ECONOMICS OF PURCHASING GENETICALLY SUPERIOR BEEF BULLS

G. M. Clary, J. W. Jordan, and C. E. Thompson

Abstract

Net present value analysis is used to derive the marginal bid price for a beef herd sire from after-tax net revenues and cash flow influenced by genetic improvements. Marginal bid price represents the additional amount a producer could pay, above the present value of the current beef herd sire, for a sire expected to exhibit superior performance as reflected by increased average weaning weights of offspring.

An analysis of the profitability of purchasing a breeding bull for a commercial beef cow herd is presented as an application. Several alternative scenarios illustrate the impact of selected determinants on the marginal bid price of a bull.

Key words: beef bulls, genetic progress, after-tax return, bid price.

The decision to purchase a beef herd sire for a commercial or purebred beef herd requires much attention by farmers and ranchers because it involves not only additions to direct costs and revenues, but other financial aspects such as income taxes, cash flow, and leverage. Additional considerations in the herd sire purchase decision include genetic technological progress resulting from crossbreeding and the improvements possible through the selection of performance tested sires.

Much research effort has been devoted to the general principles of firm-level asset replacement by farmers and ranchers. Chisholm, Dillon (Ch. 3), Faris, Perrin, and Winder and Trant have made significant contributions to development of these principles. Studies dealing specifically with replacement strategies in beef cattle herds include Bentley et al., Rister, Kay and Rister, Rogers, and Melton. However, none of these studies specifically address the problem of determining the value of a herd sire based on improved beef herd performance, nor do they incorporate the effects of recent income tax regulations.

Capital budgeting techniques were used in this study to estimate the marginal bid price, defined as the amount a producer could pay above the amount normally spent for a herd sire. Techniques were similar to those used by Kaiser in estimating the profitability of land investments. Modifications were incorporated to account for additional factors associated with the purchase of a herd sire and additional current income tax policies.

Under current tax regulations, the purchaser of breeding stock may receive tax advantages from investment credit that directly reduce their current tax liability and regular annual depreciation allowances that reduce their annual taxable income (Penson et al.). An additional annual tax savings would result from use of financing to purchase breeding stock, since interest paid is a deductible expense.

CAPITAL BUDGETING MODEL

Net Present Value

Profitability of an investment in a herd sire can be estimated using a capital budgeting technique known as the net present value method. Net present value of a herd sire is equal to summation of the discounted net revenues over the purchaser's planning horizon. The theory of net present value and its application to agricultural decisionmaking will not be reviewed in this study because such procedures are well documented in other sources such as Kaiser, Kay, and Penson et al.

Determinants of the net present value of a herd sire include the annual net revenue realized from having the new sire in the herd, the farmer's marginal tax rate, planning horizon, discount rate, and financing arrangements. Incorporation of a genetically superior sire into a herd would impact net revenue through increased weaning weights. The period of time that the farmer plans to retain the sire in the herd (planning horizon) varies with different individuals and different herd sizes (Lasley). In small herds, where one or a few sires are used each year, replacement generally should occur more frequently to avoid inbreeding. The productive life of a sire in a particular herd could be extended if available facilities provided for keeping the sire separate from his daughters.
during the breeding season. However, the additional cost of owning a bull to breed the daughters would have to be evaluated.

The appropriate discount rate for a specific investment is the risk-free opportunity rate of return, such as the after-tax interest yield on certificates of deposit at a commercial bank, plus the risk premium to compensate the purchaser for assuming the additional risks inherent with the investment. Incorporating the above determinants in a net present value formulation gives the net present value of a herd sire purchased with borrowed capital as:

\[
\text{NPV} = \frac{\sum_{t=1}^{n} \left[ \frac{(1-T)(Y) + (1)(P')}{(1+r)^t} \right] + (5-n)(.02)(P^*)}{(1+r)^n} - \sum_{t=1}^{s} \left( \frac{1}{1+r} \right)^t (1-d)(P^* \left\{ \frac{i(1+i)^s}{(1+i)^s - 1} \right\} + \sum_{t=1}^{s} \left( \frac{1}{1+r} \right)^{(1+i)^{t-1} - 1} \right) + \\
(1-T)(SV_n - [(P^* - \sum_{t=1}^{n} (D_t)(P^*))],)
\]

\[
(1+r)^n - (d)(P^*),
\]

0 ≤ n ≤ 5 and 0 ≤ s ≤ 5,

where:

NPV = net present value of a herd sire,
Y = before-tax net revenues,
T = marginal tax rate,
P* = price of herd sire,
D_t = depreciation rate,
SV_n = salvage value,
n = planning horizon,
s = loan length,
r = desired rate of return,
d = percent of bid price paid down, and
l = interest rate on loan.

The right-hand side of Equation (1) includes the following terms: (1) summation of the discounted annual after-tax increased net revenue; (2) the discounted investment tax credit (ITC) of 10 percent (.1) received at the end of the first year; (3) the discounted proportion (20 percent per year) of the total ITC taken in the first year which is recaptured should the planning horizon (n) be less than 5 years; (4) summation of the discounted benefits from regular annual depreciation of the price (reduced by half of the ITC); (5) summation of the present value of annual loan payments; (6) summation of the present value of the annual tax savings resulting from use of financing; (7) the after tax present value of the difference (gain or loss) between the salvage value of the herd sire and its book value; and (8) the proportion of the purchase price required as downpayment when financing is used.

**Marginal Bid Price**

Producers are concerned with determining the additional amount they could pay for a genetically superior herd sire based on their individual financial situation and the additional revenues that a superior herd sire would generate (as a result of increased weaning weights). Setting NPV equal to zero and rearranging terms, the price for a herd sire purchased with borrowed capital can be expressed as:

\[
P^* = \frac{n}{\sum_{t=1}^{n} \left( \frac{1}{1+r} \right)^t (1-d) \left\{ \frac{i(1+i)^s}{(1+i)^s - 1} \right\} - \sum_{t=1}^{n} \left( \frac{1}{1+r} \right)^{(1+i)^{t-1} - 1} \right\} + \\
(1-r)\left\{ \frac{5-n)(.02)}{(1+r)^n} - \sum_{t=1}^{n} \left( \frac{1}{1+r} \right)^{(1+i)^{t-1} - 1} \right\}.
\]

This assumes the farmer has a tax liability large enough to use all the ITC in the first year.

Alternatively, the sixth term is the sum of the present value of the product of the loan balance in each year over 5 years, the interest rate, and the tax rate. This term can also be shown as:

\[
\sum_{t=1}^{n} \left( \frac{1}{1+r} \right)^t (1-d) \left\{ \frac{i(1+i)^s}{(1+i)^s - 1} \right\} - \sum_{t=1}^{n} \left( \frac{1}{1+r} \right)^{(1+i)^{t-1} - 1} \right\}.
\]

where L_t = the loan balance in year t.

The model used in this study does not incorporate the benefits or costs associated with a state income tax.
This assumption is intended to represent one of the most likely scenarios. An illustration of depreciation recapture is given by modified to include a nonequal planning horizon and loan length.

The ACRS allows for 15, 22, 21, 21, and 21 percent depreciation during the first through the fifth years of ownership, respectively. Various alternative strategies concerning the claiming and recapture of depreciation are available to producers. This assumption is intended to represent one of the most likely scenarios. An illustration of depreciation recapture is given in Penson et al.

The analysis does not reflect the longrun benefits derived from the subsequent retention and use of genetically superior dams in the herd.

Production Credit Association personnel indicated that livestock loans typically are for 3 to 5 years. The analysis could be modified to include a nonequal planning horizon and loan length.

Salvage values are based on the premise that the typical, progressive, commercial cattle producer would purchase young performance-tested bulls and resell them to another producer on a per head basis. The present analysis is not designed to treat situations in which bulls are sold for more than the initial purchase price.

Marginal tax rates may vary from year to year due to changes in income or tax deductions; however, rates were assumed constant over all years for this study.

Terms in equation (2) dealing with ITC and depreciation must be deleted when estimating marginal bid prices for producers with no tax liability.
20 percent additional pounds of calf can be weaned due to heterosis or hybrid vigor. Although this is not covered in this paper. In addition, if one considers purchasing a bull of a different breed, normally 5 weight per head, assuming a 40 percent mar-

TABLE 1. MARGINAL BID PRICE FOR PURCHASED BULL BY 
ESTIMATED GAIN IN AVERAGE WEANING WEIGHT, 
MARGINAL TAX RATE, AND PLANNING 
HORIZON ASSUMING AN 11 PERCENT 
DISCOUNT RATE, $60 PER CWT. 
Calf Price, 15 Calves Sired, 
AND NO FINANCING

<table>
<thead>
<tr>
<th>Marginal tax rate (MTR) and planning horizon</th>
<th>Gain in average weaning weight (pounds per head)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 percent MTR</td>
<td>$1,014 1,037 1,059 1,082 1,104 1,128 1,151</td>
</tr>
<tr>
<td>2 years</td>
<td>$1,204 1,221 1,239 1,256 1,274 1,292 1,310</td>
</tr>
<tr>
<td>3 years</td>
<td>$1,571 1,598 1,625 1,652 1,679 1,706 1,733</td>
</tr>
<tr>
<td>4 years</td>
<td>$1,939 1,966 1,993 2,020 2,047 2,074 2,101</td>
</tr>
<tr>
<td>5 years</td>
<td>$2,307 2,334 2,361 2,388 2,415 2,442 2,469</td>
</tr>
<tr>
<td>25 percent MTR</td>
<td>$2,674 2,701 2,728 2,755 2,782 2,809 2,836</td>
</tr>
<tr>
<td>3 years</td>
<td>$3,044 3,071 3,098 3,125 3,152 3,179 3,206</td>
</tr>
<tr>
<td>4 years</td>
<td>$3,414 3,441 3,468 3,495 3,522 3,549 3,576</td>
</tr>
<tr>
<td>5 years</td>
<td>$3,784 3,811 3,838 3,865 3,892 3,919 3,946</td>
</tr>
<tr>
<td>40 percent MTR</td>
<td>$4,154 4,181 4,208 4,235 4,262 4,289 4,316</td>
</tr>
<tr>
<td>2 years</td>
<td>$4,524 4,551 4,578 4,605 4,632 4,659 4,686</td>
</tr>
<tr>
<td>3 years</td>
<td>$4,994 5,021 5,048 5,075 5,102 5,129 5,156</td>
</tr>
<tr>
<td>4 years</td>
<td>$5,464 5,491 5,518 5,545 5,572 5,599 5,626</td>
</tr>
<tr>
<td>5 years</td>
<td>$5,934 5,961 5,988 6,015 6,042 6,069 6,096</td>
</tr>
<tr>
<td>50 percent MTR</td>
<td>$6,404 6,431 6,458 6,485 6,512 6,539 6,566</td>
</tr>
<tr>
<td>2 years</td>
<td>$6,774 6,801 6,828 6,855 6,882 6,909 6,936</td>
</tr>
<tr>
<td>3 years</td>
<td>$7,144 7,171 7,198 7,225 7,252 7,279 7,306</td>
</tr>
<tr>
<td>4 years</td>
<td>$7,514 7,541 7,568 7,595 7,622 7,649 7,676</td>
</tr>
<tr>
<td>5 years</td>
<td>$7,884 7,911 7,938 7,965 7,992 8,019 8,046</td>
</tr>
</tbody>
</table>

Physical productivity and economic efficiency are important in determining the optimal planning horizon. Marginal bid price generally increased as the length of time the bull remained in the herd increased, Table 1. However, the rate at which marginal bid price increased and the price per unit of production (either per calf or per additional weaned weight) depended on production levels and marginal tax rates. The planning horizon need not be limited to 5 years; however, all tax benefits associated with the bull purchase are accrued within the first 5 years of ownership.

Increasing the desired rate of return (discount rate), while holding other values constant, decreased the marginal bid price. The amount an individual is willing to pay would decrease as a greater rate of return is required, while holding constant the stream of revenue generated by the investment. Marginal bid prices were $1,076 for a 25 percent marginal tax rate, $949 for a 40 percent marginal tax rate, and $848 for a 50 percent marginal tax rate, based on assumptions of the initial example, except for increasing the discount rate from 11 to 14 percent.

**Financed Purchase**

Marginal bid prices were also estimated for the financed (leveraged) purchases of a bull, Table 2. These prices reflect specific assumptions regarding loan interest rates, discount rates, calf prices, and number of calves weaned as

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11 The amount of response that can be expected is equal to the product of the heritability of a trait multiplied by 0.5 (the bull accounts for one-half the genetic inheritance of the calf) multiplied by the selection differential (difference between the herd average and the bull that is to be used for breeding). Since heritability of weaning weight in beef cattle is approximately 50 percent, the response = 0.5 x 0.5 x 268 pounds or 40 pounds additional calf weight attributed to the bull. An additional benefit of purchasing a superior bull is in the daughters that he produces as herd replacements, although this is not covered in this paper. In addition, if one considers purchasing a bull of a different breed, normally 5 to 20 percent additional pounds of calf can be weaned due to heterosis or hybrid vigor.
It would be difficult to present all possible scenarios regarding the purchase of a herd bull, as each farmer and rancher faces his/her own unique physical and financial situations. Additional marginal bid prices may be estimated by changing parameter values included in the net present value formulation.

### SUMMARY AND CONCLUSIONS

Present value analysis was used to determine the marginal price that could be paid for a herd sire given a producer's desired rate of return, planning horizon, marginal tax rate, expected annual before-tax net revenue, length of loan, down payment requirement, and loan interest rate. Analyses included income tax effects in terms of investment tax credit (ITC) and depreciation, allowing for recapture of these items depending on the planning horizon, and annual interest expense.

An analysis of the profitability of purchasing a breeding bull in a beef cattle herd was presented to illustrate the application of capital budgeting techniques to the herd sire purchase decision. The marginal bid price was calculated to represent the additional amount a farmer could pay, above the value of the bull currently in the herd, for a genetically superior bull. Several alternative scenarios were designed to illustrate the impact of selected determinants on the marginal bid price of a bull. Results of additional scenarios would be useful to producers in applying this analysis to their individual farming or ranching operation.

The rather wide variation in marginal bid prices reported in this study generally resulted from the assumptions of specific situations. The length of time farmers or ranchers plan to keep the purchased bull proved to be an important determinant. Marginal bid prices often more than doubled between a planning horizon of 2 years and 5 years, especially at higher marginal tax rates and average weaning weight increases.

Certain aspects of this study point to other areas of needed research. Calculations of increases in net revenue were based on short-run improvements provided by a genetically superior bull. Further research is required to accurately incorporate long-run herd improvements into the income segment of the net present value formulation. Also, additional studies should incorporate innovative breeding programs designed by animal scientists with regard to the age at which bulls should be purchased, how long a bull should remain with a particular herd, and the expected salvage value of the bull. Changes suggested by such innovative programs could have a significant impact on the marginal bid price for a breeding bull.

### Table 2. Marginal Bid Price for Purchased Bull by Estimated Gain in Average Weaning Weight, Marginal Tax Rate, and Planning Horizon, Assuming an 11 Percent Loan, 13 Percent Discount Rate, 25 Percent Down Payment, $60 Per Cwt. Calf Price, and 15 Calves Sired

<table>
<thead>
<tr>
<th>Marginal tax rate (MTR) and planning horizon</th>
<th>Gain in average weaning weight (pounds per head)</th>
<th>0</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 percent MTR</td>
<td>2 years</td>
<td>998</td>
<td>1,286</td>
<td>1,574</td>
<td>1,862</td>
<td>2,150</td>
<td>2,438</td>
</tr>
<tr>
<td></td>
<td>3 years</td>
<td>782</td>
<td>1,192</td>
<td>1,602</td>
<td>2,012</td>
<td>2,423</td>
<td>2,833</td>
</tr>
<tr>
<td></td>
<td>4 years</td>
<td>601</td>
<td>1,120</td>
<td>1,584</td>
<td>2,030</td>
<td>2,500</td>
<td>2,999</td>
</tr>
<tr>
<td></td>
<td>5 years</td>
<td>450</td>
<td>1,068</td>
<td>1,542</td>
<td>1,868</td>
<td>2,304</td>
<td>2,722</td>
</tr>
<tr>
<td>25 percent MTR</td>
<td>2 years</td>
<td>607</td>
<td>782</td>
<td>957</td>
<td>1,132</td>
<td>1,307</td>
<td>1,482</td>
</tr>
<tr>
<td></td>
<td>3 years</td>
<td>577</td>
<td>880</td>
<td>1,183</td>
<td>1,486</td>
<td>1,789</td>
<td>2,092</td>
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<tr>
<td></td>
<td>4 years</td>
<td>528</td>
<td>985</td>
<td>1,442</td>
<td>1,899</td>
<td>2,356</td>
<td>2,813</td>
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<td></td>
<td>5 years</td>
<td>480</td>
<td>1,139</td>
<td>1,798</td>
<td>2,456</td>
<td>3,115</td>
<td>3,774</td>
</tr>
<tr>
<td>40 percent MTR</td>
<td>2 years</td>
<td>546</td>
<td>703</td>
<td>861</td>
<td>1,018</td>
<td>1,176</td>
<td>1,333</td>
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<tr>
<td></td>
<td>3 years</td>
<td>531</td>
<td>810</td>
<td>1,089</td>
<td>1,367</td>
<td>1,646</td>
<td>1,925</td>
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<tr>
<td></td>
<td>4 years</td>
<td>492</td>
<td>918</td>
<td>1,344</td>
<td>1,769</td>
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<td>2,621</td>
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<tr>
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<td>5 years</td>
<td>465</td>
<td>1,104</td>
<td>1,742</td>
<td>2,381</td>
<td>3,019</td>
<td>3,658</td>
</tr>
<tr>
<td>50 percent MTR</td>
<td>2 years</td>
<td>496</td>
<td>639</td>
<td>782</td>
<td>925</td>
<td>1,068</td>
<td>1,212</td>
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<tr>
<td></td>
<td>3 years</td>
<td>492</td>
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<td>1,524</td>
<td>1,782</td>
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<tr>
<td></td>
<td>4 years</td>
<td>461</td>
<td>859</td>
<td>1,258</td>
<td>1,656</td>
<td>2,055</td>
<td>2,454</td>
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<tr>
<td></td>
<td>5 years</td>
<td>451</td>
<td>1,071</td>
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<td>2,310</td>
<td>2,929</td>
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REFERENCES


