes				
Grain rations	10			
Total		16.0	6.5	6.0
Spring spread		12.0	4.3	4.5
Fall spread		8.0	4.3	4.5
Silage rations				
Total		9.0	6.5	6.0
Spring spread		6.75	4.3	4.5
Fall spread		4.5	4.3	4.5

Source: Figures derived from unpublished University of Minnesota and University of Michigan Agricultural Experiment Station and Extension Service estimates. See (15) for documentation.

Table 5 shows investment and fixed costs for manure loading and hauling equipment. Butchbaker et al. (4) indicate that, for lots marketing less than 2,000 head per year, the lowest average total cost system for hauling solid beef waste is the tractor mounted loader and pull-type spreader. Pull-type 1,400 to 1,500 gallon tank spreaders filled by an impeller pump constitute the lowest average total cost system for cold slotted floor barns with deep pits.

Directly associated costs of loading, hauling and spreading beef wastes are reported in table 6. The per ton variable cost used in this study is $.53 for solid wastes and $.33 for liquid wastes.

Table 5. Investment and Annual Cost for Waste Handling Equipment

	1976 New Cost*	Estimated Life, Yr.	Annual Fixed Costs**
Solid wastes			
Front end loader	$1,700	10	$264
Pull-type spreader, 320-360 bu.	$4,300	10	$666
with hydraulic endgate			$930
Liquid wastes			
Impeller pump	$3,000	10	$465
Pull-type tank, 1,500 gal.	$3,900	10	$604
			$1,069

* Machinery dealer suggested list price adjusted for inflation, Minnesota tax credits, and discounts. Prices vary widely between companies. As with other machine investments used machine purchases may reduce the cash outlay for individual farmers.

** Depreciation, interest and insurance are assumed to be 15.5 percent of original investment per year.

Feed storage facilities: Three 20 foot by 70 foot concrete stave silos are available with each housing system. Silo investment is $35,169 with an annual cost of ownership (11.5 percent) of $4,044. Two unloaders are available so that shelled corn may be fed from one silo and corn silage from another at the same time. Unloader investment is $5,800 with an annual cost of ownership of $1,044.

The upright silos are used primarily for high moisture shelled corn storage (each bushel requires .033 ton storage capacity). If all the upright storage space is not required for shelled corn, such as when calves are fed, the remaining space is used for corn silage. In most instances, especially when two groups of yearlings are fed, additional bunker silo storage must be purchased for the remaining corn silage at annual cash flow cost of $2.16 per ton. 1/

An additional 25,000 bushels of grain storage is available. Raised soybeans or corn purchased at harvest time may be stored in these facilities. Annual fixed costs are approximately 6 cents per bushel, or $1,500. Any corn required beyond this 25,000 bushel limit must be purchased as needed.

1/ The tractor front end loader is used to remove silage from the bunker silo, so no additional equipment must be purchased. Small bunkers can be erected for approximately $12 per ton of corn silage storage and annual cost rates run up to 18 percent of initial investment. $12 x 18% = $2.16 (5).

Table 6.   Directly Associated Cost of Loading, Hauling and Spreading Beef Waste.

	Hours per load	Fuel, lubrication repairs/hour [1]	Total per load
Soild Beef Waste (33 Percent Dry Matter)			
Loader, front end	.2	$ .45	$ .098
Loader tractor, 50 hp	.2	2.69	.538
Spreader, 4 ton, 320-350 bu.	.3	1.29	.397
Spreader tractor, 70 hp	.3	3.67	1.101
Cost per 4 ton load			$2.126
Cost per ton (33% dry matter)			$ .53
Liquid Beef Waste (10 Percent Dry Matter)			
Impeller pump	.0333	$ .87	$ .029
Pump tractor, 70 hp	.0333	3.67	.122
Spreader, 1,500 gallon	.3330	1.17	.390
Spreader tractor, 50 hp	.3330	2.69	.896
Cost per 5.8 ton load (10% dry matter)			$1.437
Cost per ton			$ .248
Agitation charge per ton [2]			.079
Total cost per ton			$ .33

[1]   Pherson (15), pg. 91-93

[2]   Agitation charge per ton:

24' x 40' x 8' = 7,680 cu. ft. x 60 lb. cu. ft. = 460,800 lb. = 230 tons

Agitation for four hours to obtain proper mixing.

Impeller pump	4 hours at $ .87	= $ 3.48
Pump tractor, 70 hp	4 hours at $3.67	= $14.68
Total cost		$18.16

(Cost per ton $18.16 ÷ 230 tons = $.079)

Crop Enterprises

Realistic planning models to study beef housing in the northern corn belt must explicitly include cropping activities as an integral part of the farm business. The land and the cropping program (1) provide feed inputs for beef feeding, (2) provide a disposal site for beef waste, (3) utilize fertilizer nutrients in beef waste, (4) compete with beef feeding for labor during planting and harvesting, and (5) compete with beef waste spreading for field time availability.

Crop budgets· The directly associated cash costs for the corn and soybean enterprises are reported in tables 7 and 8. In this study the linear programming activities include the opportunity to sell a bushel of corn for $2.20 at harvest time and $2.25 during the remainder of the year. Similarly, soybean prices used are $4.85 and $5.00 per bushel. Corn may be purchased for feeding at $2.30 per bushel at harvest time and at $2.35 for the rest of the year.

Timeliness considerations: Field time is hours available for actual field operation after regular servicing and maintenance. It is the time available for productive work and ignores overhead, set-up and clean-up time. The study assumes a 12 hour field time day. Five spring time periods, April 1 - June 4, and six fall time periods, September 1 - November 30, are considered critical in this study. Certain field operations can be performed only during certain times of the production period. The sequence of these operations is important; for example, land must be prepared before planting can begin. Untimely operations reduce yields. The expected amount of field time available in each period is derived from the results of Boisvert's (3) regression analysis of rainfall and temperature effects on field days at the Southwest Experiment Station, Lamberton, Minnesota. Boisvert combined this information with probability distributions generated from 59 years of rainfall and temperature data, which were obtained from the Bird Island, Minnesota, weather station.

The critical labor time periods coincide with critical field time periods. The operator and family labor available is assumed to be 12 hours per day during these time periods and does not include overhead labor. Hired labor is customarily available for tractor operation during silage harvesting only.

Ideally, corn grown on fall prepared land yields 120 bushels of grain or 20 tons of silage per acre and requires 140 pounds N, 80 pounds P_2O_5, and 60 pounds K_2O. Reductions in these ideal yields occur whenever field operations are delayed, as can be seen in table 9. If beef waste handling interferes with crop operations, reductions in yields will reduce net income from crops.

Machine system: The machine system components and annual costs assumed in this study are reported in table 10. The tractor sizes are compatible with the machines listed and consistent with the waste handling equipment specified in previous tables.

Table 7. Linear Programming Budget for Corn, 1976

Description of task	Field time, hours per acre [1]/	Labor, hours per acre	Variable cost per acre [1]/
Land preparation			
Disc stalks	.125		$ .72
Plow	.370		2.54
	.500	.50	$ 3.26
Spring preparation, planting			
Disc and harrow	.125	.13	$ .80
Planting	.200	.27	1.04
Cultivation, one	not critical		.63
Seed (.3 bu. at $36)[2]/			10.80
Herbicides, miscellaneous			8.00
	.330	.40	$21.27
(overlap time allowed)	.250		

Fertilizer, pounds [3]/

	Fall	Spring	Price per Pound	(if total purchased)	
N	140	130	$.21	Fall prepared	$50.20
P_2O_5	80	80	.20	Spring prepared	48.10
K_2O	60	60	.08		

Description of task	Field time, hours per acre	Labor, hours per acre	Variable cost per acre
Harvesting grain			
Combine	.400		$ 4.08
Hauling, storing	not limiting		1.20
	.400	.85	$ 5.28
	.0033/bu.	.0071/bu.	.044/bu.
Harvesting silage			
Forage chopper	1.000		$ 7.02
Hauling	not limiting		3.00
Silage blower	not limiting		1.40
Hired labor [4]/			3.00
	1.000	2.11	$14.42
	.05/ton	.1055/ton	.72/ton

Yield, if all operations are performed on time: grain 120 bu.
silage 20 tons

1/ Pherson (15), pg. 91-93

2/ See footnote 2 on table 8.

3/ See footnote 3 on table 8.

4/ Third man needed during silage harvest to achieve the assumed efficiency.

Table 8. Linear Programming Budget for Soybeans, 1976

Description of task	Field time, hours per acre[1]	Labor, hours per acre	Variable cost per acre[1]
Land preparation			
Disc stubble	.125		$ .72
Plow	.370		2.54
	.500	.50	$ 3.26
Spring preparation, planting			
Disc and harrow	.125	.13	$ .80
Planting	.200	.27	1.04
Cultivation, two	not critical		1.26
Seed (1 1/4 bu. at $12)[2]			15.00
Chemicals, miscellaneous			8.50
	.300	.40	$26.60
(overlap time allowed)	.300		

Fertilizer[3]

	Pounds	Price		
P_2O_5	40	.20	(if purchased)	
K_2O	40	.08		$11.20

Description of task	Field time, hours per acre	Labor, hours per acre	Variable cost per acre
Harvesting grain			
Combine	.25		$ 1.75
Haul and store	not critical		.40
	.25	.60	$ 2.15
	.0063/bu.	.015/bu.	$ .054/bu.

Yield, if all operations are performed on time: 40 bu.

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1/ Field time and costs directly associated with these operations were obtained from unpublished University of Michigan Agricultural Extension Service estimates provided by J.R. Black.

2/ Seed and herbicide costs obtained from southwestern Minnesota farm record analysis summaries.

3/ Fertilizer recommendations from Fenster, et al. , Guide to Computer Programmed Soil Test Recommendations in Minnesota. Special Report 1, Agricultural Extension Service, University of Minnesota, St. Paul, Minnesota 55108.

Table 9. Percentage of Ideal Yield as Dependent on Preparation, Planting and Harvesting Time Period*

Planting Date	Corn, fall preparation	Corn, spring preparation	Soybeans
	percent of ideal yields		
April 25 - May 5	100	85	
May 6 - May 15	93	79	100
May 16 - May 25	84	71	96
May 26 - June 6			90
Harvesting Date	Corn silage	Soybeans	Corn grain
Sept. 1 - Sept. 15	100		
Sept. 16 - Sept. 30	100	100	
Oct. 1 - Oct. 15	95	95	100
Oct. 16 - Oct. 31		82	98
Nov. 1 - Nov. 15			96
Nov. 16 - Nov. 30			93

* Adapted from Minnesota Computer Decision Aid GENMTX, CDA-418, developed by University of Minnesota and Michigan State University extension economists in farm mangement.

Table 10. Investment and Annual Fixed Cost for Crop Machinery System

Equipment	Size and Description	New Cost[1]	Estimated life, years	Annual fixed cost[2]	Variable (operating) Cost/Hour
Tractor	50 hp	$10,000	10	$ 1,550	$2.69
Tractor	70 hp	16,000	10	2,480	3.67
Tractor	100 hp	19,000	10	2,945	4.76
Plow	5-16 in.	4,000	8	720	
Disc	17 ft.	1,950	10	302	
Harrow	20 ft.	850	15	106	
Planter	6-30 in. with attachments	3,000	8	540	
Cultivator	6-30 in.	1,950	10	302	
Combine	16 ft. grain, 3 row corn	28,000	8	5,040	
Silage chopper	2 row PTO	7,800	8	1,404	
2 silage wagons	self unloading	5,000	10	775	
Silo blower		1,300	10	202	
2 grain wagons		1,800	10	279	
Total annual fixed cost				$16,645	

1/ New cost and variable cost per hour as derived from (5) and (15). The new cost is considered a reasonable approximation of the original cost of this machinery to the farmer if purchased during the past few years.

2/ Annual fixed cost includes straight line depreciation, 9 percent interest, and 1 percent of total investment for taxes, insurance, and housing.

Model Summary

Figure 1 helps conceptualize the timing considerations involved in developing the Linear Programming model. The corn and soybean field operations are shown in the first two columns opposite approximate starting dates. For illustrative purposes, the calf feeding activities are shown. The income from calves purchased one year is realized in the next calendar year. A calendar income tax year and constant planning prices are used in the gross margin calculations to make the calendar year assumption plausible. If the yearling steer activity were illustrated, the feeding facility would be utilized throughout the entire year. Once land is planted, manure spreading cannot be resumed until harvest.

Fixed Cost Summary

Although fixed costs are not considered within decisionmaking linear programming models, one must calculate basic fixed costs (summarized in table 11) for the alternative systems in order to choose the most "profitable" system. Fixed costs of runoff control device and spray disposal pump operating costs are included as fixed costs on open lots and drylots. Once a control device is built, it must be pumped each year, because runoff is a function of precipitation. The pumping cost calculations are detailed in an earlier report (14). Labor costs for the spray disposal are not included, as pumping takes place when it does not compete for time with other activities. In this study, annual fixed costs range from $89,435 for the farm-feedlot with open lot feeding facilities to $96,889 on a similar farm with slotted floor unit.

The specific nature of pollution control investment requirements will vary considerably according to individual circumstances, and this likely would change the relative annual overhead costs of these four housing systems somewhat for each individual. Also, inflation and/or local contracting prices for these different facilities may change the relative investment costs of the different facilities in any specific location in a specific year. Therefore, the authors encourage individual farmers and farm planners to calculate their own overhead costs, both on the basis of depreciation through expected life and on a cash flow, debt retirement basis. These costs should be used in the sixth line of tables 12, 13 and 14 for subtraction from the optimum program results.

Programming Results

Farmers with successful feeding experience are most interested in investigating alternative housing systems when considering expansion. The focus of the following sections is to discuss the relevance of the linear programming results to (1) the well-managed family operation, (2) the well-managed two-man farm-feedlot, and (3) the average to below average farm-feedlot (one with below average management in achieving good feed conversion and/or favorable buy-sell price relationships). Another section will deal with the financing implications of these results.
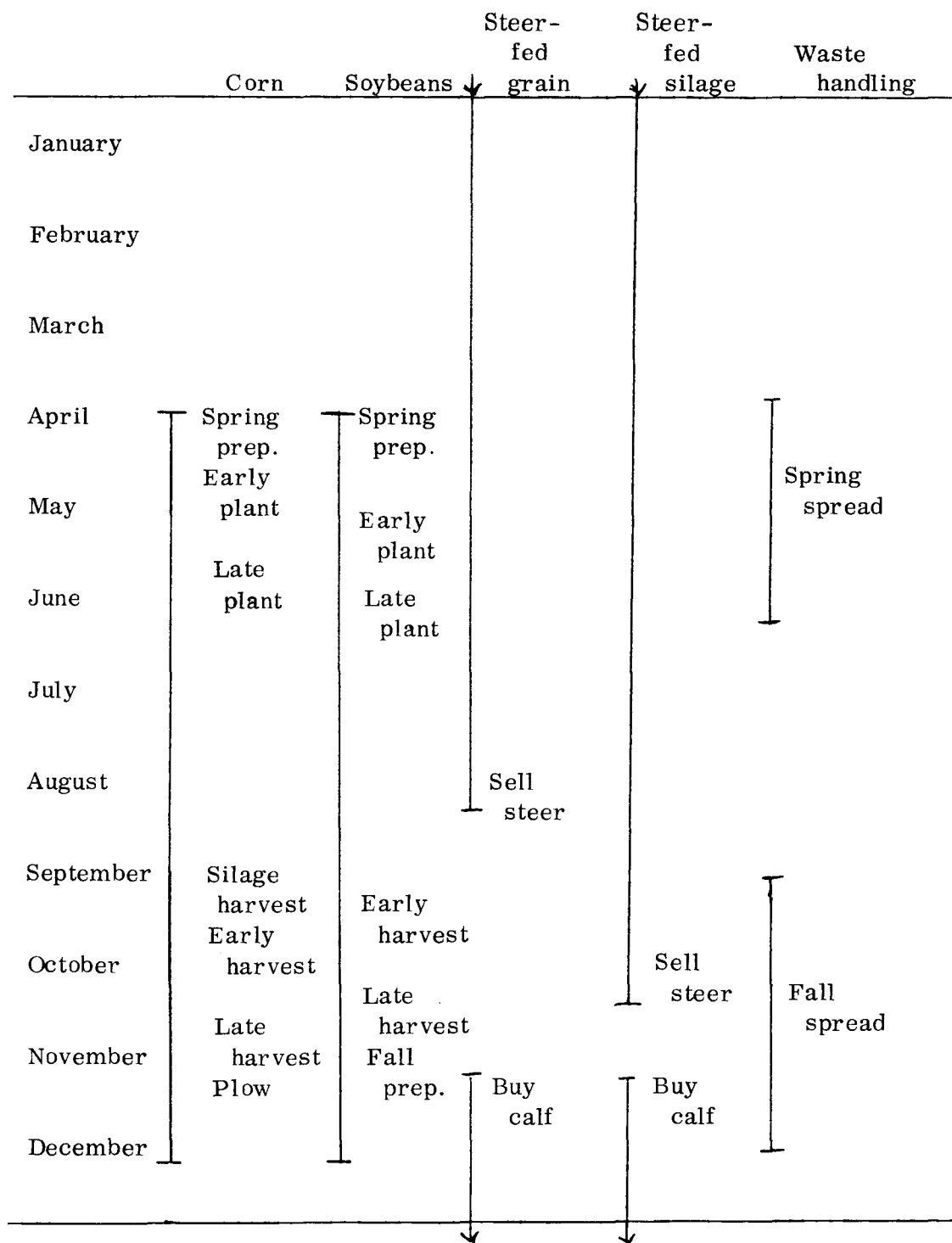
Figure 1. Illustration of Activity Cycles

Table 11. Summary of Annual Fixed Costs, 500 Acre Farm with 500 Head Capacity Feedlot, Southwestern Minnesota, 1976.

Description	Annual Costs	Comments
Items common to all systems		
Land, 520 acres at $1,200	$59,280	9% interest, $6 per acre taxes
Silos, 3, 20 feet by 70 feet	4,044	See (5), $35,169 investment
Silo unloaders, 2	1,044	See (5), $5,800 investment
Grain storage, 25,000 bu.	1,500	$.06 per bushel, Extension estimate
Grinder-mixer	542	$3,500, 10 year life
Feed wagon with scale	760	$4,900, 10 year life
Crop machinery	16,645	See table 10
Auto, truck (farm share)	1,080	$6,000, 8 year life
Sub-total annual fixed cost	$84,895	
Housing systems		
Open lot facility	$ 2,357	See table 1
Waste handling equipment	930	See table 5
Pumping runoff control device*	825	Pump cost + 53 hours at $2.94
Runoff control device	428	See (14). Adjusted for inflation
Total annual cost	$89,435	
Conventional drylot facility	$ 5,750	See table 1
Waste handling equipment	930	See table 5
Pumping runoff control device*	792	Pump cost + 42 hours at $2.94
Runoff control device	428	See (14). Adjusted for inflation
Total annual cost	$92,795	
Manure scrape barn facility	$ 7,590	See table 1
Waste handling equipment	930	See table 5
Total annual cost	$93,415	
Slotted floor barn facility	$10,925	See table 1
Waste handling equipment	1,069	See table 5
Total annual cost	$96,889	

* For more detail, see (14). For the open lot, 210,461 cubic feet of runoff is detained from a 4.46 acre drainage area. For the drylot, 165,165 cubic feet from a 3.5 acre drainage area must be pumped. Individual sites vary as to pollution potential, therefore some may avoid this cost. The investment is estimated at $4,080 for constructing a runoff control device and $5,348 for pumping and spray disposal equipment.

Family farm feedlots: Above average farmer-feeders want to know which alternative housing system leads to the most profitable farm feedlot business. Results in table 12 use the following basic assumptions of this study:

> 500 acres of cropland
> 500 head capacity feedlot
> gross margins of $43 on calves, $48 on yearlings
> grain prices of $2.25 corn, $5.00 soybeans (1975 dollars)
> operator and family labor - 1.5 workers

The first section of the table shows the return over the directly associated costs included in the Linear Program and the total number of cattle fed during the entire year for each age and ration considered. In the next section of the table, subtraction of the fixed cost previously calculated in table 11 determines the return of all labor and management for each farm feedlot system. (Here is where each serious planner may wish to substitute the annual costs he has calculated for his own specific situation.) Given the assumptions previously outlined for this model and subtracting the overhead costs spelled out in table 11, the slotted floor housing system earns the highest labor and management return ($41,050), followed by the conventional drylot ($39,309), manure scrape barn ($38,578), and the open lot ($21,838). One lot of calves on silage rations gives the highest return in the open lot, while two lots of grain fed yearlings are selected in the other three systems. These decisions are based on the assumption that rates of gain are faster and feed conversions more efficient in the latter facilities. These results suggest that the operator of the open lot should be more concerned with low cost gains on roughage rations and less concerned with turnover rates and length of feeding period than the operators of higher fixed cost facilities.

Two reasons help to explain the superior return in the slotted floor facility. First, due to more rapid waste handling, earlier timing of crop planting and harvesting can be achieved. Second, no bedding is purchased or produced for the slotted floor facility. The first reason can be examined in the next section of table 12, where acres planted, production harvested and tons of waste spread are reported by time period. Note that the slotted floor building enables more acres of corn to be planted in the first planting period and more bushels to be harvested in the first harvest period than any of the other facilities.

One caution should be given at this point. The near $2,000 annual return advantage shown for the slotted floor facility ($41,050 vs. $39,309 for the drylot) is based on a 20 year life of the facility. A shorter "pay back" period could shift the result in favor of the conventional drylot or the scrape barn. This problem will be discussed in a later section.

Another interesting feature of the linear programming results is reported in the final section of table 12. In many economic studies, beef waste is assigned an arbitrary "manure credit" according to fertilizer value without consideration of the effect of delayed cropping activities which could reduce farm income. The linear program internally calculates the value of the last ton of manure which must be spread. For example, in table 12 the value of the last 315 tons of waste spread from the manure scrape facility is $4.57

per ton. However, in the fall, when manure spreading competes for harvesting and plowing time, the last 55 tons of waste has a negative value (a cost) to the farm business of $1.39 per ton. Most of the values are positive, as one might expect after recent fertilizer cost increases. (As reported in tables 7 and 8, N was valued at $0.21, P_2O_5 at $0.20, and K_2O at $0.08 per pound in this study. Cutting $0.10 per pound off the value of N would not significantly affect the relative returns among the four systems.) One strength of the linear programming approach is its ability to determine the "value" of the manure by-product in terms of overall farm-feedlot profitability.

The final column in table 12 indicates the expected level of income on this example farm without any cattle or feedlot facilities. Given the land, corn and soybean price levels assumed in this study, a labor and management return of only $8,196 would be expected. Thus, a well-managed feeding enterprise can increase income significantly, if buy-sell prices are favorable enough to permit the average gross margins assumed in this study over a period of years.

Looking at labor availability, the linear programming results reported above were from a resource situation which restricted labor to that commonly available on one-man family farm operations--1.5 workers. Close inspection of these results indicated that additional labor could increase returns substantially. Table 13 reports the results of an analysis which was made of a farm situation in which two full-time workers were available during the critical time periods. 1/

Two noteworthy changes occur when more labor is available. First, the silage-fed yearling enterprise is selected in each system. These results, therefore, agree with previous research findings that high silage rations become more profitable when grain prices are relatively high (8,18). The choice of grain-fed yearlings in the one-man family operations was dictated by the fact that grain rations require less labor for feeding and manure handling. Thus, this total farm model points out another condition that may exist before the high silage ration can be superior--namely that labor must be in sufficient supply to (1) harvest, handle and feed the additional silage and (2) handle, in a timely manner, the added manure produced from cattle fed high silage rations. Additional evidence of this can be seen in the lower portion of table 13, where all the per ton values of manure are positive.

The second major change that occurred when more labor was made available was the systems ranking in terms of return to all labor and management. Now the scrape barn return is $45,986; while the slotted floor ranks second with return of $45,368; the drylot return is $44,929; and the open lot return is $26,707. Using the 20 year lifespan assumption, no clear advantage is given to any particular one of the three facilities with shelter when labor is adequate.

1/ Available labor is as follows: April 1 - 25, 450 hours; the remaining spring periods, 180 hours every 10 days; and in the fall periods, 260 hours every 15 days.

Table 12. Optimal Organization for Family Operated Farm Feedlots with Alternative Housing Systems, 500 Crop Acres, 500 Head Capacity, 1976

Value of program	Open Lot Return	Head[1]	Conventional Drylot Return	Head[1]	Scrape Barn Return	Head[1]	Slotted Floor Return	Head[1]	No Lvstk.
Grain-fed calf	$104,263	500	$113,905	500	$116,117	500	$118,429	500	
Grain-fed yearling	108,443	900	132,104	1000*	131,993	1000*	137,939	1000*	
Silage-fed calf	111,273	500*	127,674	500	129,509	500	130,816	500	
Silage-fed yearling	108,084	592	124,961	731	124,592	697	132,736	800	

Net return figures	Return		Return		Return		Return		Return
Optimum program	$111,273		$132,104		$131,993		$137,939		$ 86,701
Fixed cost (table 11)	89,435		92,795		93,415		96,889		78,505[2]
Return to all labor	$ 21,838		$ 39,309		$ 38,578		$ 41,050		$ 8,196

Scheduling of:

Planting		Acres	Acres	Acres	Acres	Acres
Fall corn	4/26	213	219	219	224	224
	5/6	212	171	167	195	208
	5/16					
Spring corn	4/26					
Soybeans	5/6		47	52	37	54
	5/16	75	59	63	45	14
	5/26		3			

Harvesting		Tons	Tons	Tons	Tons	
Silage	9/1	1,209	736	669	1,000	
	9/16	810	264	330		
	10/1	409				

		Bushels	Bushels	Bushels	Bushels	Bushels
Corn	10/1	13,317	18,451	18,451	19,507	25,353
	10/16	12,105	14,088	1,746	16,065	24,637
	11/1	5 924	6,842	6,842	7,024	
	11/16	3,349		11,842		
Soybeans	9/16	2,805	4,223	4,410	3,140	2,718
	10/1					
	10/16					

Waste handling		Tons	Tons	Tons	Tons	
	Early	380	279	480	1,000	
	4/1		370	315	250	
	4/26					
	5/6					
	5/16	130	402	270	400	
	5/26		63			
	9/1		280	386	133	
	9/16				817	
	10/1					
	10/16	390			250	
	11/1		280	549	250	

Value of waste/ton	Dollars	Dollars	Dollars	Dollars	
Spread in spring	+ 3.73	+ 4.57	+ 4.57	+ 3.43	
Spread in fall	- 2.48	+ .72	- 1.39	+ 1.89	

* The feeding program showing highest returns over cash costs

1/ Number fed during entire year.

2/ Non-livestock fixed costs from table 11.

Table 13.   Optimal Organization for Two-Man Farm Feedlots with Alternative Housing Systems.
500 Crop Acres, 500 Head Capacity, 1976.

Value of program		Open Lot		Conventional Drylot		Scrape Barn		Slotted Floor	
		Return	Head[1]	Return	Head[1]	Return	Head[1]	Return	Head[1]
Grain-fed calf		$105,982	500	$115,236	500	$117,448	500	$119,394	500
Grain-fed yearling		110,549	900	134,139	1000	135,193	1000	139,431	1000
Silage-fed calf		114,386	500	129,036	500	130,834	500	131,789	500
Silage-fed yearling		116,142	750*	137,724	800*	139,401	800*	142,257	800*
Net return figures		Return		Return		Return		Return	
Optimum program		$116,142		$137,724		$139,401		$142,257	
Fixed cost (table 11)		89,435		92,795		93,415		96,889	
Return to all labor		$ 26,707		$ 44,929		$ 45,986		$ 45,368	
Scheduling of:									
Planting		Acres		Acres		Acres		Acres	
Fall corn	4/26	224		224		224		224	
	5/6	227		226		226		227	
	5/16								
Spring corn	4/26								
Soybeans	5/6	37		32		28		35	
	5/16	11		18		22		15	
	5/26								
Harvesting:		Tons		Tons		Tons		Tons	
Silage	9/1	1,231		1,348		1,690		1,190	
	9/16	1,694		1,452		1,110		1,610	
		Bushels		Bushels		Bushels		Bushels	
Corn	10/1	29,225		29,718		29,718		30,775	
	10/16	5,464		5,605		5,559		4,590	
	11/1								
	11/16								
Soybeans	9/16	1,921		1,945		1,951		1,940	
	10/1								
	10/16								
Waste handling		Tons		Tons		Tons		Tons	
	Early	425		480		480		1,000	
	4/1			390		554		775	
	4/26								
	5/6			16				15	
	5/16	150		364		446		585	
	5/26					42			
	9/1								
	9/16								
	10/1								
	10/16	390		770		771		577	
	11/1	85		279		550		1,448	
Value of waste/ton		Dollars		Dollars		Dollars		Dollars	
Spread in spring		+ 3.73		+ 3.73		+ 1.92		+ 2.32	
Spread in fall		+ 2.80		+ 2.80		+ 1.92		+ 1.86	

*   Optimal program.
1/   Number fed during entire year.

Can the additional labor cost be justified? A comparison of tables 12 and 13 indicates that return to all labor and management increase by more than $4,000 in all four housing systems, when half a man unit is added. The scrape barn returns increase by $7,408 (from $38,578 to $45,986); the drylot by $5,620; the open lot by $4,869; and the slotted floor barn by $4,318. It is logical to expect less increase in the slotted floor unit returns when labor is increased, because it is the least labor intensive system. If a full-time hired man's annual salary of $6,000 were assumed, only the scrape barn owner could justify hiring an additional worker. If monthly labor could be hired during April, May, September, October, and November for approximately $800 per month, each system could justify the added expenditures for labor.

Another suggestion arising from these results is that the scrape barn might fit best in the smaller family farm-feedlot situation, where one family operates only 300-400 acres and feeds only 100-300 head of cattle. Previous research (8) indicates that the feeder with fewer acres should intensify production per acre by going to high silage rations. This research suggests that he might look closely at the scrape barn facility.

Turning to low margin feeding, when a lower level of management is assumed or when fed cattle prices fall, a lower gross margin is obtained. Alternatively, the less skilled manager may obtain poorer feed conversions. The results in table 14 show what happens on a family farm-feedlot when the gross margin falls from $43 to $39 per hundredweight of gain for calves and from $48 to $43 per hundredweight of gain for yearlings. (Or, when the operator has feed and cash costs that are $4 or $5 per hundredweight higher than the good management level assumed in the previous analysis for calves and yearlings, respectively.) Under these conditions only one lot of silage fed calves is fed in each system. The ranking according to return to all labor is $23,094 for manure scrape barn, $21,879 for the drylot, $20,927 for the slotted floor unit, and $10,084 for the open lot.

Under these undesirable circumstances the return to labor and management is nearly cut in half in all systems. These results emphasize the need for "buying and selling right," as well as careful feeding. They suggest that the average or below average manager may have a very difficult time generating adequate returns to cover family living expenses as well as interest and debt repayment for high cost slotted floor facilities. Rather, he should strongly consider the scrape barn facility and a one group-a-year feeding program that utilizes a high silage ration. Also, he might feed half heifers and half steers so as to spread his marketings over a large period of time.

Concerning financing, the foregoing analysis dealt with the profitability question but not with the cash-flow, facility debt repayment question. Depreciation over a 20 year period is realistic in terms of usable life. However, many farmers and agricultural lenders will want to consider building financing as intermediate term credit, with a five to seven year "pay back" period. Would the cost of paying off a loan in such a short period of time change the ranking of the alternative system? One could attempt to answer this question with a sophisticated cash-flow analysis, using various assumptions about current debt load, family living expenses, down payments, interest rates, and even patterns in price expectations. However, individual farm operators face such a variety of circumstances, that a more simple analysis will be used here to arrive at some general conditions.

Table 14. Optimal Organization Under Low Margin Conditions for Family Operated Farm Feedlots with Alternative Housing Systems, 500 Crop Acres, 500 Head Capacity, 1976

Value of program	Open Lot		Conventional Drylot		Scrape Barn		Slotted Floor	
	Return	Head[1]	Return	Head[1]	Return	Head[1]	Return	Head[1]
Grain-fed calf	$ 92,594	434	$101.905	500	$104,117	500	$106,429	500
Grain-fed yearling	89,568	578	109,604	1000	109,494	996	115,439	1000
Silage-fed calf	99,519	451*	114,674	500*	116,509	500*	117,816	500*
Silage-fed yearling	94,432	488	107,882	488	108,505	597	113,484	701

Net return calculation	Return		Return		Return		Return	
Optimum program	$ 99,515		$114,674		$116,509		$117,816	
Fixed cost (table 11)	89,435		92,795		93,415		96,889	
Return to all labor	$ 10,084		$ 21,879		$ 23,094		$ 20,927	

Scheduling of:

Planting		Acres		Acres		Acres		Acres	
Fall corn	4/26	221		219		219		224	
	5/6	221		218		219		222	
	5/16					6			
Spring corn	4/26								
Soybeans	5/6	58						10	
	5/16			63		57		45	
	5/26								

Harvesting		Tons		Tons		Tons		Tons	
Silage	9/1	1,217		893		990		876	
	9/16	949		1 307		1.210		1,324	
	10/1								

		Bushels		Bushels		Bushels		Bushels	
Corn	10/1	23,128		25.352		25,352		25,352	
	10/16	12.106		12,110		12.693		13,704	
	11/1	2,964							
	11/16								
Soybeans	9/16	2,166		2,337		2,121		2,054	
	10/1								
	10/16								

Waste handling		Tons		Tons		Tons		Tons	
	Early			480		480		273	
	4/1	55		351		471		1,177	
	4/26								
	5/6								
	5/16	405		269		396		430	
	5/26								
	9/1			60		274			
	9/16								
	10/1								
	10/16	352		640		599		1,120	
	11/1								

Value of waste/ton	Dollars		Dollars		Dollars		Dollars	
Spread in spring	+ 3.73		+ 3.73		+ 2.80		+ 2.33	
Spread in fall	+ 1.01		+ 2.79		+ 2.80		+ 1.86	

* Optimal program

1/ Number fed during entire year.

Table 15 uses the income data previously reported in table 12 for the family operated farm feedlot. The annual cost data for the feedlot facility has been revised by assuming a seven year life for debt repayment plus interest, repairs, taxes, and insurance for a total annual cost of 20.8 percent rather than the 11.5 percent used in table 1.

Table 15. Optimal Returns to Labor and Management for Family Operated Farm Feedlots Using Intermediate Term Credit to Purchase.

	Open Lot	Conventional Drylot	Scrape Barn	Slotted Floor
Optimal program				
Ration	Silage	Grain	Grain	Grain
Age of cattle	Calves	Yearlings	Yearlings	Yearlings
Value of program (table 12)	$111,273	$132,104	$131,993	$137,939
Annual fixed cost 1/	91,342	97,445	98,995	105,724
Return to all labor	$ 19,931	$ 34,659	$ 32,998	$ 32,215

1/ Annual fixed costs on feedlot facilities are calculated at a seven year life (14.3 percent) plus 9 percent interest on half the investment (4.5 percent) plus repairs, taxes, insurance (2 percent) equals 20.8 percent. Other fixed costs are reported in table 11.

As the calculations indicate in table 15, requiring repayment of the investment in facilities in seven years rather than 20 years gives the advantage to the conventional drylot. The annual return to all labor and management is now $34,659 for the conventional drylot, $32,998 for the scrape barn, $32,215 for the slotted floor barn, and $19,931 for the open lot. This simplified analysis ignores the problems of higher interest payments in the first several years of ownership,which makes the higher cost facilities relatively more expensive during the early phase of the debt retirement. However, such analysis does suggest that the financing and cash flow aspects of the alternative housing decision should be carefully budgeted for the individual farmer-feeder.

Conclusions

The alternative beef housing system decision should take the interactions between the crop enterprises and beef feeding into consideration. The linear programming model used in this study indicates that the ranking of the four systems considered can change under various circumstances.

For 500 acre - 500 head well-managed farm-feedlots restricted to one operator and limited family labor, the most profitable choice is the slotted floor confinement facility, followed by the conventional drylot, the scrape barn, and the open lot. A grain-fed yearling feeding program is selected for each of the units with shelter, under this restrictive labor situation.

When two men are available to operate this same farm-feedlot the ranking slightly favors the scrape barn, followed by the slotted floor facility, the conventional drylot, and the open lot. A silage-fed yearling feeding program becomes most profitable when more labor is available. The additional income generated by this additional labor may not be adequate to pay full-time labor a competitive wage.

The less well-managed family operated farm-feedlot, which faces lower gross margins, probably cannot justify the investment in capital intensive housing systems. The ranking for the low margin farm-feedlot is scrape barn, drylot, slotted floor, and open lot. The optimal feeding program is silage-fed calves for each system. Thus, it appears that the average non-specialized feeder in southern Minnesota should seriously consider the scrape barn facility and a high silage calf feeding program.

Finally, cash flow and financing considerations may continue to make the conventional drylot the most common housing system for northern Corn Belt feeders. The investment in slotted floor and scrape barn facilities may not be feasible for operators who already have heavy debt loads. Individual farmer-feeders should apply their own financial data and past feedlot performance to the information in this report to tailor a specific answer.

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