OPTIMAL ECONOMIC RANGE COW CULLING DECISIONS: BIOLOGICAL AND MARKET FACTORS COMBINED

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This is the third in a series of three articles addressing culling decisions. The first article addressed biological considerations while the second article focused on market considerations. This article focuses on combining the biological and market considerations to increase profits. These decisions must take into account the dynamic aspects associated with the culling decision. That is, cows kept in the herd will become one year older and on average have a different; chance of calving, calf weaning weight, cow weight, and chance of remaining fit for the herd. Also, future returns and expenses are discounted so that all economic comparisons are made with current dollars.

Optimal economic culling decisions are made for two basic scenarios. The first scenario assumes that the rancher has the ability to only calve cows once a year (i.e., spring calving). The second scenario assumes that a rancher has the ability to breed and calve cows at two different times during the year (i.e., spring and fall calving). The latter scenario has about a six month time lead for bringing an open cow back into production. For example, if a cow is tested open in the fall, this cow couldn't be bred until the following summer with only spring calving. Whereas, if calving is possible in both fall and spring, this cow has the opportunity to be bred in late fall and brought into production six months earlier than with only spring calving possible. When looking at culling decisions, six months has a noticeable difference on economic profitability.

On average, market price conditions are higher for eight month old weaned calves sold in the spring than in the fall as pointed out in the second article on market conditions. However, calves born in the fall and weaned in the spring are expected to be five percent lighter than calves sold in the fall from spring calving. These differences, among others pointed out in the previous two articles, are accounted in the optimal economic culling decisions.

Costs associated with selling a cull cow and bringing a replacement into the herd are also important. For the costs associated with selling a cull cow, this analysis used a 4% shrink, $.01/lb. trucking cost, and a sale commission equal to 1.5% the gross selling price. The cost of bringing a bred replacement heifer on the ranch was $10/head for veterinary costs and $10/head for trucking costs.

The optimal culling decisions and associated economic results are presented in Figure 1 through Figure 3b as decision trees. A decision tree is simply a branched structure where a choice must be made at each branch. Imagine a cat climbing a tree. At each branch the cat must make a decision on which way to go. Decision trees are simply upside down trees where at each branch you must decide which way to go. For the culling decision model presented, the decision of which way to go at each branch is determined by: cow age, cull cow prices, calf prices, or replacement cow prices. When you run out of branches the decision on whether to cull or keep a cow is revealed. For example, consider the case of open cows in the fall with both spring and fall calving possible. This situation is depicted in the decision tree in Figure 2. If current replacement prices are $850/head, current calf prices average $95 and cull cow values are $650/head, should a 5 year old open cow be kept or culled? A "replace" is put in the top box of Figure 2 indicating that the optimal economic decision would be to replace an open cow if no further criteria was utilized. But the first decision on which direction to go is made on the basis of age. The cow was identified as 5 years old so the left branch is chosen (i.e., 5 < 7.5 years of age). Replacement prices determine the direction to take at the next branch. Since the current replacement price of $850/head is greater than $695, the right branch is chosen. Calf prices determine the direction for the next branch. Calf prices are $95/cwt., thus the right branch should be taken. Another decision is made on replacement prices. Replacement prices are greater than $805/head so the right branch is chosen. Cull cow values determine the direction at the final decision branch. If your cow's cull value is less than $768/head, which it is at $650/head, our economic model says that you should keep this cow. The terminal box or node for this scenario is box #13.

Table 1. Economic Values that are Associated with the Terminal Boxes from Figure1.

Terminal Box Number	Optimal Cull Value	Cost of Mistake	Chance of Box Occurring
1	$1,552	$49	0.1057
2	$1,464	$24	0.0044
3	$1,557	$3	0.0024
4	$1,779	$7	0.0046
5	$1,771	$13	0.0061
6	$1,592	$99	0.4649
7	$1,384	$500	0.0144
8	$1,917	$23	0.0007
9	$1,830	$74	0.0139
10	$1,873	$14	0.0001
11	$1,984	$12	0.0003
12	$1,762	$179	0.0062
13	$1,784	$95	0.0645
14	$1,873	$108	0.0196
15	$1,841	$19	0.0030
16	$1,794	$26	0.0064
17	$1,598	$246	0.0032

Tables 1 through 3 give the optimal expected returns for each terminal box or node displayed in Figure 1 through Figure 3b. For example, Table 2 and box #13 gives an optimal value of $1,574. This optimal decision value represents our estimated value for this slot in the herd for the next 15 years when a correct (keep for box #13) decision is made, given our initial price conditions. The expected cost of making a mistake is also given. This cost is a "one year" culling mistake since it is assumed that optimal culling decisions are made after the "one year" mistake. If the same culling decision mistake is made year after year the costs will add up. The cost of making a "one year" mistake at box #13 is $43/head.

Tables 1 through 3 also give the chance that on average a cow would end up in a box. These chances are based on the herd fertility and market conditions presented in the first two articles. Thus, the chance of being in any box is dependent on the chance of a cow falling into a given age bracket, the odds of a cow being open or pregnant, and the chance of market conditions represented by every terminal node existing. The sum of all chances occurring from both pregnant and open cows doesn't sum to 1

Table 2. Economic Values that are Associated with the Terminal Boxes from Figure 2.

Terminal Box Number	Optimal Cull Value	Cost of Mistake	Chance of Box Occurring
1	$1,412	$12	0.0098
2	$1,367	$46	0.0114
3	$1,548	$34	0.0245
4	$1,426	$32	0.0119
5	$1,474	$2	0.0020
6	$1,640	$32	0.0116
7	$1,438	$67	0.0118
8	$1,416	$43	0.0011
9	$1,580	$8	0.0015
10	$1,549	$33	0.0005
11	$1,545	$19	0.0015
12	$1,693	$31	0.0042
13	$1,574	$43	0.0030
14	$1,703	$13	0.0020
15	$1,505	$106	0.0622

because these chances only include cows that were fit to breed (i.e., these chances don't include cows that died or became unfit to remain in the herd). Terminal boxes that have a relatively high chance of occurring and a large "cost of mistake" should be given close attention. However, the culling decision is often more obvious for these cases. For example, terminal box #6 from Table 1 has a "cost of mistake" at $99 and a relatively high chance of occurring at about 47% probability. This decision rule reinforces the economic reality that under typical price conditions it makes economic sense to keep a pregnant cow. Box # 7 from Table 1 indicates that the cost of keeping a cow beyond the age of 13.2 years of age is quite large at $500 since it was assumed that the cow would die if kept beyond 14 years of age.

Even if some market price and cow age situations rarely occur, large "cost of mistake" values are important on an individual cow basis when found in those specific situations. For example, terminal box #23 from Table 3 and Figure 3b indicates that the cost of keeping a pregnant cow with spring only calving is quite high at $221. For box #23, market prices are such that replacement prices are less than $805/head, calf prices are less than $80/cwt., cull cow values are above $493/head, and the cow exceeds 11.75 years in age. When replacement values are not real high and the odds of getting a high priced calf out of an older cow are not great (i.e., calf price less than $80/cwt.), economic results suggest that you should replace this cow, even though she is pregnant.

Figures 1 and 2 plus Tables 1 and 2 represent culling decisions where both spring and fall calving are possible. Our economic results indicated that the value expected for an average slot in the herd for the next 15 years was $1,561 when both spring and fall calving were possible. However, this value slipped by $100 to $1,461 when only spring calving was possible. This translates to an estimated 6.8% increase in herd profitability by having both spring and fall calving instead of just spring calving. Much of the difference between these two calving systems is attributed to the economic profitability of the open cow. When only spring calving is considered, our results indicate that it is never optimal to keep an open cow. Irrespective of how high replacement prices may be and even if the cow is at a prime age, our economic model indicates that it is always more

Table 3. Economic Values that are Associated with the Terminal Boxes from Figures 3a and 3b.

Terminal Box Number	Optimal Cull Value	Cost of Mistake	Chance of Box Occurring
1	$1,444	$48	0.0748
2	$1,396	$9	0.0053
3	$1,643	$13	0.0049
4	$1,517	$19	0.0109
5	$1,720	$30	0.0068
6	$1,494	$74	0.1373
7	$1,794	$19	0.0023
8	$1,625	$7	0.0072
9	$1,796	$20	0.0019
10	$1,559	$129	0.2778
11	$1,467	$42	0.0216
12	$1,720	$10	0.0019
13	$1,650	$34	0.0038
14	$1,786	$13	0.0001
15	$1,899	$31	0.0004
16	$1,781	$104	0.0196
17	$1,769	$11	0.0024
18	$1,717	$41	0.0025
19	$1,355	$118	0.0310
20	$1,309	$14	0.0032
21	$1,415	$29	0.0108
22	$1,245	$26	0.0040
23	$1,256	$221	0.0068
24	$1,335	$6	0.0037
25	$1,317	$25	0.0078
26	$1,146	$20	0.0004
27	$1,283	$91	0.0050
28	$1,532	$120	0.0437
29	$1,461	$21	0.0031
30	$1,636	$56	0.0072
31	$1,460	$42	0.0049
32	$1,315	$15	0.0015
33	$1,504	$15	0.0013
34	$1,640	$4	0.0009
35	$1,621	$32	0.0017
36	$1,331	$680	0.0015

profitable to replace an open cow in the fall with a bred replacement heifer. The six month time jump associated with bringing an open cow into production under a dual calving season translates into almost a 7% increase in herd profitability, for the herd estimated.

A simple culling rule is to cull all cows that are open and keep all cows that are less than 12.5 years of age and pregnant in the fall. However, a representative slot in the herd has a value of only $1,414 for this type of culling strategy, with only spring calving possible. This translates into 3% less profit than if culling decisions were made optimal with spring only calving (Figures 3a and 3b for pregnant cows plus culling all open cows) and over 10% less profit than if optimal culling decisions were made given that both spring and fall calving were possible (i.e., Figures 1 and 2).

It should also be pointed out that the culling decisions and economic values presented are for cows with production potentials as reported in the first article of this series. A particular cow could have either a better or worse production potential. The best use for this information is as a guide to help you judge whether individual cows in your herd should be kept or replaced. If our model recommends culling a specific cow but the cost of making a mistake (according to the model) is low then you should feel free to use your own knowledge and judgment to determine whether this cow should be culled or kept. On the other hand, if our model projects a large cost of making a mistake and your judgment does not agree with the model then you should try to find out why the model is wrong. Review the first article in this series to check if our biological productivity estimates and costs by age group are representative of your particular situation? Review the second article to check if our market price predictions are out of line with your expectations. Calculate the expected economic profits of replacing or keeping a particular cow. Going through such a process should help you fine tune your culling strategy for your specific conditions. It might even convince you that there is value on having information quickly available to you at culling time on past cow performance and cow age.

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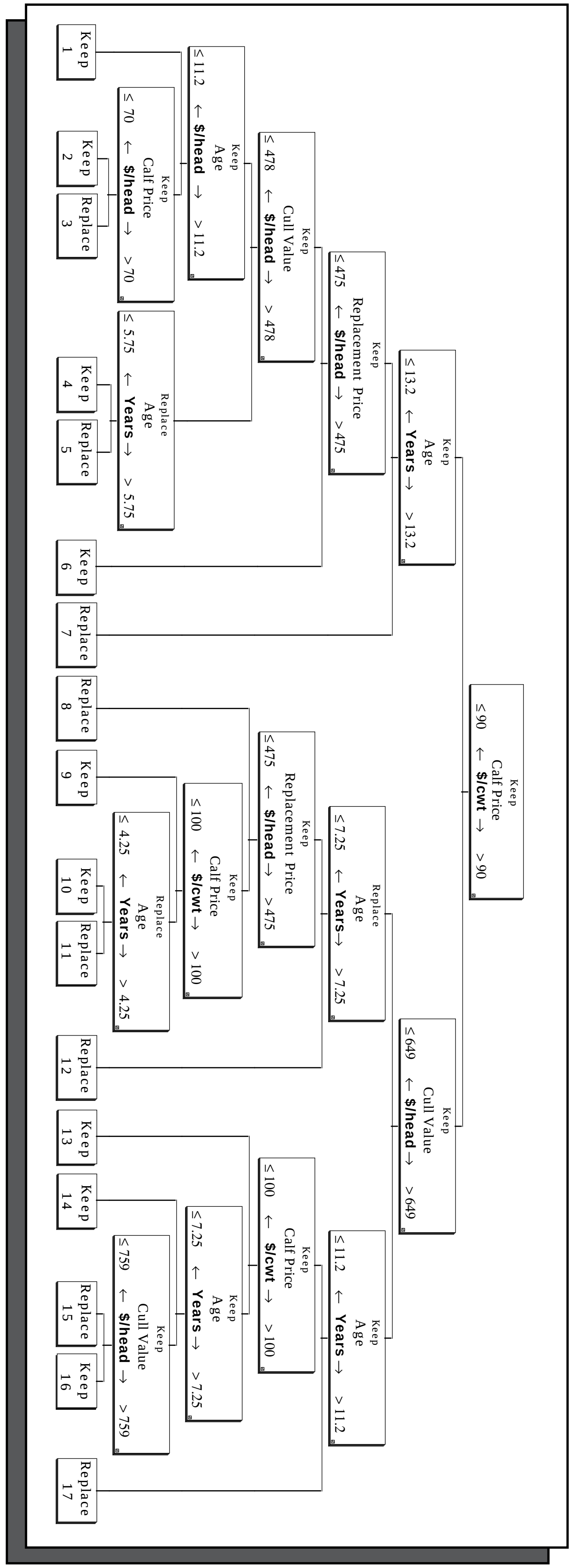
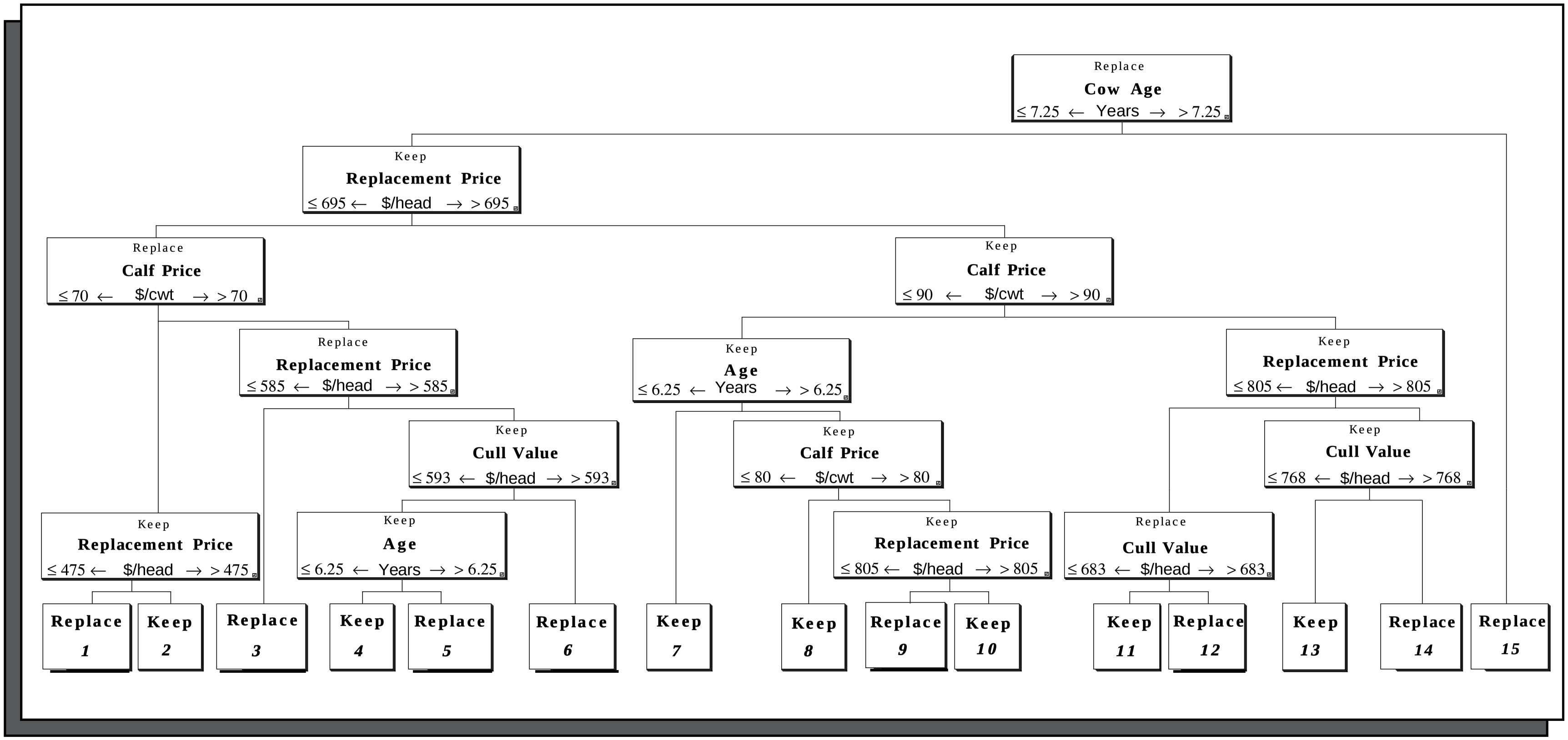


Figure 1. Decision Tree for Pregnant Cows in the Fall when Spring and Fall Calving are Possible.

Figure 2. Decision Tree for Open Cows in the Fall when Spring and Fall Calving are Possible.



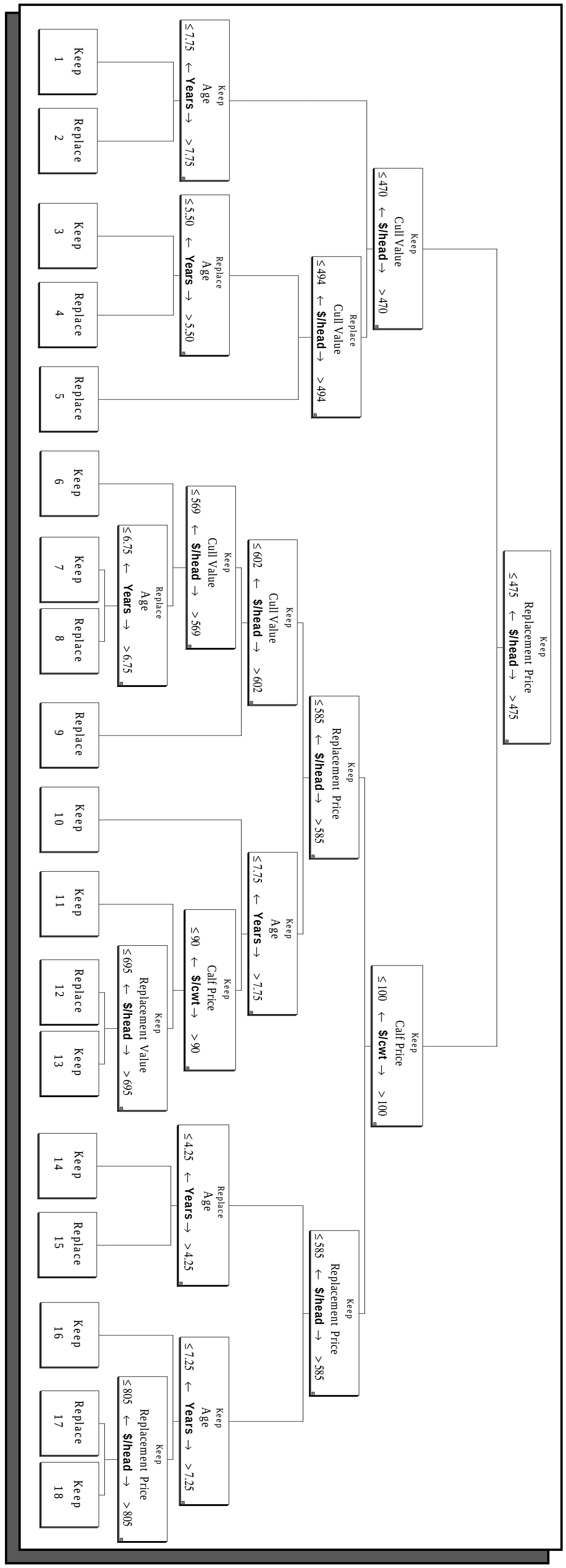
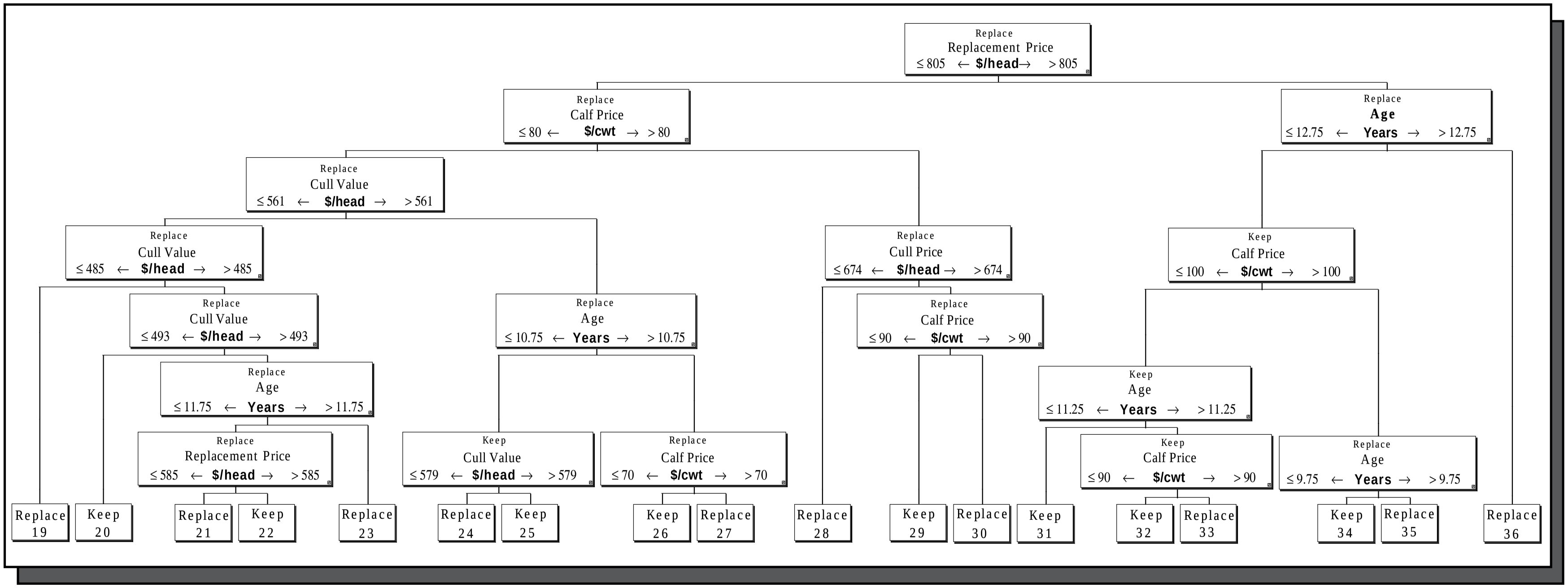


Figure 3a. Decision Tree for Pregnant Cows in the Fall that are Younger than 8.75 Years of Age when only Spring Calving is Possible.

Figure 3b. Decision Tree for Pregnant Cows in the Fall that are Older than 8.75 Years of Age when only Spring Calving is Possible.



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