Cattle – Feeding

SCHOOL OF AGRICULTURAL ECONOMICS AND EXTENSION EDUCATION

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AN ECONOMIC EVALUATION OF FEEDING SYSTEMS FOR ONTARIO BEEF COW-CALF ENTERPRISES

by

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FOREWORD

This publication reports on a study which was undertaken to evaluate, using computer models, the optimum feeding systems for Ontario beef cow-calf enterprises. The study was part of a series of inter-disciplinary studies carried out at the Ontario Agricultural College to develop computer models which would simulate the beef cow-calf enterprises under Ontario conditions.

In conducting this study the authors are indebted to J.W. Wilton, D.N. Mowat, G.H. Crow and James Lee of the Department of Animal and Poultry Science, O.A.C. who provided the basic data and formulae used in the computerized feeding equations for beef animals. Also, the authors are indebted to J.E. Winch of the Department of Crop Science, O.A.C., who provided the pasture data used in the models and W.C. Pfeiffer and G. Robertson of the School of Agricultural Economics and Extension Education, O.A.C., who helped develop the computer models.

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ABSTRACT

When computer models were used to evaluate the profitability of alternative beef cow-calf feeding systems in the corn grain producing area of Ontario the following results were indicated.

1. Improved roughland pasture is the least cost source of summer feeds for beef cow-calf herds. Pasture costs per acre would have to increase to $61. before drylot systems would be competitive.

2. Creep feeding of grain corn to calves to maintain a growth rate of 1.1 Kg per day from birth to 255 days about doubles the returns over feed cost at 1978 costs and prices. The models estimated the amount of creep feed required to be in the range of 484-616 Kg of grain corn per calf, to maintain this fast growth rate.

3. Early weaning of calves which were then fed on a drylot doubled the carrying capacity of the pasture but if the availability of the pasture limited the size of cow herd it was more profitable to supplement calf feeding by creep feeding and weaning at 7 months and supplement cow feeding while on pasture with hay and corn silage.

4. The least cost feed for overwintering cows and replacement heifers in this area was corn silage, corn stover and hay. The amounts per cow estimated by the models were:

	Winter Feed per Cow When Corn Stover Not Available	Winter Feed per Cow When Corn Stover is Available
Hay	.31 Tonne	.51 Tonne
Corn Silage	4.6 Tonne	2.8 Tonne
Corn Stover	-	.9 Tonne

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1.0 Introduction

During 1976-79 the School of Agricultural Economics and Extension Education in cooperation with the Department of Animal and Poultry Science and the Department of Crop Science developed a set of computer programs to simulate and evaluate alternative feeding systems for Ontario beef cow-calf enterprises. The objectives of the study were to use computer programs to simulate the least cost cow and calf feeding systems under Southwestern Ontario conditions and to evaluate these systems based on the 1978 cost-price relationships. The models estimated the yearly feed for maintenance and milk production of the cow herd plus feed for calf growth up to eight and one half months of age when these calves could either be sold or transferred to feedlots for finishing.

The computer program comprised three separate mathematical models:

A. A computerized nutrient requirement program was developed to estimate the net energy and protein needs for cow maintenance and milk production and for calf growth up to 255 days of age. The California net energy system as developed by Lofgreen and Garrett (9) was used for energy requirements and the protein system as developed by Preston (10) was used to compute protein requirements. National Research Council tables were used to estimate nutrients available in the feeds and to limit feed intake of the animals based on weight and age of calves and a standard beef crossbred cow weighing about 500 Kg.

B. A linear programming model was developed to compute the least cost feeds for cows and calves for each stage of calf growth. This model was used to estimate the least cost feed for a range of calf growth rates during each feeding period. Five stages of calf growth were used to correspond to alternative winter feeding and pasture seasons for cows and calves on the assumption that the calves were born on March 1 and were marketed or transferred to a feedlot on November 10. A final sixth stage covered the overwintering period of the cows.

C. A dynamic programming model was developed to compute the optimum growth path for calves for each feeding and management system. The optimum growth path is the one which maximizes the gross margin over feed cost for a selected feeding and management system.

The selected feeding and management systems evaluated were as follows:

Option 1. - Pasture feeding of cows
- no creep feeding of calves
- winter feeds were the least cost combination required to maintain the cows plus milk production from March 1 to pasture date. Pasture provided the feeds needed for cow maintenance, cow milk production and some calf feed.

Option 2. - Pasture feeding of cows
- calves were creep fed a least cost feed from 45 days of age until November 10.
- winter feeds were the least cost feed for cow maintenance and milk production from March to pasture date. Pasture provided feed for cow maintenance, cow milk production and some calf feed.

Option 3. - Pasture feeding of cows.

- calves were weaned at 45 days of age and fed in drylot until November 10.
- winter feeds were the least cost feed for cow maintenance and milk production from March 1 to April 15. Pasture requirements were for cow maintenance only. Harvested feeds were fed in drylot to calves.

Option 4. - Drylot feeding of cows and calves. Calves were weaned at the normal time but creep feeds were available after 45 days of age. Summer and winter feeds of cows were the least cost feed to maintain cows and provide optimum milk production required by the calves until sold or transferred to the feedlot at 255 days of age.

2.0 The Stages of Calf Growth

The calendar year was divided into 6 time periods in order to analyze optimum feeding and management systems. The first time period was 45 days commencing March 1. In Option 3 the calves were weaned at the end of this period whereas in all other systems the weaning age was determined by the models based on the least cost feeds for the optimum calf growth path. This weaning date was on October 1 for Options 1 and 4 and on November 10 for Option 2.

The second time period was the time between April 15 and the date that the herd could be put on pasture. This pasture date varied from system to system and was determined by the models, based on early pasture availability and feed requirements of the cows. When cows were milking in Options 1 and

2 the pasture date was around May 20. However, with Option 3, the dry cows could be turned out to pasture earlier. It was assumed that the farmer had early pasture available on tillable land which later would be cut for hay.

The third and fourth time periods ran from June 1 to October 1. This was the summer pasture period when the herds would be pastured on improved roughland pasture. This pasture period was divided into 2 - two month periods to allow feeding adjustments of cows and calves in order to account for different quantity and quality of feeds available from pasture early in the summer and later after August 1.

The fifth period was from October 1 to November 10. The calves would be sold on November 10 and the herd was moved from the roughland pasture on October 1. The herd obtain some feed from aftermath pasture and was fed supplemental feeds depending upon cow requirements. Cows producing milk could be pastured to about October 8, but the dry cows requiring only maintenance feeds in Option 3 could be pastured until about October 28.

Finally, there was the wintering period until the cows calved again in March.

3.0 The Cow Herd

The number of animals in the herd varied over the time periods. Estimated calf production assumed a 90% calf crop for the pasture systems and a 93 percent calf crop for the drylot system. These calf crop percentages were based on number of cows plus bred heifers tested as being safe in calf on November 10. Cows and first calf heifers which did not produce a live calf were assumed to be culled at the end of the first time period on April 14. Conception rates were estimated at 83 percent for drylot systems and 75 percent for the pasture systems. Cows and bred heifers not safe in calf on November 10

were culled on that date.

Thus the herd included cows plus yearling heifers and calves from April 14 to November 10. The total number of cows plus yearlings maintained for winter feeding was reduced to those animals safe in calf plus the weaned heifer calves kept for breeding the next year.

The rates of calf losses and conception used for the drylot system were those obtained in the beef cow calf trials at the Elora Research Station. The lower rates used for the pasture system were estimated as being representative of average management of Ontario herds.

4.0 Costs and Availability of Feeds Used

All feeds were considered to be grown on the farm except for purchased soyabean meal used to balance some of the rations. The harvested crops evaluated were corn grain, oats, barley, corn silage and hay. Pasture was available on tillable land as early pasture in time period 2 and as aftermath pasture in time period 5. The amount of this pasture available depended upon the amount of hay harvested in the least cost feed system as this same land was used to harvest one cutting of hay in late June. Hay production for the drylot system was based on two cuttings, one in June and the other in August.

Improved roughland pasture was available between June 1 and October 1. (Time periods 3 and 4). The yields of this pasture land were based on estimated dry matter yields from pasture clipping trials of trefoil bromegrass mixtures at the Elora Research station adjusted for expected utilization rates.

Yield and quality of this pasture growth declined from period 3 to time period 4 and if the herd required extra feed, supplemental feed would be available in the models. Improved pasture was valued at the cost of

renovation and maintenance of the pasture growth plus a minimum return to land of $10. per acre.

Feeds grown on the tillable land were valued at the cost of growing and harvesting each crop plus an opportunity cost to land if the land were to be used to grow a cash crop of grain corn. This opportunity cost of land based on 1978 costs and returns for grain corn was estimated to be $85. per acre. In this way, the least cost feeding program suggested by the computer models resulted in optimum land use at least equivalent to the grain corn cash-crop alternative. Grain corn was selected as the most profitable cash crop alternative for the area which can be grown on most farms without marketing or production restrictions.

The estimated costs per acre, and per tonne of available feed to the beef cow-calf herd are shown in Table 1. The per acre yields of roughages and pasture recorded in this table are adjusted for storage and harvesting losses in the case of hay and corn silage and for actual consumption of herbage by grazing animals in the case of pasture.

Because oats and barley have relatively low yields compared to grain corn in this area these feeds are high cost sources of both T.D.N. and protein when the opportunity cost of land is included in total costs per tonne. These feeds sell at lower prices per tonne and are rarely grown for sale in this area except under special situations where they are grown for seed.

Pasture was the lowest cost source of nutrients during the summer feeding period and corn silage was the cheapest source of energy feeds in the winter. Hay was a low cost source of crude protein during the winter period.

5.0 Least Cost Feeding System to Optimize Returns

The optimum feeding systems suggested by the models were directly

TABLE 1. YIELD AND COST ESTIMATES OF HOME GROWN FEEDS USED IN THE BEEF COW-CALF FEEDING MODEL

Crop	Yield Per Acre[1] Available to Beef Herd	Estimated Cost per acre	Cost per tonne as Fed	Cost per Kg of TDN[4]	Cost per Kg of Crude Protein[4]
	Tonnes	$/ac.	$/tonne	$/Kg	$/Kg
Grain Corn	2.25	210.	93.30	.12	1.03
Oats	.80	133.	166.25	.25	1.49
Barley	1.04	144.	138.45	.19	1.23
Corn Silage	11.03[2]	216.	19.58	.08	.65
Hay 2 Cuts	2.75[2]	130.	47.27	.10	.37
Hay 1 Cut	1.76[2]	78.	44.32	.09	.40
Tillable Pasture (available in Periods 2 and 5)	1.42[3]	48.	33.80	.07	.22
Improved Roughland Pasture (available in Periods 3 and 4)	1.33[3]	26.	19.55	.03	.14

(1) Crop yield averages for 1978 reported in Monthly Crop and Livestock Report, Economics Branch, OMAF. Pasture yields from Elora Research Station Pasture Clipping Trials.

(2) Harvested yields are actually 10% higher. Adjustment made to account for storage and feeding wastage.

(3) Dry matter yields actually grazed by animals. Herbage yield 40% higher.

(4) Total digestible nutrient and crude protein estimates based on the nutrient analysis of feed samples at the Feed Analysis Laboratory, University of Guelph, Years 1974-1976.

related to the feed costs. Oats and barley did not enter any solution. Cows were fed hay and corn silage during the winter months and pastured during the summer. When the cows were nursing calves in the early spring before pasture the amount of hay fed increased to satisfy the protein requirements of milking cows. Pasture provided enough of both protein and energy nutrients for milking cows under Options 1 and 2. When creep feeding was allowed the major feed for nursing calves was grain corn. The optimum feeding programs developed by the models are shown in Tables 2 and 3.

5.1 Option 1.

The pasture system with no creep feeding would be the system used by most Ontario cow-calf operators. The models estimated that calves fed using this system would obtain an expected weight of about 184 Kg (405 lbs) at 255 days of age, based on the average weight of both heifer and bull calves. This would be about the average achieved by most farmers in Ontario. The optimum weaning age of calves was about 7 months of age after which they were started on a hay-corn silage ration for the last 41 days before sale. Cows were wintered on a hay-corn silage ration. The least cost cow feed amounted to .32 tonnes of hay and 4.2 tonnes of corn silage per cow. Improved roughland pasture of 1.1 acres per cow plus hay aftermath pasture provided the summer feed for a pasture season extending from about May 20 to October 10.

5.2 Option 2.

When this pasture system was supplemented by a calf creep feeding option a total of 616 Kg of corn grain was fed to the calves to obtain the least cost feeding program and to maximize profits over feed costs. The

optimum weaning date was extended to 255 days and cows were fed to produce an extra 418 litres of milk per head. Grain corn was the only creep feed required. The expected sale weight of the calves increased from 184 Kg to an average of 315 Kg (695 lbs) per calf. Thus creep feeding of 616 Kg of grain corn increased the average weight of the calf by 130 Kg at 255 days. This is a feed conversion rate of 4.7 Kg of grain corn per Kg of extra gain. The model started the calves on grain corn at about 1.0 Kg per day at two months of age and gradually increasing this amount to about 5.0 Kg per day at seven months of age. Creep feeding maintained a growth rate of the calves at about 1.1 Kg per day while the growth rate declined to less than .5 Kg per day for calves not creep fed (Option 1) when milk yield of cows declined four months after freshening.

The total of the roughages and pasture feeds required was about the same for both pasture options. When the calves were creep fed the cows were fed a little extra roughage feeds in the fall, the yearly totals of corn silage required by both cows and calves were similar. Some extra hay was fed to calves after weaning in Option 1 but this was offset by a small reduction in the acreage of roughland pasture requirements when the calves were creep fed.

5.3 Option 3.

The third feeding option evaluated early weaning of calves at 6.5 weeks. The dry cows were turned out to pasture with the calves raised in a drylot. This option reduced pasture requirements by one-half as the cows were not milking and calves were fed in the feedlot. Also, the pasture season could be stretched out to cover a period from about May 11 to October 28. However, when calves did not nurse the least cost feeding system resulted

TABLE 2. ESTIMATED OPTIMAL FEED REQUIREMENTS PER COW (1) BY PRODUCTION PERIOD AND FEEDING OPTION

BEEF COW-CALF ENTERPRISE SOUTHWESTERN ONTARIO IN 1978

	FEEDING OPTION			
	Pasture No Creep Feeding	Pasture Plus Creep Feeding	Cows Pastured Calves Weaned at 45 days	Drylot Feeding of Cows & Calves Calves Creep Fed
Feeds per Production Period				
Calf Birth to Pasture Period				
Number of Days	82	80	72	92
Feed - Hay (tonnes)	.17	.19	.21	.30
- Corn Silage (tonnes)	1.60	1.80	1.32	1.59
Pasture Period				
Number of Days	142	141	170	122
Feed - Pasture (ac.)	1.1	1.08	.5	-
- Hay (tonnes)	-	-	-	.38
- Corn Silage (tonnes)	-	-	-	1.75
Wintering Period				
Number of Days	141	144	123	151
Feed - Hay (tonnes)	.15	.12	.10	.14
- Corn Silage (tonnes)	2.60	2.90	2.13	3.56
Total Feeds				
Pasture (ac)	1.1	1.08	.5	-
Hay (tonnes)	.32	.31	.31	.82
Corn Silage (tonnes)	4.20	4.70	3.45	6.90
Nursing Period of Calves (days)	214	255	45	214
Milk Production/Cow (litres)	1118	1536	323	1264

(1) This feed also includes the feed for replacement heifers.

TABLE 3. ESTIMATED OPTIMAL FEED REQUIREMENTS PER CALF BY PRODUCTION PERIOD AND FEEDING OPTION

BEEF COW-CALF ENTERPRISE SOUTHWESTERN ONTARIO IN 1978

	FEEDING OPTION			
	Pasture No Creep Feeding	Pasture Plus Creep Feeding	Cows Pastured Calves Weaned at 45 days	Drylot Feeding of Cows and Calves Calves Creep Fed
Feeds per Production Period				
Birth to Weaning				
Days to Weaning	214	255	45	214
Feed - Milk (litres)	1118	1536	323	1264
- Corn Grain (Kg)	-	616	-	484
- Soyabean Meal (Kg)	-	-	-	2
- Pasture (Hay equivalent) (Kg)	338	221	-	-
Weaning to Sale Date				
Days on Feed	41	-	210	41
Feed - Corn Grain	-	-	550	-
- Soybean Meal	-	-	21	-
- Hay	50	-	213	195
- Corn Silage	428	-	80	507
- Pasture (Hay equivalent) (Kg)	21	-	-	-
Total Feed for 255 Days				
Milk (litres)	1118	1536	323	1264
Corn Grain (Kg)	-	616	550	484
Soyabean Meal (Kg)	-	-	21	2
Hay (Kg)	50	-	213	195
Corn Silage (Kg)	428	-	80	507
Pasture (Hay Equivalent) (Kg)	359	221	-	-
Weight at 255 Days of Age (Kg)	184	315	234	315

in an expected average rate of gain of only .75 Kg per day and a final sale weight of 234 Kg (516 lbs) at eight and a half months of age. Calves required a grain corn-soybean ration of 571 Kg plus 213 Kg of hay and a small amount of corn silage to obtain that growth rate. On the other hand, the winter corn silage requirements for the cow herd declined by about one quarter because of the shorter winter feeding period.

5.4 Option 4.

Finally, the fourth feeding option evaluated a feedlot system for both cows and calves. Calves were allowed to nurse and also had access to other feeds up to the age of 255 days. The expected weight was 315 Kg when this system was used. This was the same weight gain achieved with cows on pasture and calves being creep fed grain corn. The optimum weaning age was 214 days then calves were fed corn silage and hay in the drylot. During lactation the least cost ration for the cows consisted of 3.6 Kg of hay and 17.3 Kg of corn silage per head per day. During the cows' dry period the least cost ration was about .55 Kg of hay plus about 17.2 Kg of corn silage per day. The least cost calf feed included about 484 Kg of grain corn during nursing plus a hay corn silage ration after weaning to maintain a rate of gain of about 1.1 Kg per day.

Overall, when the herd is fed in a drylot year-round the least cost ration required an extra 3.0 tonnes of corn silage and an extra .8 tonne of hay to replace 1 acre of roughland pasture. Also, the amount of grain corn required to creep feed the calf declined by about 130 Kg since the calves are weaned 40 days sooner.

6.0 Estimated Net Returns For The Least Cost Feeding System

The computer models completed the analysis by estimating the gross

margin over feed cost for each of the least cost feeding systems which maximized annual returns over feed cost to the beef cow-calf herd. Gross revenue from the sale of calves and cull cows were included in the model to estimate the growth path for the calves which maximized the herd gross margin from birth to sale of calves at 255 days.

The least cost feeding system for each of the feeding options tested was reported in Section 5. The data in Table 3 indicate that the expected sale weights which maximized returns over feed costs varied by feeding system. The expected sale weight for light calves on the pasture system with no supplemental feeds was 184 Kg; for calves weaned early and raised in a feedlot it was 234 Kg; and for calves produced with grain corn as a creep feed after the age of 6 weeks it was 315 Kg.

Feedlot operators generally pay a premium for light calves, when slaughter prices for finished animals are above the cost of feeding which was the case in 1978. Therefore, the market price per Kg of weight varies for each of the least cost systems estimated. The average prices in the fall of 1978 used in the analysis of gross margins are shown in Table 4.

TABLE 4. TORONTO STOCKYARD PRICES - GOOD STEERS AND HEIFERS, OCTOBER-NOVEMBER 1978

	Weight Category Kg	Average Price
Light Weight - Good Steer & Heifer Calves	136 - 227	$1.79/Kg (81¢ per lb)
Medium Weight - Good Steer & Heifer Calves	182 - 273	$1.73/Kg (79¢ per lb)
Good Steers and Heifers	273 - 318	$1.58/Kg (72¢ per lb)

The estimated gross margins based on these prices and costs of feed are shown in Table 5.

TABLE 5. ESTIMATED RETURNS OVER FEED AND DIRECT COSTS PER COW

BEEF COW-CALF ENTERPRISE SOUTHWESTERN ONTARIO IN 1978

FEEDING OPTION

	Pasture No Creep Feeding	Pasture Plus Creep Feeding	Cows Pastured Calves Weaned at 45 days	Drylot Feeding of Cows and Calves Calves Creep Fed
Calf Weight at 255 days (Kg)	184	315	234	315
Percentage Calf Crop	90%	90%	90%	93%
Gross Revenue $ per Cow	296.	449.	365.	469.
Feed Cost $ per Cow	151.	210.	182.	258.
Other Direct Expenses $ per Cow	36.	36.	39.	46.
Total Direct Expenses $	187.	246.	221.	304.
Returns over Direct Expenses $ per Cow	109.	203.	144.	165.
Capital Cost of New Facilities per Cow $	590.	630.	645.	845.
Labour hours per Cow	15	16	18	22

At these prices and costs the pasture plus creep feeding system was the most profitable and the unsupplemented pasture system the least profitable. Creep feeding of grain corn to calves cost an extra $59. per cow but the extra gain was worth an extra $153. per cow. Pasturing cows was also more profitable than feeding them on a dry lot without pasture. Improved roughland pasture was charged to the herd at $26. per acre. This pasture feed would remain the least cost source of summer feed up to a cost of $61. per acre. In addition, drylot feeding required an extra 6 hours of labour per cow plus the overhead costs on extra buildings and storage facilities. At 1978 prices of new facilities these facilities were estimated to represent an extra capital cost of $215. per cow. Finally, although early weaning of calves minimized pasture needs and the costs of winter feeding of cows, this system was less profitable than pasture plus creep feeding because early weaning resulted in slower calf gains.

If pasture availability were restricted, (with pasture at less than $61. per acre) the more profitable strategy would be to pasture the cow herd but continue to have calves nurse and supplement both cow and calf feeds with corn grain, corn silage and hay.

Also, the most profitable system of pasture plus creep feeding was tested with corn stover as a winter feed. The amount of corn stover available from the land used for the creep feed was made available to the cow herd at a nominal cost of harvesting of $15.34 per tonne. If this feed were available, about .88 tonnes of stover per cow would substitute for 2.8 tonnes of corn silage but hay requirements per cow would increase by .2 tonnes to .51 tonnes per cow, winter feeding costs would decline by $13. per cow and returns over direct costs would increase to $216. per cow. Thus harvesting of corn stover to use as part of the winter feed can reduce feed costs for the cow herd by 12% and increase returns over direct costs by a comparable $13. per cow.

7.0 Conclusions and Interpretation of Results

This study used computerized beef cow-calf models to evaluate optimum feeding systems for Ontario farms in the grain corn growing areas of the province. At 1978 cost of feeds and prices for weaned calves the results suggest that creep feeding of calves would be profitable based on a growth rate of calves of just over 1 Kg per day up to the age of eight and one-half months.

The results are based on computerized feeding simulations - not on actual feeding trials - but the models were verified by reference to results obtainable by farmers and calf feeding trials at the Elora research station. Within the limitations of the method, the results indicate several conclusions.

1. The least cost winter feed for beef cow herds when the winter feed is grown on land that will grow a crop of grain corn is about 4.6 tonnes of corn silage and .31 tonnes of hay per cow.

2. Improved roughland pasture plus hay aftermath pasture is the least cost summer feed for the beef cow-calf herd when pasture costs $26. per acre.

3. At 1978 feed costs and calf prices creep-feeding of 6 week old calves beginning with one Kg per day and increasing to five Kg per day at six months of age increases the average market weight of calves by 130 Kg and nearly doubles the return over direct costs per cow.

4. Early weaning of calves which are then fed in a drylot can double the carrying capacity of the pasture. However, if the pasture limits the number of cows it would be more profitable to supplement calf feeding by creep-feeding of grain corn to calves and also supplement the cow feed by offering extra corn silage rather than weaning the calves at 45 days.

5. Drylot feeding of the cow-calf herd can be profitable at 1978 costs of feed and calf prices but this system would not be competitive with the pasture system unless costs of pasture increase to $61. per acre.

6. Corn stover, harvested from the land used to produce the grain corn creep-feed for calves, can reduce the demand for corn silage for cow winter feeds but requires extra hay to balance the protein winter feed requirements. This adjustment of the ration assuming a harvest cost of $15. per tonne for corn stover, reduces overall winter cow feed cost by about $13. per cow.

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