FEEDLOT: A DECISION ANALYSIS MODEL

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SUMMARY

The study aimed at the development of a decision-aid model for the feedlot production activity. Decision trees were used to determine optimal strategy for beef cattle management during the dry season. Results showed that feeding the animals with high total digestive nutrients content rations, aiming at higher weight gains, was the best alternative available. When managers belief, with probability equal to or greater than 0.3, that the economy is in the descendent phase of the beef price cycle, them selling the feeder cattle is the best strategy.

Introduction

Feedlot is a recent economic activity in Brazil. Without experience on the activity it is difficult for farmers to forecast variables related to the business. Besides technical risks involved in normal feedlot, tropical countries price risks are probably higher than in nontropical countries, because most of its feeder cattle is fattened on grass only. This makes supply heavily dependent on climate conditions that prevail during the dry season. Furthermore, in 1986 government closed the beef futures market for several months. People lost confidence in the market. This prevent Brazilian farmers from hedging in order to reduce price risks. As is generally known, when comes to price forecast, the performance of econometric models is much poorer than that of future markets (Irwin, 1989 and Kassouf, 1988).

This work reports the building of a decision model to help farmers from the central region of Brazil make decisions on whether to feedlot or not. It is estimated that feedlots provide less than 5% of the total amount of beef produced in the country (Correa, 1986). In general, poor weather conditions prevent fattening of animals on grass from July to October. Beef real price goes up during this period, picking on October-November. Feedlot may be economically viable during these months, if price differentials are big enough and if higher rates of live daily weight gains can be attained.

The case of "Well Managed Farm" is studied. Its feedlot activity is typical for the region. Animals of different races and ages may be used by other farms, but the basic problem of deciding whether to feedlot or not during the dry season is common to most of them. By changing specific coefficients and probabilities, the model can be adapted for use in a larger group of farms. Next section shows the model for the studied case. It is followed by a section with results and incorporation of information on the long run beef price cycle. Last section concludes with best strategies and opportunities of developing a software to help farmers make decisions on feedlot activities.

Decision Analysis Model: A Case Study

Well Managed Farm is a mainly cattle breeding and raising farm from the northern region of State of São Paulo, Brazil. It has approximately 3,000 heads of zebu cattle (Nelore). Through artificial insemination, 200 half blood Nelore-Charolais steers and heifers are produced yearly. They reach an average weight of 320kg at age 20-22 months and are well adapted to the weather conditions of the region.

In order to evaluate the best strategy to be followed by managers of the case studied farm, a decision tree was built. Figure 1 shows the tree with its four strategies: (a) to feed the animals with high total digestive nutrients (TDN) rations (CONFALRD) in order to attain higher daily weight gain; (b) to feed the animals with medium TDN rations (CONFMDRD) trying to achieve medium daily weight gain; (c) to let them only on pasture grazing and minerals (EMPASTA) and finally, (d) to sell the feeder cattle immediately (VENDE).

Feeding the animals with high energy rations will likely yield higher daily weight gain (1.2kg/animal). However, it may yield medium (0.95kg/animal) or low (0.70kg/animal) daily weight gain, although the probabilities associated with these outcomes are low. These three chance outcomes exhaust the possibilities of attaining different daily weight gain if animals are fed high TDN rations. If, alternatively, animals are fed medium TDN rations, which cost less than high TDN rations, farmers may expect only two possible outcomes: either the animals will gain medium level daily weight, with high probability, or they may attain low daily weight gain, with low probability. Probabilities associated with each chance node are parenthesized in Figure 1.

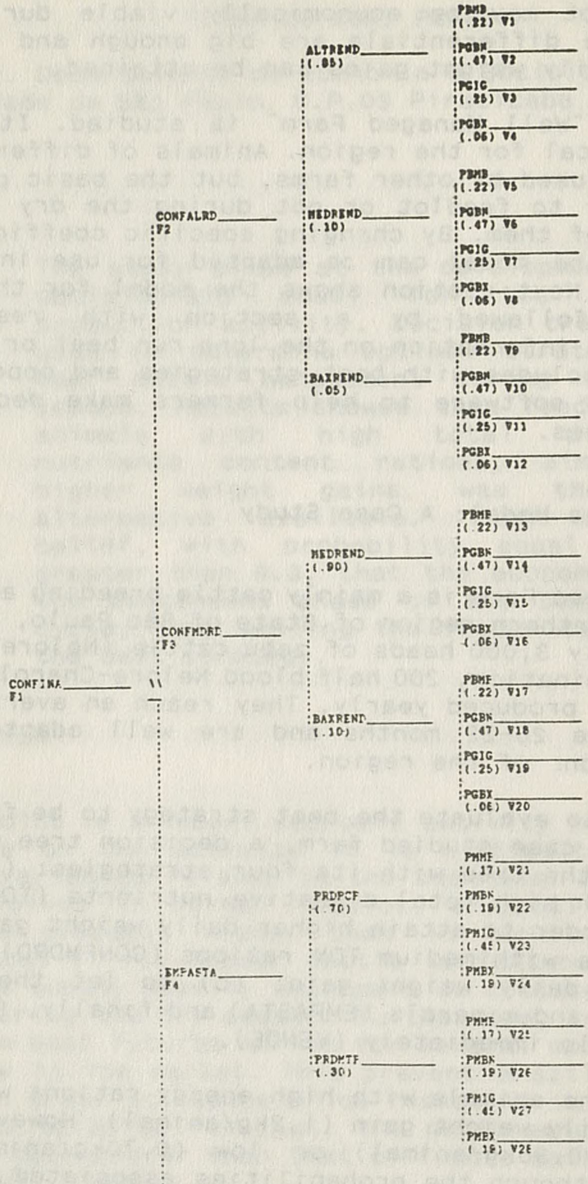

Figure 1. CONFINA Tree, with probabilities

As seen in Figure 1, for each chance node that shows alternative daily weight gain per feedlot, there are four possible price increase levels expected by the farmer. A very high price increase (PBMB=+70%), a medium price increase (PGBN=+30%), a no price increase (PGIG), and a price reduction (PGBX=-30%). The corresponding values for the strategy of letting the feeder cattle only on pasture during the dry season are: a very high price increase (PMMB=+50%); a medium price increase (PMBN=+25%); a low price increase (PMIG=+5%), and a price reduction (PMBX=-20%). Finally, the last strategy corresponds to selling the feeder cattle at the beginning of the dry season (July). This is a non-risk strategy.

Managers of Well Managed Farm do not have good estimates of the probabilities of beef real price increases (or decreases) from the end of June, when decisions about feedlotting or not have to be made, to the end of October, after four months of feedlot activities. Based on data of Brazilian beef prices that prevailed from 1954 to 1989, collected by CEPEA/FEALQ probabilities for each (arbitrary) class of price differentials for both finished and feeder cattle were estimated. These estimates were presented to the managers and were immediately accepted as good approximations to theirs degree of believe. Figure 1 shows the probabilities associated with each class of price differentials.

Based on their expertise, Animal Nutritionists provided estimates for the probabilities of attaining alternative daily weight gains for each treatment. Their suggestions were shown to the managers and accepted as good estimates. Well Managed Farm managers provided estimates for the probabilities of stock animals to loose weight during the four months dry season. PRDPCP and PRDMTP are chance nodes that correspond to stock animals on grass, loosing little (5%) or a lot (15%) of live weight during the period. They also indicated that a discount rate of 0.7% per month or 2.83% for the four months should be used in bringing money figures to present values.

Figure 2 contains a series of values (V_i), each associated with an end node, whose formats are given by the expression ((PXJ*dddd)/RT) - (CTRX + DSPX) where PXJ is the July price received by farmers for 15kg of meat (arr) of finished animals (X=G) or of feeder cattle (X=M). dddd are four digit numbers that embody a series of coefficients of weight gains and percentages of price increase for each possible outcome. They result from the product of the initial carcass weight (12 arr) plus the daily weight gain per animal, times 120 days, times 0.55 (the expected percentage of carcass yield over live weight) divided by 15, times 200 (number of animals) times the percentage (%/100) weight increase in price. As an example, 5882 - the dddd value for V_1 - is the one decimal place rounded result of (12+(1.2*120*0.55)/15) times 200*1.7. CTRX is the cost of rations (X=A for high TDN rations and X=M for medium TDN rations).DSPX are expenses with medicines, veterinary expenses, minerals, and labor for feedlot animals (X=E) and medicines, veterinary expenses, minerals, labor, and renting of pasture land for grazed animals (X=P). Since feedlot activity requires four months to be completed, returns ought to be compared on the same time period basis. A discount rate (RT) must be chosen to provide the necessary reduction of cash flow to an specified point in time.

Rations corresponding to strategies CONFALRD and CONFMDRD cost, respectively, US$23,760.00 and US$21,600.00 for 200 heads. Other expenses for the feedlot were common to both strategies and amounted to US$10,118.00. They included maintenance of buildings and equipment, machinery operation, vaccines, medicines, veterinary expenses, and labor costs. Strategy EMPASTA, on the other hand, had expenses (DSPP) that amounted to US$4,343.00 for the 200 heads, over the four months. They included labor, vaccines, medicines, veterinary expenses and pasture rent.

Two criteria were used to solve the model: maximization of expected return and maximization of expected utility. Arborist, a Texas Instrument software, was used to solve the model. In evaluating utilities, a quadratic approximation to the true utility function of Well Managed Farm managers was estimated to the relevant returns range, according to so called ELCE method presented in Anderson, Dillon, and Hardaker (1977, p.70). Present values of gains over strategy VENDE ranged from a maximum of US$75,290.00 to a minimum of -US$60,660.00 (loss). The adjusted utility function was

$$U(R) = 0.605836 + 0.007592\ R - 0.000032\ R^2 \quad (1)$$

which showed risk aversion, as expected. R was measured in thousands of US$ in the equation. Since utility functions are invariant up to linear transformations, its range was limited to the interval from 0 to 1.

Results and Simulations

Figure 2 shows the solved model for the maximization of expected return problem. The strategy of feeding high TDN (CONFALRD) rations reveals the highest expected value. Also, feeding medium TDN (CONFMDRD) rations presented expected values higher than the non-risk strategy VENDE although the difference was much smaller. Strategy EMPASTA, corresponding to letting the feeder cattle on pasture only, during the dry season, showed the lowest expected value.

Dollar prices of both finished and feeder cattle were exceptionally high in June/90. Managers of Well Managed Farm indicated two causes to explain it. First, exchange rates are known to be overvalued. Secondly, they believe that new upward movements are in order with the long term beef price cycle. Furthermore, the dollar price of corn -feedlot rations main

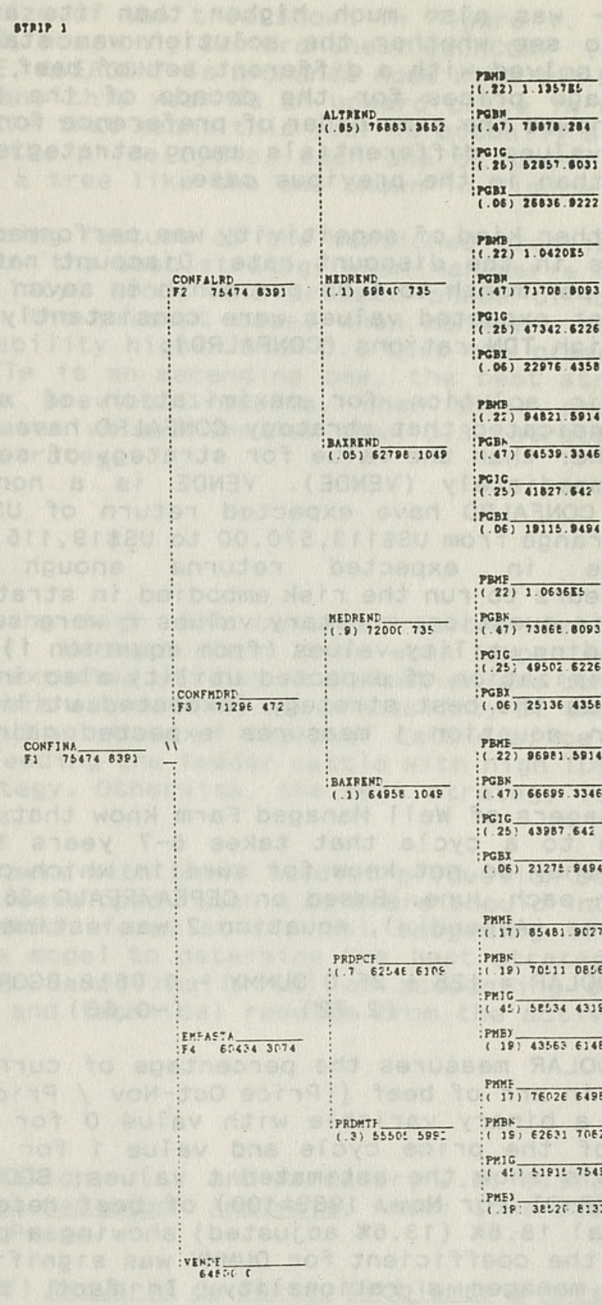

Figure 2. CONFINA Tree, with expected returns.

component- was also much higher than its average for last decade. To see whether the solution was stable or not, the model was solved with a different set of beef and corn prices. When average prices for the decade of the 80's were used, results showed the same order of preference for the strategies. Expected values differentials among strategies were smaller, however, than in the previous case.

Another kind of sensitivity was performed. It allowed for variations in the discount rate. Discount rate was increased from 0.5% per month to 1.0% per month in seven equal intervals. The highest expected values were consistently associated with feeding high TDN rations (CONFALRD).

Basic solution for maximization of expected returns problem indicated that strategy CONFALRD have expected returns 18.6% higher than the value for strategy of selling the feeder cattle immediately (VENDE). VENDE is a non-risk strategy. Although CONFALRD have expected return of US$75,475.00, its outcomes range from US$113,570.00 to US$19,115.00. Is the 18.6% difference in expected returns enough to compensate entrepreneurs to run the risk embodied in strategy CONFALRD? To answer this question, monetary values V_i were substituted by the corresponding utility values (from equation 1) in the decision tree. Maximization of expected utility also indicated strategy CONFALRD as the best strategy (expected utility=.67). Notice that R in equation 1 measures expected gains over strategy VENDE.

Managers of Well Managed Farm know that beef prices vary according to a cycle that takes 6-7 years to be completed. However, they do not know for sure in which part of the cycle one is in each June. Based on CEPEA/FEALQ 36 years series of beef prices (Appendix), equation 2 was estimated:

$$BGDOLAR = 125 + \underset{(2.72)}{25.0}\ DUMMY - \underset{(-0.65)}{0.0612}\ BGORIGP \qquad (2)$$

where BGDOLAR measures the percentage of current dollar price increase in arr of beef {(Price Oct-Nov / Price May-Jun)*100}; DUMMY is a binary variable with value 0 for descending parts (years) of the price cycle and value 1 for ascending parts; parenthesis show the estimated t values; BGORIGP is the real price (IGP-DI for Nov. 1989=100) of beef received by farmers. R^2 is equal 18.6% (13.6% adjusted) showing a poor explanation, although the coefficient for DUMMY was significant. Equation 2 confirms manager's rationality. In fact, dry season price differentials are higher during ascending parts of the price cycle.

Based on equation 2, new price brackets were defined for each part of the cycle with their corresponding probabilities: four price differential levels for the ascending part of the cycle and four for the descending part. A new tree was built with twice the size of the tree shown in Figure 1. Its first decision node had, now, only two branches: QUERCONF (decide to feedlot) or VENDE. QUERCONF is a chance node with two branches. ECLALTA, that means this year is an upward price in the price cycle, and ECLBAIXA that means this year is actually a downward price period in the price cycle. Each one of these two last nodules sustains a tree like the one shown in Figure 1.

An interesting feature of the mentioned tree is that it allows one to know the best strategy when manager's degree of believe (probability) about the present phase of the price cycle varies. In the present case, when managers assessment indicates a probability higher than 0.3 that the present phase of the price cycle is an ascending one, the best strategy is CONFALRD like in previous results. When their probability assessment indicates values smaller than 0.3, strategy VENDE became the best strategy.

Conclusions

Feedlot using high TDN content rations is the best strategy for Well Managed Farm both when expected income maximization and expected utility maximization are considered. When decision makers estimate of the probability of the economy being in an ascending phase of the beef cattle price cycle is higher than 0.3 feeding the feeder cattle with high TDN rations is the best strategy. Otherwise, the best strategy is to sell the feeder cattle.

To help farmers with their feedlot production decisions, a software may be developed. Such a software should include (a) minimum price ration formulation, (b) budgeting of feedlot activities, (c) a model to determine the best strategy, as in the present study, and finally (d) an accounting system to measure economic and technical results from the activity.

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Appendix

BEEF PRICES AND PRICE DIFFERENTIALS

BGDOLAR 1/	BGIGP89 2/	BMDOLAR 1/	BMIGP89 2/	DUMMY	BGORIGP 3/	ANO
81.66	120.44	76.38	112.60	0	108.18	54
124.91	111.71	114.17	102.16	0	129.86	55
175.14	98.17	157.25	88.20	1	114.97	56
112.73	111.31	109.18	107.81	1	97.30	57
90.48	106.46	87.26	102.71	0	104.71	58
109.82	122.54	103.91	115.85	0	111.50	59
150.95	126.61	131.89	110.65	1	150.72	60
125.45	116.19	109.11	101.10	1	164.25	61
96.80	113.58	92.31	108.33	1	162.47	62
144.83	122.10	119.16	100.53	0	141.33	63
106.71	114.65	97.78	104.90	0	130.33	64
122.05	111.28	134.28	122.44	1	131.57	65
119.14	106.51	100.84	90.17	1	196.15	66
124.49	115.79	112.30	104.46	0	132.93	67
103.02	109.69	95.67	101.85	0	134.98	68
120.11	113.92	99.97	94.73	0	129.84	69
126.48	121.54	134.85	129.66	1	146.24	70
105.46	104.86	111.44	110.80	1	177.62	71
119.81	117.16	110.01	107.58	1	184.43	72
176.50	168.53	150.37	143.56	1	205.96	73
96.28	97.33	83.43	84.33	0	255.76	74
107.50	104.88	97.27	94.90	0	210.33	75
105.44	100.83	89.50	85.58	0	187.14	76
140.35	138.02	122.46	120.41	1	161.87	77
158.54	155.07	136.08	133.11	1	201.92	78
140.65	133.13	118.39	112.06	1	294.07	79
130.17	109.29	107.31	90.10	0	272.79	80
111.23	116.87	85.75	90.08	0	177.69	81
112.59	116.38	111.44	115.14	0	154.42	82
151.73	144.15	130.36	123.80	0	172.93	83
116.89	114.12	108.18	105.63	1	223.17	84
213.85	203.17	159.00	151.03	1	125.18	85
161.02	154.28	146.29	140.27	1	217.58	86
117.82	111.96	112.40	106.84	0	160.80	87
169.43	161.99	147.21	140.69	0	134.36	88
68.06	57.55	55.07	46.63	0	263.81	89

1/ Price increase from Oct-Nov. over May-Jun. (official US$)
2/ Price increase from Oct-Nov. over May-Jun. (IGP-DI of FGV)
3/ Real price of 15kg (arr) of beef. (IGP-DI of FGV)
DUMMY is equal 1 for ascending phases of the beef price cycle
Source of data: CEPEA/FEALQ.