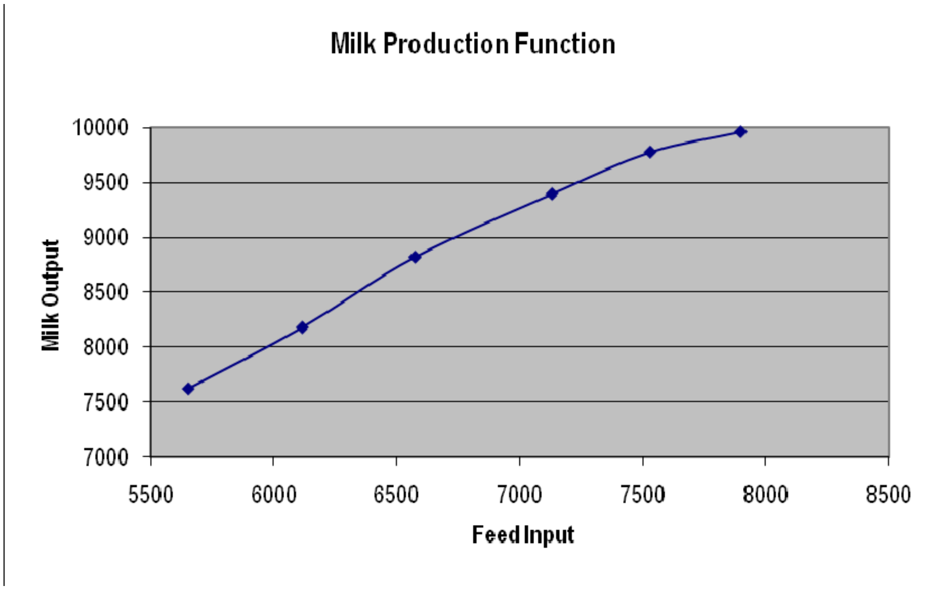
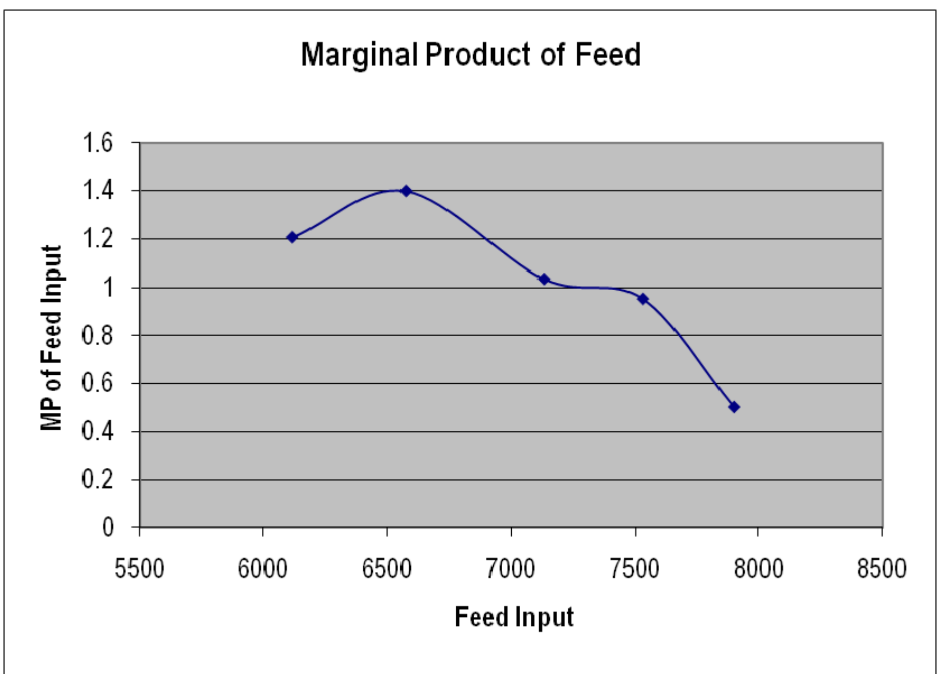
1. Graph the production function and the marginal product curve for feed based on the numbers in Table 1. Do they follow the patterns that Pindyck & Rubinfeld's Chapter 6 represents as typical?

The production function and marginal product function are shown below:





Although the production function looks almost linear, it has the usual shape, which is shown more clearly by the marginal product curve that moves upward and the downward as we often depict.

2. Calculate the actual cost values for each of the six feed levels in Table 1. Do the approximations in Table 2 seem to represent them faithfully? Be sure to consider units carefully, remember that the farm in question has 25 cows, and that each cow consumes 3,000 pounds of feed for free by grazing.

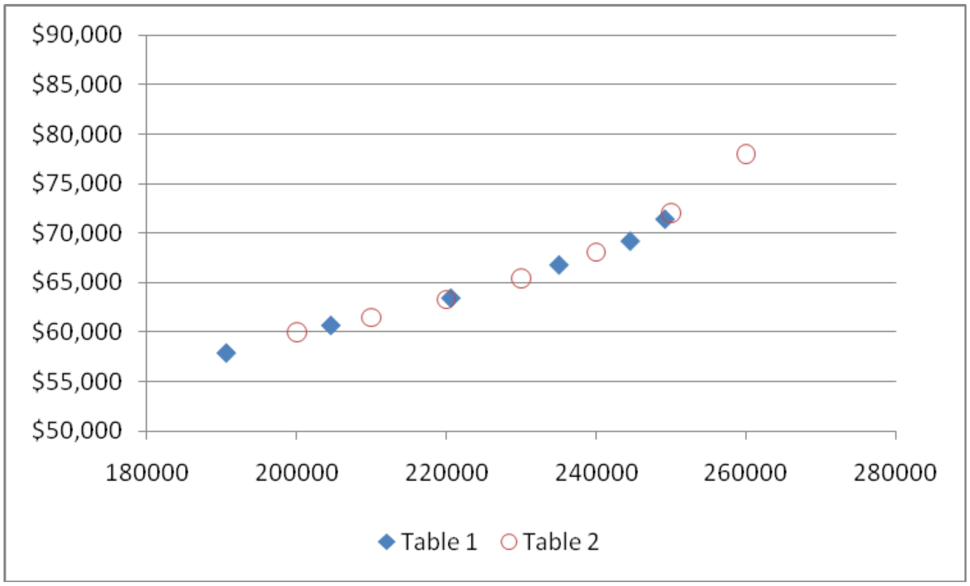
1	2	3	4	5	6	7	8
Milk output per cow	**Total milk output**	**Nutrient input per cow**	**Purchased nutrient per cow**	**Total purchased nutrient**	**VC = total nutrient cost**	**FC = Fixed cost**	**TC = Total cost**
pounds	*pounds*	*pounds*	*pounds*	*pounds*	*dollars*	*dollars*	*dollars*
7,626	190,650	5,654	2,654	66,350	15,924	42,000	57,924
8,184	204,600	6,117	3,117	77,925	18,702	42,000	60,702
8,824	220,600	6,575	3,575	89,375	21,450	42,000	63,450
9,400	235,000	7,132	4,132	103,300	24,792	42,000	66,792
9,780	244,500	7,531	4,531	113,275	27,186	42,000	69,186
9,965	249,125	7,899	4,899	122,475	29,394	42,000	71,394

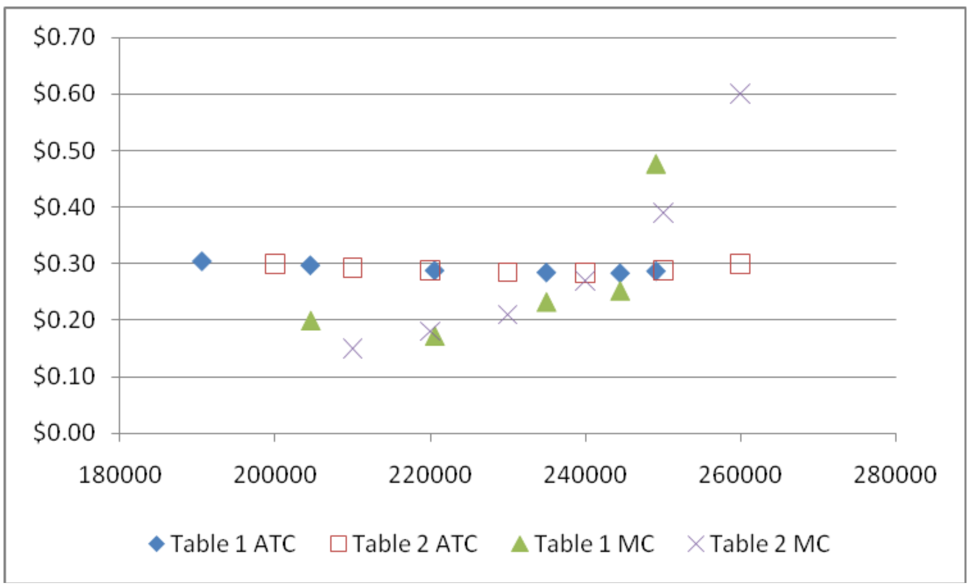
The table above summarizes the results. Columns (1) and (3) come directly from Table 1 of the case. Column (2) translates the "per cow" numbers from column (1) into total output by multiplying by 25 cows. Column (4) subtracts 3,000 from column (3) to reflect the 3,000 pounds of nutrient that each cow gets "free" from grazing. Column (5) multiplies the purchased nutrient per cow in column (4) by 25 cows to get total nutrient purchased. Column (6) is variable cost, which is obtained by multiplying nutrient purchased (5) times the price of nutrient ($0.24/lb). Fixed cost (7) is given at $42,000, and total cost (8) is the sum of variable cost (6) and fixed cost (7).

Columns (2) and (8) (shaded orange above) give output and total cost values that are claimed to be comparable to Table 2 in the case. The next problem shows how well the data from Table 2 correspond to the calculations from Table 1.

3. Graph the corresponding total, average, and marginal cost curves based on Table 2 and on your calculations from the previous problem. Are they similar to Pindyck & Rubinfeld's typical curves? (Since the units differ, you should put total cost on one graph and average and marginal on a second. *Remember that cost curves relate costs to output, not to input, so you need output or the change in output in the denominator of your calculations and the level of output on the horizontal axis.*)

The first figure below plots together the calculated total cost values from Table 1 and the values given in Table 2. The values do correspond well, so it seems that the writers of the study faithfully represented the production data in Table 1 with the cost data in Table 2.





The lower figure above shows the correspondence between the average-total and marginal cost curves. The marginal cost figures don't appear to line up quite as cleanly because of scaling issues, but the Table 2 curves are clearly "smoothed" approximations of those in Table 1.

4. Based on the data in Table 3, what shape does the long-run average cost curve have for the dairy industry? Explain how you reached that conclusion.

Average costs are declining for all levels of production in Table 3, but they decline rapidly at low output levels and very slowly at the highest levels. This suggests that the LRAC slopes downward throughout the range of output levels shown in the table, but that it levels out to be close to flat at the highest level.

5. For a dairy farm, what are fixed inputs and what are variable inputs in the short run? Does it seem likely (from what you know about farming, not from the table) that the short-run average cost curves have the U shape that we usually draw, as shown by the ATC curve in Pindyck & Rubinfeld's Figure 7.1 on page 222? Show in a diagram how the six hypothetical short-run ATC curves (one for each category of farm in the table) would relate to the long-run average cost curve you discussed in the previous question.

The fixed inputs are the ones shown in Table 2. The only variable input is feed. Is seems very likely that the ATC curves would have the usual U shape, and this is corroborated by the one drawn in the figure in problem 3. The diagram of ATC curves and LRAC curve would look like Pindyck and Rubinfeld's Figure 7.1, except that the LRAC curve in this case does not turn upward within the range of output shown in our tables.

6. Do the data indicate the presence of increasing, constant, or decreasing returns to scale in dairy farming? If you found increasing or decreasing returns, do you think that if farms were to become large enough (i.e., much bigger than the ones in the table) the increasing/decreasing returns would cease?

The data suggest economies of scale, which are probably due to increasing returns to scale. If dairy farms became large enough, it is likely that the LRAC curve would turn upward and there would be decreasing returns to scale due to management inefficiencies. However, it appears that farms must be larger than the largest Census class in 1964 in order to reach this level.

7. Based on this analysis of costs, would you expect that dairy farms should have increased or decreased in size since 1964? Is this conclusion supported by what you know about trends in farm size? (If you have time, you may want to explore library sources or the Internet for data on the current distribution of farms by size.)

With economies of scale, there would be a tendency for farms to grow in size in order to lower average costs. This does seem to have continued since the 1960s.