INCOME TAX EFFECTS ON BEEF COW REPLACEMENT STRATEGY*

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Little work has been done on the effect of income taxes on the firm-level decisions made by farmers and ranchers. Krause and Shapiro [4] identified this gap in agricultural economic research, noting that much of the published work on income taxes is descriptive rather than an analysis of the effect on firm level decision-making and resource allocation. Yet farmers make few investment or production decisions which do not affect their income tax liability for one or more years.

An exception to the usual practice of omitting income taxes from a research study is a recent article by Lin, Dean and Moore [5]. They used quadratic programming to derive an E-V (expectation-variance) boundary for after-tax income on several large California farms. Both the level and curvature were different than for the E-V boundaries based on before-tax income. This implies that maximizing utility based on after-tax income may result in a different farm plan than when using before-tax income. Chisholm [2], in an article commented on by Kay and Rister [3], reported the income tax effects on the optimum replacement age for farm machinery. Both articles found income tax regulations tended to reduce optimum replacement age, particularly at lower discount rates and higher marginal tax rates.

Owners of beef cow herds may also find income tax regulations affecting their decisions. With cash accounting, which is assumed throughout the rest of this article, a different set of tax regulations apply to purchased replacement heifers than to those which are raised. This difference in applicable tax regulations should be considered when deciding whether to buy or raise replacement heifers and what the replacement interval should be.

Under the current (1976) tax regulations, owners of beef cow herds who buy replacement breeding stock receive tax advantages from investment credit, additional first-year depreciation and regular depreciation. Investment credit is equal to 10 percent of the purchase price if a useful life of seven years or more is assigned to the replacement. This amount is reduced if useful life is from three to six years and none can be taken if useful life is less than 3 years. Purchased breeding animals are eligible for additional first-year depreciation equal to 20 percent of the purchase price provided a useful life of six years or more is used. Regular depreciation can also be taken on purchased breeding stock. A fast depreciation method can be used if a useful life of three years or more is assigned and the purchase is a new rather than a used asset.[1] These three items result in a rather marked effect on the amount of income taxes due the year in which a replacement is purchased with some effect in later years as any remaining depreciation is taken.

The cow-calf producer who raises his own replacement heifers cannot take investment credit or depreciation on these animals. Tax advantages in raising replacements come from the current deduction of expenses as replacements are being raised and from long-term capital gains when they are sold. With cash accounting, the entire income from selling raised breeding stock is subject to capital gains if the animal has been owned for at least 24 months. A taxpayer

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[1] Double declining balance and sum-of-the-year digits are considered to be fast depreciation methods since they cause much of the allowable depreciation to be claimed early in the asset's useful life.

need never pay tax on more than one-half of any income subject to long-term capital gains which can result in considerable tax savings.

THE MODELS

Whether purchasing or raising replacements will result in greater long-run, after-tax income may depend upon beef prices, cost of replacement animals, after-tax discount rate and applicable marginal tax rate. A present value model was constructed for each replacement alternative and they were used to study interaction of these factors with the applicable tax regulations in determining the optimal replacement strategy. Assuming an existing cow herd, the replacement decision has to be made the year in which a replacement heifer must be retained if the decision is to raise replacements. This is one year before the cull cow is sold and two years before the replacement heifer's first calving season.

Beginning with the year the above decision must be made, each model discounts the after-tax income and expense flow for the number of years in the replacement cycle. This value is then multiplied by the appropriate annuity factor to give the present value of a given replacement strategy for a perpetual planning horizon. The last step is necessary to fairly compare replacement intervals of varying length.

The models assume all financial transactions take place at the end of each year and are as follows:

RAISE Strategy

$$RPV_n = \frac{1}{1-(1+r)^{-n}}\left[\left[(1-t)\sum_{i=1}^{n} NR_p(1+r)^{-i}\right] + \left[(1-.5t)SV_n(1+r)^{-2}\right]\right],$$

BUY Strategy

$$BPV_n = \frac{1}{1-(1+r)^{-n}}\left[\left[(1-t)\sum_{i=1}^{n} NR_p(1+r)^{-i}\right] + [I_n(1+r)^{-2}] + [t(A_n)(1+r)^{-2}] + \left[t\sum_{i=1}^{n} D_p(1+r)^{-i}\right] + [SV_n(1+r)^{-2}] - [C_{rh}(1+r)^{-2}]\right],$$

with $p = (i-2)$ when $i > 2$,

$p = i + (n-2)$ when $i \leq 2$,

and with:

RPV_n = present value of a perpetual policy of raising replacements with a replacement interval of n years
r = after-tax discount rate
i = a year counter for discounting which runs from 1 to n
t = marginal income tax rate
NR_p = net returns in calving year p including income from calf sales less operating expenses and forage costs
SV_n = salvage value of cow after n calving seasons
BPV_n = present value of a perpetual policy of buying a replacement every n years
I_n = investment credit that can be taken with a replacement policy of n years
A_n = additional first year depreciation that can be taken with a replacement interval of n years
D_p = double declining balance depreciation in calving year p and
C_{rh} = cost of a replacement heifer.

Table 1 is an example for a four-year replacement interval ($n = 4$) showing the sequence of events and model notation. The BUY model assumes correct anticipation of salvage value which eliminates the need for considering depreciation recapture.

The model included costs typical for current central Texas conditions. Different weaning percentages, calf weaning weights and cow weights were

TABLE 1. MODEL SEQUENCE AND NOTATION EXAMPLE FOR A REPLACEMENT POLICY OF FOUR CALVING YEARS (n = 4)

Calving Yr. p= / Discount Yr. i= / Replacement Alternative	3 1	4 2	1 3	2 4
Buy Heifers	1)Sell all calves 2)Regular deprec.	1)Sell all calves 2)Regular deprec. 3)Sell cow 4)Buy replacement heifer a. Inv. Credit b. AFYD	1)Sell all calves 2)Regular deprec.	1)Sell all calves 2)Regular deprec.
Raise Heifers	1)Retain heifer calf (decreases net revenue	1)Sell all calves 2)Sell cow a. capital gain income	1)Sell all calves	1)Sell all calves

assumed for each stage of the cow's productive life and are shown in Table 2. The cow production data were chosen to provide the following averages for a cow herd with an equal age distribution from two to ten years: 90 percent calf crop, 485 pound steer calves and 460 pound heifer calves. While other physical production data may affect the optimal replacement age and possibly points at which the BUY or RAISE decision changes, it should not affect any of the trends or tendencies identified in the results.

The cost for purchased replacement animals was considered at four levels from $450 to $225 per head. A relationship between the prices for steer calves, heifer calves and cull cows were estimated from 1955-1974 Forth Worth data by Rister [6] and used in this study. Steer calf prices of $.30, $.40, $.50 and $.60 per pound were used with the corresponding heifer calf and cull cow prices calculated from the estimating equations. No limit was placed on forage availability with the required quantity charged as an expense when calculating net revenue. This makes the results applicable to a situation where a constant herd size is maintained and necessary forage and pasture purchased or rented.

Both the BUY and RAISE models were evaluated for each possible replacement age for a single animal. That replacement system and replacement age which maximized the present value of the stream of after-tax net income under a specific combination of prices, tax rate and discount rate was selected as optimal.

RESULTS

Table 3 includes the optimal replacement strategies for combinations of two after-tax discount rates, three marginal income tax rates, four beef price levels and four replacement costs. While different operating expenses, price relationships between calves and cull cows and physical production data may change the points where the BUY or RAISE decision is changed, results indicate some tendencies which should hold regardless of changes in these items.

The discount rate had little effect on optimal replacement strategy. Results were the same for after-tax discount rates of 1 percent, 5 percent and 10 percent. Using a 15 percent rate, three more BUY stragegies were indicated than for the lower rates. Only two discount rates are shown in Table 3 to conserve space.

The marginal tax rate did affect the results obtained from the present value models. At higher tax rates, the RAISE strategy is favored as tax savings on income subject to capital gain become increasingly important. At the 70 percent tax rate, the optimal replacement strategy is RAISE regardless of replacement cost, discount rate or beef price. Even for those situations where BUY is indicated at low replacement costs and higher beef prices, capital gains may be influencing the results. At some of these combinations, selling price for cull cows is above

TABLE 2. ASSUMED PHYSICAL PRODUCTION DATA

Age of Cow	Calving Year	Weaning Percentages	Calf Weaning Weights Steers	Calf Weaning Weights Heifers	Cow Weights
2	(1)	70%	435	414	821
3	(2)	80%	455	433	905
4	(3)	85%	476	453	986
5	(4)	90%	500	476	1041
6	(5)	95%	500	476	1100
7	(6)	95%	500	476	1100
8	(7)	95%	500	476	1100
9	(8)	95%	500	476	1100
10	(9)	95%	500	476	1100
11	(10)	93%	490	467	1100
12	(11)	90%	476	453	1075
13	(12)	86%	459	437	1050

TABLE 3. OPTIMAL REPLACEMENT STRATEGIES*

Discount Rate	Marginal Tax Rate	Steer Calf Price	Replacement Cost $450	$375	$300	$225
5%	22%	$.30	Raise^{a}(10)	Raise^{a}(10)	Raise^{a}(10)	Buy^{d}(10)
		$.40	Raise^{a}(10)	Raise^{a}(10)	Raise^{c}(10)	Buy^{b}(9)
		$.50	Raise^{a}(10)	Raise^{a}(10)	Buy^{d}(9)	Buy^{a}(9)
		$.60	Raise^{a}(10)	Raise^{c}(10)	Buy^{a}(9)	Buy^{a}(7)
5%	48%	$.30	Raise^{a}(9)	Raise^{a}(9)	Raise^{a}(9)	Raise^{b}(9)
		$.40	Raise^{a}(9)	Raise^{a}(9)	Raise^{a}(9)	Raise^{d}(9)
		$.50	Raise^{a}(9)	Raise^{a}(9)	Raise^{b}(9)	Buy^{c}(7)
		$.60	Raise^{a}(6)	Raise^{a}(6)	Raise^{c}(6)	Buy^{a}(5)
5%	70%	$.30	Raise^{a}(3)	Raise^{a}(3)	Raise^{a}(3)	Raise^{a}(3)
		$.40	Raise^{a}(3)	Raise^{a}(3)	Raise^{a}(3)	Raise^{a}(3)
		$.50	Raise^{a}(3)	Raise^{a}(3)	Raise^{a}(3)	Raise^{a}(3)
		$.60	Raise^{a}(3)	Raise^{a}(3)	Raise^{a}(3)	Raise^{a}(3)
10%	22%	$.30	Raise^{a}(10)	Raise^{a}(10)	Raise^{b}(10)	Buy^{d}(9)
		$.40	Raise^{a}(9)	Raise^{b}(9)	Raise^{d}(9)	Buy^{b}(9)
		$.50	Raise^{a}(9)	Raise^{c}(9)	Buy^{d}(9)	Buy^{a}(9)
		$.60	Raise^{b}(9)	Raise^{e}(9)	Buy^{b}(9)	Buy^{a}(7)
10%	48%	$.30	Raise^{a}(9)	Raise^{a}(9)	Raise^{b}(9)	Raise^{c}(9)
		$.40	Raise^{a}(9)	Raise^{a}(9)	Raise^{b}(9)	Raise^{e}(9)
		$.50	Raise^{a}(9)	Raise^{b}(9)	Raise^{c}(9)	Buy^{c}(7)
		$.60	Raise^{a}(6)	Raise^{b}(6)	Raise^{e}(6)	Buy^{b}(7)
10%	70%	$.30	Raise^{a}(3)	Raise^{a}(3)	Raise^{a}(3)	Raise^{b}(3)
		$.40	Raise^{a}(3)	Raise^{a}(3)	Raise^{a}(3)	Raise^{b}(3)
		$.50	Raise^{a}(3)	Raise^{a}(3)	Raise^{a}(3)	Raise^{b}(3)
		$.60	Raise^{a}(3)	Raise^{a}(3)	Raise^{a}(3)	Raise^{a}(3)

*The optimal replacement stragegy (RAISE or BUY) which maximizes the present value of after-tax income is shown for each combination of discount rate, marginal tax rate, beef price and replacement cost. The sensitivity of each indicated strategy in terms of the difference in present value over the alternative strategy is shown by a superscript with the following values.

a: $>$ $100
b: $50 – $100
c: $25 – $50
d: $10 – $25
e: $<$ $10

The optimal replacement age in number of calving years is shown in parentheses for each replacement strategy.

replacement cost, which generates some income subject to capital gains under the BUY strategy. Lower replacement cost would be expected to favor BUY, but this is reinforced at the higher beef prices by the resulting capital gains which compensate, in part, for that received with a RAISE strategy. However, at the higher tax rates the larger amount of income subject to capital gains received from selling a raised cow negates the lower replacement cost of the BUY alternative and causes the replacement strategy to be RAISE for all price and cost combinations.

While the main focus of the study was not to determine optimal replacement ages, they are included in Table 3. Keeping in mind that the optimal replacement ages would likely be different using a different set of physical production data, some tendencies are still apparent. For marginal tax rates below 48 percent, the RAISE strategy shows a predominate 9 or 10 calving-year replacement policy. The assumed physical production begins to decline with the tenth calving year indicating a cow should not be kept past the point where calf weaning percentage and/or calf weaning weights begin to decline.[2] At the 70 percent tax rate, the indicated replacement age is uniformly at three calving years or before the cow has reached her full physical production capability. However, income subject to capital gains becomes a higher proportion of total income as the replacement age is lowered. The tax savings on this income at high rates causes higher after-tax income even though total before-tax income is less.

CONCLUSIONS

The results reported here apply to a cow herd fixed in size with required forage varying with replacement strategy and age. Necessary forage is purchased or leased. Under these conditions, raising replacement heifers is generally preferable to buying replacements when maximizing long-run, discounted, after-tax income. A BUY replacement strategy is indicated only for some unlikely combinations of low replacement costs and high beef prices and is favored at somewhat lower marginal tax rates.

This study implicitly assumes equal productivity for both replacement strategies. To the extent this may not be true for a given producer, the results would be different. Other factors such as availability of an adequate number of quality replacements, the possibility of introducing disease into the herd via purchased animals, calving problems with first-calf heifers and cross-breeding programs will also influence the replacement strategy selected by an individual herd owner.

With a limited amount of forage available, another factor enters into the BUY or RAISE decision. Raising replacements with a limit on forage availability will result in a smaller producing cow herd than when replacements are purchased. The forage required by the replacement herd leaves less available for producing cows and their number must be reduced. This would be expected to change some of the replacement strategies to BUY.

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[2]Bentley, et al. [1] obtained somewhat shorter replacement ages in their study. However, their cow production data was lower than that used in this study and it began to decline in the seventh year.