**AAE 320 Fall 2019** **Exam #1** **Name: KEY**

**1) (10 pts.)** *Based on material covered in class*, are these True or False? Mark your answer.

a) T_X_ F___ Almost half of the world's farmed cranberries are grown in Wisconsin.

b) T___ F_X_ USDA data shows that most (75%) of Wisconsin farms are fairly large with more than $500,000 in annual sales.

c) T___ F_X_ As Dr. Brian Luck discussed, it's still a few years before fertilizer can be applied using field prescription maps that vary on less than a 5 acre grid.

d) T_X_ F___ As Dr. Brian Luck discussed, most farmers will likely use crop consultants or other specialists to manage their data and make management decisions.

e) T_X_ F___ One reason farmers use too much of some inputs (put some more on) is that underuse is obvious, overuse is invisible and the inputs are low cost.

**2) (10 pts.)** You manage a small vegetable farm. This table reports how many bags of potatoes are dug, cleaned, and ready for sale in one hour with different numbers of workers.

| Workers Hired | Bags/Hour | Marginal Product | Value of Marginal Product |
|---|---|---|---|
| 3 | 50 | -- | -- |
| 5 | 75 | 12.5 | 25 |
| 7 | 95 | 10 | 20 |
| 9 | 105 | 5 | 10 |

a) Using numbers given in this table, show below how to calculate the Marginal Product for one example, and then fill in the Marginal Product column in the table above.

*MP = ΔQ/ΔX = (75 – 50) / (5 – 3) = 25/2 = 12.5*

b) Potatoes sell for $2/bag. Using numbers from this table, show below how to calculate the Value of Marginal Product for one example, and then fill in the Value of Marginal Product column in the table above.

*VMP = P x MP = 2 x 12.5 = 25*

c) What optimality condition defines the profit maximizing amount of the input to use? (Be brief and to the point.)

*VMP = r (the cost of the input)*

d) If wages, taxes, materials, etc. cost you $25.00/hour to hire a worker, what is the profit maximizing number of workers to hire? (You may need to interpolate between entries.)

*VMP = r at 5 Workers*

**3) (10 pts.)** You are a farmer considering whether to switch from regular corn to food-grade (non-GMO) corn. Food-grade corn has a lower yield and higher price, plus different seed and pesticide costs. Regular corn yields 200 bu/ac and its seed costs $100/ac. Food-grade corn yields 150 bu/ac and its cost for seed and extra insecticide is $85/ac. The price for regular corn is $3.00/bu, but $4.00/bu for food-grade corn.

a) Use the information given above to conduct a partial budget analysis of this switch in corn type planted by filling in the table below. Show your calculations in the space provided.

<table>
<tr><td colspan="2">Benefits</td><td colspan="2">Costs</td></tr>
<tr><td colspan="2"><u>Additional Revenues</u><br>What new revenue will be generated?<br><br>With food grade corn, new revenue is<br>150 bu/ac x $4/bu = $600</td><td colspan="2"><u>Additional Costs</u><br>What new costs will be added?<br><br>With food grade corn, new cost is $85/ac<br>for seed and insecticide</td></tr>
<tr><td colspan="2"><u>Costs Reduced</u><br>What costs will be eliminated?<br><br>No longer pay $100/ac for regular seed</td><td colspan="2"><u>Revenues Reduced</u><br>What revenues will be lost?<br><br>Lose revenue from regular corn<br>200 bu/ac x $3/bu = $600</td></tr>
<tr><td>Total Benefits</td><td>$700/ac</td><td>Total Costs</td><td>$685/ac</td></tr>
<tr><td colspan="3">Total Benefits – Total Costs = Net Benefit</td><td>$15/ac</td></tr>
</table>

b) Based on your results, considering only the money earned, is switching to growing food-grade corn a profitable change? Briefly explain.

*Yes, the net benefit or profit gain would be $15 per acre for growing food grade corn. The lower yield is exactly made up for by the higher price for food grade corn and the cost for seed and insect control is lower by $15/acre.*

**4) (3 pts.)** Based on the "Nitrogen and Agriculture" materials, which of the following are practices farmers are encouraged to adopt to help reduce nitrogen losses to the environment

- □ Maintain buffers of grass, trees and wet lands around water bodies
- □ Use soil and crop tissue testing to determine how nitrogen much crops actually need
- □ Plant cover crops recycle nutrients and improve the soil
- □ Develop nutrient management plans based on university guidelines
- □ Account for the nitrogen in applied manure and previous crops like alfalfa or soybeans
- ■ All of the above

**5) (16 pts.)** Soybean yield as a function of seeding rate is $Q = 3 + 2S - 0.01S^2$, where yield Q is total bushels of soybeans harvested per acre and the seeding rate S is thousands of seeds planted per acre. The soybean price is \$9 per bushel and the price of seeds is \$0.35 per thousand seeds.

a) What is the economically optimal seeding rate (S) to plant? Set up and solve this economic problem using calculus and this information. **Check the second order condition**.

*Set up:* $\pi = 9(3 + 2S - 0.01S^2) - 0.35S$

*FOC:* $d\pi/dS = 9(2 - 0.02S) - 0.35 = 0$

*Solve FOC:*
$9(2 - 0.02S) = 0.35$
$2 - 0.02S = 0.35/9 = 0.039$
$2 - 0.039 = 0.02S$
$S = 1.961 / 0.02 = 98.05$ (or 98 thousand seeds per acre)

*SOC:* $d^2p/dS^2 = 9(-0.02) = -1.8 < 0$ passes SOC for maximum

b) At the seeding rate you derived in part a, what is the soybean yield (bushels per acre)?

$Q = 3 + 2S - 0.01S^2 = 3 + 2(98) - 0.01(98)^2 = 102.96$ bu/acre (or 103 bu/ac)

c) Besides the cost of seeds, other costs are \$800/acre. What are net returns (\$ per acre)?

$\pi = 9(103) - 0.35(98) - 800 = \$92.70$/acre

$\pi = 9(102.96) - 0.35(98.05) - 800 = \$92.32$/acre

**6) (10 pts.)** Feeder pigs fed these corn and soybean meal rations gain 1.6 pounds per day.

| Corn (lbs) | Soybean Meal (lbs) | Marginal Rate of Technical Substitution | |
|---|---|---|---|
| 9.8 | 7.5 | *If Corn = X* | *If Corn = Y* |
| 10.5 | 6.5 | *1.43* | *0.70* |
| 11.6 | 5.5 | *0.91* | *1.10* |
| 12.5 | 4.9 | *0.67* | *1.50* |

a) Using numbers from this table, show below how to calculate the Marginal Rate of Technical Substitution between corn and soybean meal for the second row in the table and then fill in the missing entries in the table above.

*RTS = –ΔY/ΔX*
*Do it one of these two ways, depending on if Corn is X or Y*
*If Corn = X: MRTS = –(6.5 – 7.5)/(10.5 – 9.8) = 1.0/0.7 = 1.43*

*If Corn = Y: MRTS = –(10.5 – 9.8)/(6.5 – 7.5) = 0.7/1.0 = 0.70*

b) What optimality condition defines the profit maximizing amount of both inputs to use? (Be brief and to the point.)

$MRTS = \frac{r_x}{r_y}$

c) If corn cost \$0.10/lb and soybean meal costs \$0.13/lb, what is the profit maximizing level of each to feed? (Note: you may need to interpolate between entries.)

*Do it one of these two ways, depending on if Corn is X or Y*
*If Corn = X:* $\frac{r_x}{r_y}$ *= 0.10 / 0.13 = 0.77*

*If Corn = Y:* $\frac{r_x}{r_y}$ *= 0.13 / 0.10 = 1.30*

*In either case, this equality between the price ratio and MRTS happens roughly at the mid-point between the 3rd and 4th rows or at Corn = (11.6+12.5)/2 = 12.05 and Soybean Meal = (5.5+4.9)/2 = 5.2, which is the optimal feed ration*

d) If the cost of soybean meal decreased and corn cost did not change, the economically optimal soybean meal would increase, but would economically optimal corn increase or decrease?

Optimal corn use would decrease.

**7) (20 pts.)** Corn yield is $Y = 10 + 20N - 0.1N^2 + 30S - 0.3S^2 - 0.1NS$, where Y is corn yield as bushels per acre, N is pounds of nitrogen fertilizer per acre and S is thousands of seeds planted per acre. The corn price is \$3 per bushel, the price of nitrogen fertilizer is \$0.4 per pound, and the price of seeds is \$3 per thousand.

What is the profit maximizing amount of nitrogen (N) and seeds (S) to use per acre to grow corn (Y)? (Note: you will not need to convert prices to set up the profit function.)
**Be sure to check the second order conditions.**

2 pts *Set up:* $\pi = 3(10 + 20N - 0.1N^2 + 30S - 0.3S^2 - 0.1NS) - 0.4N - 3S$

*FOCs:* $d\pi/dN = 3(20 - 0.2N - 0.1S) - 0.4 = 0$
$d\pi/dW = 3(30 - 0.6S - 0.1N) - 3 = 0$

4 pts
2 each

*Solve FOCs:* $3(20 - 0.2N - 0.1S) = 0.4$ — *There are multiple ways to solve this.*
$20 - 0.2N - 0.1S = 0.4/3 - 0.133$ — *This is one way to solve it.*
$20 - 0.133 - 0.1S = 0.2N$
$19.866 - 0.1S = 0.2N$
$N = 99.33 - 0.5S$ — *Substitute this into the 2nd FOC*

4 pts

$3(30 - 0.6S - 0.1N) = 3$ — *First simplify the 2nd FOC*
$30 - 0.6S - 0.1N = 1$
$30 - 0.6S - 0.1(99.33 - 0.5S) = 1$
$30 - 1 - 0.6S - 9.933 + 0.05S = 0$
$19.067 = 0.55S$
$S = 19.067/0.55 = 34.67$

2 pts

$N = 99.33 - 0.5S = 99.33 - 0.5(34.67) = 81.995 = 82$

*SOC:* $d^2\pi/dN^2 = 3(-0.2) = -0.6 < 0$ *passes*
$d^2\pi/WN^2 = 3(-0.6) = -1.8 < 0$ *passes*
$d^2\pi/dNdW = 3(-0.1) = -0.3$

4 pts

$(-0.6)(-1.8) - (-0.3)^2 = 1.08 - 0.09 = 0.99 > 0$ *passes*

**8) (12 pts.)** The table below reports the cost of producing free-range organic eggs on a farm.

1/4 pt per entry, 2 pts total

| Eggs (dozens/year) | Fixed Cost | Variable Cost | Total Cost | Marginal Cost | Average Variable Cost | Average Total Cost |
|---|---|---|---|---|---|---|
| 1,800 | 2,000 | 1,100 | *3,100* | *---* | *0.61* | *1.72* |
| 2,000 | 2,000 | 1,400 | *3,400* | *1.50* | *0.70* | *1.70* |
| 2,150 | 2,000 | 1,700 | *3,700* | *2.00* | *0.79* | *1.72* |
| 2,250 | 2,000 | 2,000 | *4,000* | *3.00* | *0.89* | *1.78* |

a) Using numbers from this table, show below how to calculate Total Cost, Marginal Cost, Average Variable Cost, and Average Total Cost for 2,000 dozen eggs in the table and then fill in the missing values in the rest of the table.

4 pts
1 each

*TC = FC + VC = 2,000 + 1,400 = 3,400*
*MC = ΔTC/ΔQ = (3,400 – 3,100) / (2,000 – 1,800) = 300/200 = 1.5*
*AVC = VC/Q = 1,100 / 2,000 = 0.70*
*ATC = TC/Q = 3,100 / 2,000 = 1.70*

b) What optimality condition defines the profit maximizing amount to produce? (Be brief and to the point.)

2 pts

*P = MC*

c) If the farmer sells eggs wholesale for $2.50 per dozen, what is the profit maximizing number of eggs to produce? (Note: you may need to interpolate between entries.)

2 pts

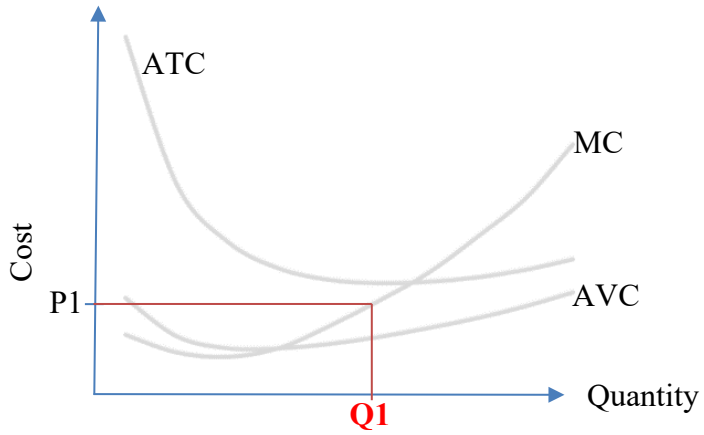
*MC = $2.00 with Q = 2,150 and MC = $3.00 at Q = 2,250, so MC would be $2.50 right in the middle at Q = (2,150 + 2,250)/ 2 = 2,200*

d) At this price, is the farmer making a profit? How do you know?

2 pts

*Yes, because the market price P of $2.50 exceeds the ATC of around $1.75 at that level of Q*

**9) (9 pts.) Short Answer:** Answer each of the short questions below.




3 pts if know MC is supply curve and can identify where Q1 is

The figure above plots Marginal Cost (MC), Average Total Cost (ATC) and Average Variable Cost (AVC) with quantity produced on the horizontal axis and cost or price on the vertical axis.

a) Show the quantity the profit maximizing farm should produce (or supply) at price P1 and **label it Q1**.

*With a price of P1, profit maximizing output would be P = MC (i.e., on the supply curve), so go to the right to the MC curve, and then down to the output Q1 as labeled.*

b) At price P1, is the farm's economic profit positive, zero or negative? How do you know?

2 pts

At price P1, profit is negative because the price-quantity point is less than the ATC. Profit is negative, but still above the fixed cost, so the farm finds it economical to still produce.

c) Suppose a farm is earning negative economic profit.

i. Does this necessarily mean the farm is earning negative accounting profit? Give a Yes or No answer and briefly explain.

2 pts

*NO, the farm can still be earning a positive accounting profit, but if it has a negative economic profit, this means the farmer is earning below average rates of return on the farm assets and his/her time.*

ii. Briefly list two options discussed in class for a farm (or business) in this situation – what can they do?

2 pts

- Cut costs to get the ATC below the market price – be more efficient with inputs
- Invest in a new technology or learn new methods in order to reduce the ATC to be below the market price
- Quit farming and do the activities used to determine opportunity costs of time and assets, to get a normal rate of return on your assets and time
- Take the alternative job and rent or sell the farm assets
- Wait until prices go back up (earning below average returns in the meantime
- Accept below average rates of return because you enjoy farming