Optimal Calving Season on Northern Plains Integrated Livestock-Crop Farms and Ranches

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Abstract

Many Northern Plains agricultural producers are confronted with labor constraints during critical times of the production process. Calving, tillage and planting, and harvest seasons often tax a producer's labor resources. Further, the choice of calving season and crop enterprises largely determines the timing of labor demands. This mix of calving season and crop enterprise choices can lead to conflicts in labor scheduling. This study investigates alternative calving seasons and crop enterprises under various labor availability scenarios. Using a linear programming model, optimal crop plans are developed given calving season and labor availability. Results indicate that when labor is not constraining late spring calving is optimal. Only under the most severe labor constraints is the fall calving season the highest returning.

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Most beef cow producers understand that calving season significantly impacts profitability and on-farm labor demands. The determination of an economically optimal calving date is confounding by competing labor demands of the cow-calf and cropping enterprises.

Calving season determines scheduling of major activities, such as breeding, processing, vaccinating, and weaning, for the rest of the year, thereby determining when labor will be needed for that enterprise. Many northern plains operations produce crops as well as calves and have a fixed quantity of labor available to the farm/ranch. The most labor-intensive times for these operations are planting, harvesting, calving, and weaning. Planting and harvesting dates are determined by weather conditions but vary little from year-to-year. Calving season can be manipulated by varying breeding dates to accommodate the crop schedule. While it would seem that calving should occur in early spring when there is little interference with planting or harvesting, there is much less labor needed with a late spring calving herd, assuming calving occurs on pasture.

Various factors influencing the calving season argue for a late winter-early spring calving season, others argue for a late spring-early summer calving season, and yet others favor a late summer-early fall calving season. The purpose of this study is develop an economic model of a northern plains integrated crop and cow-calf producer. The model explicitly considers the trade-offs between alternative calving dates, labor constraints, feed costs, and other economic factors. We consider a finite number of scenarios and evaluate the economics of alternative calving dates. Generalizing from these scenarios, we propose a set recommendations for calving dates and crop rotations for North Dakota crop and calf producers. The model maximizes net returns to unpaid labor, management and fixed costs subject to herd size, crop acres, and labor availability.

Factors Influencing the Calving Season Decision

Alignment of labor availability with labor demands is potentially one the most important considerations in the calving decision calculus. Dr. R. Clark of the University of Nebraska (personal communication, August 16, 2001) reports that March calving cows require 0.61 hours of labor per cow while June calving cows require only 0.3 hours per cow. However, identification of calves will take longer for calves born on pasture because they are not in an enclosed area and are more difficult to capture and restrain.

Availability of labor may constrain the choice of a calving season. In 2000, the average unemployment rate in eight counties (Adams, Bowman, Dunn, Golden Valley, Hettinger, Billings, Slope, and Stark) in southwestern North Dakota was 3.1% compared to a national average of 4.0% (Labor Force Projections, 2002). Furthermore, of those employable people, an even smaller amount are qualified to work on a crop and livestock operation. Additionally, there are situations in which sufficient amounts of paid full-time labor or unpaid (family) labor are available. Each of these scenarios may warrant a different calving season. The timing of labor requirements is dependent on calving season as well as crops grown.

Additional factors, such as calf price, annual cow feed cost, the number of calves weaned, weaning weights, veterinary expenses, and cow reproductive efficiency, also influence the calving date choice. The price received for calves is determined, in part, by the seasonal price cycle for calves. From 1980-1989, the price paid to farmers for feeder calves weighing less than 500 pounds in the state of North Dakota peaked in August with the low occurring in June. For the years 1990 to 1999, the price peaked in June and reached a low in November. Figure 1.1 shows differences in monthly price averages. Calving season determines what part of the annual price cycle will be realized when calves are sold at weaning.

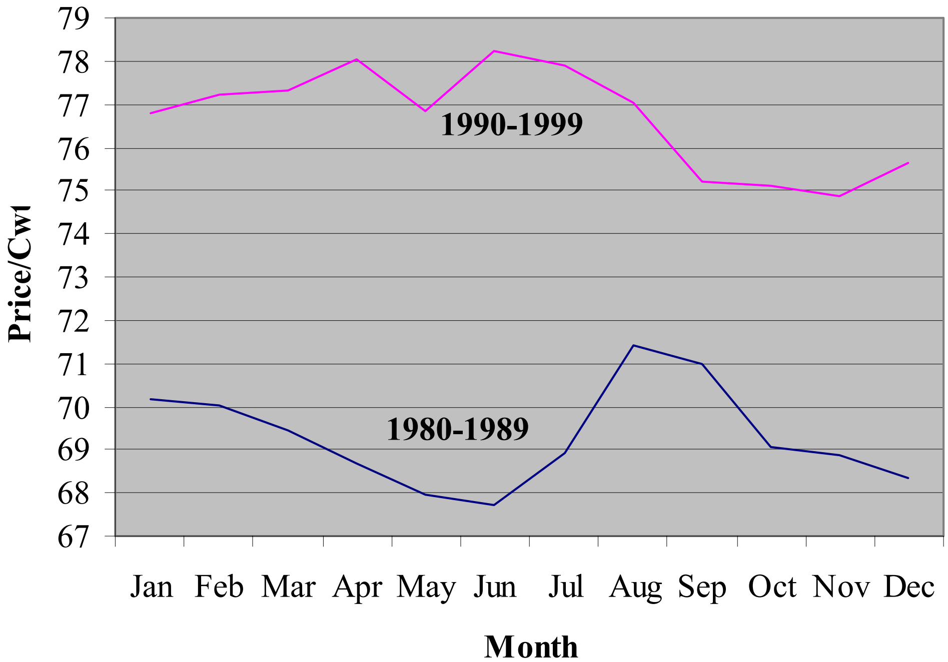

Figure 1.1. Average monthly real price per hundred weight for two 10-year intervals. All calves sold by North Dakota farmers weighing less than 500 pounds (North Dakota Agricultural Statistics Service, 1980-1999).

When a cow calves affects feed cost, which typically accounts for 65-70% of annual cow costs (Stokka, 1998). Harvested forage requirements vary depending on calving season because a cow's stage of production determines both the level of nutrients required and the time they are needed. Lowest feed costs are realized when a cow's most demanding production phases occur on pasture, therefore decreasing the amount of harvested forage needed during the winter months (Adams et al., 2001). May et al. (1998) report that a late spring calving season decreases annual feeding costs by $20 per cow under Wyoming conditions.

The number of calves weaned and pounds of calf weaned per cow exposed are also affected by calving season due to morbidity and mortality rates during different calving seasons. Late spring and fall born calves are exposed to fewer pathogens and are more likely to absorb colostral immunoglobulins because they are born during more favorable weather conditions (Stokka, 1998). The calves are exposed to fewer pathogens because calving occurs on pasture where the cow is more likely to find a secluded place to calve. Furthermore, the calves are not consistently congregating in places of shelter where disease organisms are easily spread. A North Dakota study showed that the incidence of scours was 3.8 times as likely in early calving herds as compared to late calving herds (Clement et al., 1993). A difference of this magnitude has a significant effect on veterinary costs and labor. There are also indications that less absorption of immunoglobulins occurs under stressful conditions because the calf's energy requirements are greater (Stokka, 1998). Due to these factors, medical costs will vary with calving season.

Timing of calving season influences the amount of labor needed to maintain the cow herd. An early calving season requires cows to be checked frequently so that calves can be moved to areas of shelter immediately after calving for protection from the elements. Later calving seasons do not require as intense observation because there is less threat of adverse weather conditions. Furthermore, there is less chance for sickness with later calving seasons. Less sickness equates to lower labor requirements and less money spent on calf treatment. Additionally, when cows have nutrient requirements that are more closely matched to the grazed forage, they need to be fed less supplemental forage throughout the year (May et al., 1998). The need for less supplemental forage also decreases labor demands.

Empirical Methods

A model farm (Sell and DeVuyst, 2000) is employed to represent a typical operation in southwestern North Dakota. The Sell and DeVuyst model utilizes information from the 1997 Census of Agriculture (USDA, 1997) and multiple years (1993-2000) of publications of the North

Dakota Farm Business Record Keeping program. Information included regarding the farm are cow herd numbers, crop acres for the crops typically grown in western North Dakota, costs of production, scheduling of various activities, and returns for various enterprises.

Three different calving dates are simulated using this representative farm (Table 1.): early spring (ES; March), late spring (LS; May), and fall (FC; August). A labor-constrained net return-maximization model is developed to compare net returns of the three alternative calving dates and the options for each. Labor is limited in each of the 52 weeks of the year. The model also takes into account the amount and type of labor available to the operation. Three different labor availability scenarios are evaluated. These scenarios include limited unpaid (family or operator) labor, part-time seasonal labor, and annual full-time paid labor.

Table 1. Description of calving seasons, calving dates, calving location, and weaning dates

Calving Season	Calving Dates	Calving Location	Weaning Date
Early	March 1-April 30	dry lot	October 1
Late	May 1-June 30	pasture	December 1
Fall	August 1-September 30	pasture	March 1

Depending on climate in the area, certain cropping activities can be scheduled within a range of time without having adverse effects on production. In contrast, activities involving the cow herd are automatically determined once the cows are bred, as calving starts approximately 285 days later. The programming model allocates crop acres to each enterprise subject to labor availability, an acreage constraint, and crop rotation constraints.

Data

A representative farm, having 200 beef cows and 1800 acres of cropland, is developed using various data sources. Data on biological efficiencies, morbidity (sickness rates), and mortality (death) rates are collected from various research studies in North Dakota and other states. For instance, a North Dakota study showed that calves born in herds that began calving before March 10th were 3.8 times more likely to develop scours than those that began calving after March 10th (Clement et al., 1993). A study conducted by Carriker et al. (2001) compared differences in amount of hay fed between March and June calving herds in the Nebraska Sandhills. The June calving strategy reduced the amount of hay fed during the winter by 1.5 tons per cow. Cow requirements and compositions of diets in this model are based on the Nutrient Requirements of Beef Cattle (NRC, 2000). Changes in both nutritional and health performance due to different calving seasons affect the profitability of the entire operation.

The data on labor needs for specific activities involved in crop and calf production are collected from North Dakota Agricultural Statistics Service publications and research centers across the state. Labor required for cropping activities is assumed to be a function of speed of machinery used for those activities. Monthly feeder calf and cull cow prices are collected to determine revenues. The data is analyzed according to the calving scenarios described earlier as a constrained net return-maximization model. There are a variety of constraints taken into account, including land and labor. The model determines the optimal labor and land allocation for several scenarios. The maximum expected returns are compared to determine the optimal calving season.

Data regarding feed costs, veterinary expenses, market expenses, fuel and other expenses are compiled from various sources. These data are reported in Table 2. Revenues are computed using monthly price data. Prices assume early spring (ES) calves are weaned and sold in October, late spring (LS) calves are weaned and sold in December, and fall calves are weaned and sold in March. Figure 1 shows these prices for several years and clearly demonstrates the need to consider monthly prices. Revenues include calf sales and cull cow sales.

Table 2. Beef Herd Expenses by Calving Season

Costs	Early Spring	Late Spring	Fall
Hauling	0.75	0.75	0.75
Marketing	2.43	2.43	2.43
Utilities	0.25	0.25	0.25
Fuel	10.70	10.70	10.70
Supplies	5.71	5.71	5.71
Miscellaneous	18.61	18.61	18.61
Vet/pregnancy check	6.30	6.30	6.30
Medicine	8.70	4.98	4.98
Vitamins	1.36	1.36	1.36
Minerals	3.11	3.11	3.11
Salt	0.79	0.79	0.79
Feed costs	111.32	98.35	131.29
Total Variable Expenses	$170.04*	$153.35*	$186.28

*Totals do not exactly equal the sum of listed expenses due to rounding error.

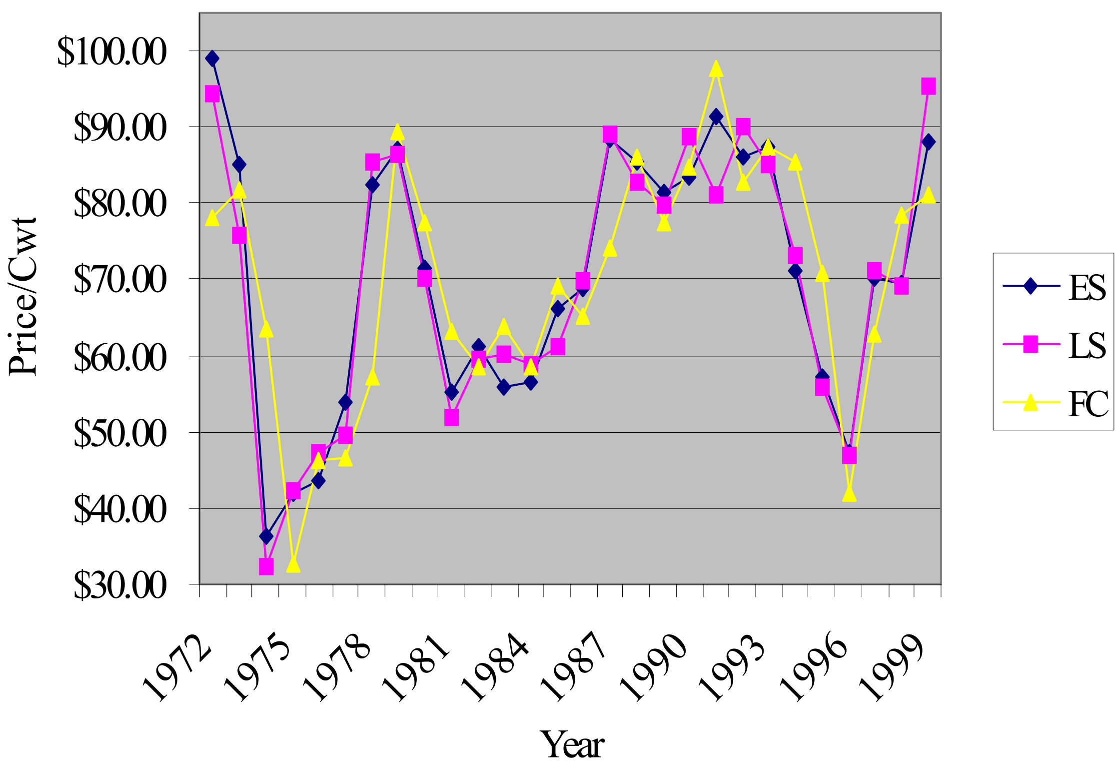

Figure 1. Comparison of monthly prices assuming Early spring (ES) sells in October; late spring (LS) sells in December; and fall (FC) sells in March.

Total revenue, total variable expenses and returns to unpaid labor, management and fixed costs per cow are reported in Table 3. Late spring born calves generate the highest returns despite having the lowest revenue. This is due to the $13 per head feed cost advantage over the next highest returning calving season, early spring. Fall calving herds generate the highest revenue but also have the highest feed expense of the calving seasons considered.

Table 3. Revenue and expenses per cow by calving seasons

Calving Date	Feed Expense	Total Variable Expenses	Revenue	Returns*
Early spring	$111.32	$170.04	$408.68	$238.64
Late spring	$98.35	$153.35	$404.54	$251.20
Fall	$131.29	$186.28	$415.08	$228.80

*Returns are to unpaid labor, management, and fixed costs.

Average returns for crops are reported in Table 4. Unpublished budgets from Sell and DeVuyst are used to generate these average returns to unpaid labor, management and fixed costs.

Table 4. Average Returns to Unpaid Labor, Management and Fixed Costs, 1972-1999,* and Labor Hours Required

Crop	Mean Return	Hours Labor per Acre
Durum	$57.82	0.389
Alfalfa	$55.94	0.465
Spring Wheat	$50.46	0.389
Canola	$48.37	0.445
Other Hay	$45.51	0.376
Barley	$29.54	0.488
Oats	$14.96	0.488
Corn	$10.70	0.717
Sunflowers	$1.86	0.435

*Data from 1972-1999 are used for all crops except canola. Canola yields and budgets are only available since 1993 for all of North Dakota and since 1998 for western North Dakota. From 1998 to 2000, western North Dakota canola returns were 74.37% of the state average returns. Returns for western North Dakota from 1993 to 1997 are computed as 74.37% of the state average returns for those years.

Model Constraints

Several constraints are imposed on the model. In addition to weekly labor constraints, rotation considerations are included. Small grains–barley, spring wheat, durum and oats–may not comprise more than one-half of the non-hay acres to prevent small grains from following small grains. Similar constraints restrict both corn and sunflower production to one-half of the non-hay acres. Data regarding days-suitable-for-field-work restrict the total labor that can be allocated each week to completing crop tasks. An additional set of constraints restricts the time window for completing various tasks. For example, corn cannot be planted before May 1 or after May 21.

Results

Three labor availability scenarios are considered. These include: 1) an operator-only labor situation with 65 hours per week of available labor; 2) an operator at 65 hours per week plus part-time seaonal labor up to 50 hours per week at $8 per hour wage; and 3) an operator at 65 hours per week plus one full-time, year-round employee providing 60 hours per week at a salary of $30,000 per year. Results for the representative farm with these three scenarios are reported in Table 4. Also reported in Table 4 are the optimal crop allocations. Crop acres are allocated to maximize returns given the calving season, labor constraints, rotational considerations, and days-suitable-for-field-work.

Of the three labor availability scenarios, operator labor supplemented with part-time seasonal labor generates the highest returns. In the operator only scenario, too little labor is available and the ability to raise alfalfa is compromised. Less profitable crops, other hay and canola, are grown. In the operator plus seasonal labor scenario, other hay is not grown. Sufficient labor is available to grow higher value crops–durum, alfalfa and canola. The final labor scenario–operator plus a full-time

Table 4. Returns by Calving Season and Labor Availability

Calving Season	Labor*	Herd Size	Crop Total	Acres Alfalfa	Canola	Durum	Other Hay	Returns to Operator Labor, Management and Fixed Costs
Early	Operator			323.2	492.3	618.9	319.8	$138,610.18
Late		200	1800	288.0	660.1	732.1	119.8	$144,338.90
Fall				512.4	579.8	707.9	-	$142,007.03
Early	Operator			930.6	318.4	551.0	-	$143,186.75
Late	Plus	200	1800	655.4	490.4	654.2	-	$145,376.49
Fall	Seasonal			512.4	579.8	707.9	-	$142,007.03
Early	Operator			1,024.5	259.7	515.8	-	$116,059.24
Late	Plus full-	200	1800	954.5	303.4	542.1	-	$117,915.89
Fall	time			1,075.5	227.8	496.7	-	$114,258.61

*Operator equals up to 65 hours of labor per week Seasonal labor is available whenever needed at a maximum of 50 hours per week with an $8 per hour wage. Full-time labor is 60 hours of labor per week at a salary of $30,000.

employee–allows for the largest allocation to alfalfa and durum. But, due to the higher labor expense, this scenario is the lowest returning.

Comparing early spring, late spring and fall calving seasons reveals very little difference in net returns. In all three labor availability scenarios, late spring calving enjoys an economic advantage of about $2,000 over the next highest returning season. For these three scenarios, the largest spread between the highest and lowest returning calving season is less than $6,000. Under the operator labor only scenario, fall calving is the second highest returning season due to fewer scheduling conflicts with higher value crops. In the other two scenarios, early spring calving is the second highest return season.

For the representative farm, a late spring calving season is the highest return of the three seasons considered. Several sensitivity analyses are completed to evaluate the robustness of this result. Up to 1800 acres, late spring is still the highest returning system under operator-only labor. At some point between 1800 and 2000 acres, a fall calving season becomes the highest returning due to fewer scheduling conflicts. With part-time seasonal labor or full-time labor available to supplement the operator's labor, late spring calving remains the highest returning up through at least 2200 acres. When herd size is varied, herds of 200 or less with operator-only labor are highest returning under late spring calving. Over 200 cows requires more labor than can be provided by just the operator. With part-time labor or full-time labor supplementing the operator's labor, late spring calving is higher returning at least through herds of 300 cows.

Conclusions

A producer's choice of a calving season has numerous impacts on his/her farming operations, including profitability and labor scheduling. For a representative farm, this study investigates the interaction between labor constraints and calving season for a integrated crop/beef-cow operation in western North Dakota. Labor budgets are developed for various crop enterprises and for the beef-cow enterprise conditional on calving season. Crop enterprise budgets are adapted from Sell and DeVuyst and other sources. Beef-cow enterprise budgets are developed conditional on calving season. The impact that calving season has a supplemental feed expenses, veterinary expenses, mortality and sales price, among other factors, are explicitly considered in the budgets.

The representative farm runs 200 beef cows and farms 1800 acres annually. Three labor availability scenarios are considered for the representative farm. These are 1) operator-only labor for 65 hours per week; 2) operator labor plus part-time seasonal labor of up to 60 hours per week with a wage of $8 per hour; and 3) operator labor plus one full-time, year-round employee providing 50 hours per week with an annual salary of $30,000. The results indicate that optimal crop acreage allocation varies by labor availability and calving season. However, the difference in returns to unpaid labor, management and fixed costs is only $2,000 between the highest and second highest returning seasons in all scenarios. The largest difference observed is about $6,000 between the highest returning and the lower returning seasons for a given scenario. In all but the most labor constrained scenarios, late spring calving is the highest returning calving season. When labor is very tightly constrained, as when acres and the herd size are increased, fall calving becomes the highest returning season.

Crop acres are allocated to alfalfa, canola, durum and other hay is the most tightly constrained labor scenario–operator-only labor. Otherwise, alfalfa, canola and durum are grown.

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