**AAE 320 Fall 2018** **Exam #1** **Name: _______KEY__________________**

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

a) T_X_ F___ More cheese is produced in Wisconsin than in any other state.

b) T_X_ F___ USDA data shows that most (85%) of Wisconsin farms are small, with gross agricultural sales below $250,000 per year.

c) T__ F_X__ After 3 years of tight margins, farmers have started making money from crop prices above their costs and have been struggling with excess capital.

d) T_X_ F___ Agricultural supply and food demand are relatively inelastic, so large price changes mean small quantity changes by farmers and food consumers.

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 vegetable farm. This table reports how many pounds of carrots are picked, cleaned, and ready for sale in one hour with different numbers of workers.

| Workers Hired | Pounds/Hour | Marginal Product | Value of Marginal Product |
|---|---|---|---|
| 2 | 400 | -- | -- |
| 4 | 500 | 50 | 25 |
| 6 | 580 | 40 | 20 |
| 8 | 650 | 35 | 17.50 |

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 = (500 – 400) / (4 – 2) = 100/2 = 50*

b) Carrots sell for $0.50/pound. 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 = 0.50 x 50 = 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 $20.00/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 6 Workers*

**3) (10 pts.)** You are a farmer considering switching from Bt corn to using a seed treatment to manage corn rootworm (the seed treatment is an insecticide in a polymer coat around each seed). Bt corn costs $100/acre for seed, while regular corn with a seed treatment costs $85/acre for seed. The seed treatment is not as effective, and so you expect to lose on average 4 bushels per acre. You expect to sell your corn for $3.25 per bushel.

a) Use the information given above to conduct a partial budget analysis of this switch in weed control 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>None</td><td colspan="2"><u>Additional Costs</u><br>What new costs will be added?<br><br>$85 to buy seed treated seed</td></tr>
<tr><td colspan="2"><u>Costs Reduced</u><br>What costs will be eliminated?<br><br>$100 due to not buying Bt seed</td><td colspan="2"><u>Revenues Reduced</u><br>What revenues will be lost?<br><br>4 bu/ac x $3.25/bu = $13/ac</td></tr>
<tr><td>Total Benefits</td><td>$100/ac</td><td>Total Costs</td><td>$98/ac</td></tr>
<tr><td colspan="3">Total Benefits – Total Costs = Net Benefit</td><td>100 – 98 = $2/ac</td></tr>
</table>

b) Based on your results, considering only the money earned, is switching to a seed treatment to manage corn rootworm a money making change? Briefly explain.

*Yes, the net benefit or profit gain would be $2 per 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 around water bodies such as grass, trees and wet lands
- □ 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.)** Alfalfa yield as a function of sulfur fertilizer is $Q = 2 + 0.5S - 0.01S^2$, where yield Q is total tons alfalfa harvested per acre and the sulfur rate S is lbs/ac. The price for alfalfa is $200 per ton and the price of sulfur fertilizer is $0.80/lbs.

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

*Set up:* $\pi = 200(2 + 0.5S - 0.01S^2) - 0.8S$

*FOC:* $d\pi/dS = 200(0.5 - 0.02S) - 0.8 = 0$

*Solve FOC:*
$200(0.5 - 0.02S) = 0.8$
$0.5 - 0.02S = 0.8/200 = 0.004$
$0.5 - 0.004 = 0.02S$
$S = 0.496 / 0.02 = 24.8$

*SOC:* $d^2p/dS^2 = 200(-0.02) = -4 < 0$ *passes SOC for maximum*

b) At the sulfur rate you derived in part a, what is the alfalfa yield (tons/acre)?

$Q = 2 + 0.5S - 0.01S^2 = 2 + 0.5(24.8) - 0.01(24.8)^2 = 8.25$ *tons/acre*

c) Besides the cost of sulfur, other costs are $700/acre. What are net returns ($/acre)?

$\pi = 200(8.25) - 0.8(24.8) - 700 = \$930.16/acre$

**6) (10 pts.)** Feeder pigs fed the following corn and soybean meal ration gain 1.6 pounds per day.

| Corn (lbs) | Soybean Meal (lbs) | Marginal Rate of Technical Substitution | |
|---|---|---|---|
| 8.9 | 6.5 | *If Corn = X* | *If Corn = Y* |
| 9.5 | 6.0 | *0.833* | *1.200* |
| 10.6 | 5.4 | *0.545* | *1.833* |
| 12.1 | 4.7 | *0.467* | *2.143* |

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.

*MRTS =* $-\Delta Y/\Delta X$

*Do it one of these two ways, depending on if Corn is X or Y*

*If Corn = X: MRTS = –(6.0 – 6.5)/(9.5 – 8.9) = 0.5/0.6 = 0.833*

*If Corn = Y: MRTS = –(9.5 – 8.9)/( 6.0 – 6.5) = 0.6/0.5 = 1.200*

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

MRTS = $r_X / r_Y$

c) If corn cost $0.07/lb and soybean meal costs $0.15/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:* $r_X / r_Y$ *= 0.07 / 0.15 = 0.467*

*If Corn = Y:* $r_X / r_Y$ *= 0.15 / 0.07 = 2.143*

*In either case, this equality between price ratio and MRTS happens at Corn = 12.1 and Soybean Meal = 4.7, 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 <u>corn</u> increase or decrease?

Optimal corn use would decrease.

**7) (20 pts.)** Corn yield is $Y = 10 + 12N - 0.2N^2 + 15W - 0.3W^2 - 0.1NW$, where Y is corn yield as bushels per acre, N is pounds of nitrogen fertilizer per acre and W is acre inches of water applied per acre. The corn price is \$3 per bushel, the price of nitrogen fertilizer is \$0.5 per pound, and the price of pumping an acre inch of water is \$12 per inch.

What is the profit maximizing amount of nitrogen (N) and water (W) 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.**

*Set up:* $\pi = 3(10 + 12N - 0.2N^2 + 15W - 0.3W^2 - 0.1NW) - 0.5N - 12W$

*FOCs:*
$d\pi/dN = 3(12 - 0.4N - 0.1W) - 0.5 = 0$
$d\pi/dW = 3(15 - 0.6W - 0.1N) - 12 = 0$

*Solve FOCs:* *There are multiple ways, this is one*
$3(12 - 0.4N - 0.1W) = 0.5$
$12 - 0.4N - 0.1) = 0.5/3 - 0.167$
$12 - 0.167 - 0.1W = 0.4N$
$N = 29.58 - 0.25W$ *Substitute this into the 2nd FOC*

$3(15 - 0.6W - 0.1N) = 12$
$15 - 0.6W - 0.1N = 4$
$15 - 0.6W - 0.1(29.58 - 0.25W) = 4$
$11 - 0.6W - 2.958 + 0.025W = 0$
$8.042 = 0.575W$
$W = 13.99$ or $W = 14$

$N = 29.58 - 0.25W = 29.58 - 0.25(14) = 26.08 = 26.1 = N$

*SOC:*
$d^2\pi/dN^2 = 3(-0.4) = -1.2 < 0$ *passes*
$d^2\pi/WN^2 = 3(-0.6) = -1.8 < 0$ *passes*
$d^2\pi/dNdW = 3(-0.1) = -0.03$
$(-1.2)(-1.8) - (-0.03)^2 = 2.16 - 0.09 = 2.07 > 0$ *passes*

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

| Chickens (per year) | Fixed Cost | Variable Cost | Total Cost | Marginal Cost | Average Variable Cost | Average Total Cost |
|---|---|---|---|---|---|---|
| 3,500 | 5,000 | 2,100 | *7,100* | --- | *0.60* | *2.03* |
| 3,900 | 5,000 | 2,700 | *7,700* | *1.50* | *0.69* | *1.97* |
| 4,200 | 5,000 | 3,300 | *8,300* | *2.00* | *0.79* | *1.98* |
| 4,400 | 5,000 | 3,900 | *8,900* | *3.00* | *0.89* | *2.02* |

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

TC = FC + VC = 5,000 + 2,100 = 7,100
MC = $\Delta$TC/$\Delta$Q = (7,700 – 7,100) / (3,900 – 3,500) = 600/400 = 1.5
AVC = VC/Q = 2,100 / 3,500 = 0.60
ATC = TC/Q = 7,100 / 3,500 = 2.03

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

P = MC

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

*MC = $2.00 with Q = 4,200 and MC = $3.00 at Q = 4,400, so MC would be $2.50 right in the middle at Q = 4,300*

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

*Yes, because the market price P of $2.50 exceeds the ATC of around $2 at that level of Q*

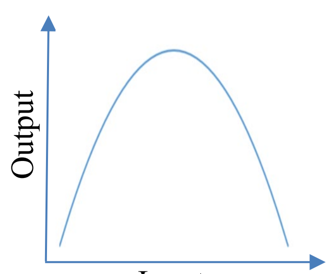
**9) (9 pts.) Short Answer:** Answer each of the short questions below.

a) You are at a party and someone says: "I feel bad that farmers are losing money because prices are low, but it's simple – farmers just need to learn to produce less when prices are low. That's why the lose money, they keep producing." Based on class lectures, give one reason why farmers and agricultural supply is relatively inelastic to price changes.

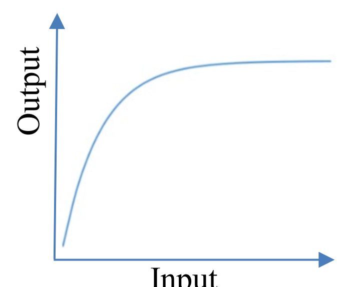
*Some mentioned in class/pptx file*

1) *Long life cycles of livestock, don't stop crops from growing, crop/livestock biology*
2) *Few uses of land other than for crops/ag*
3) *This the "natural" way production functions are (non-responsive/inelastic)*
4) *Farmers have strong cultural identity with farming: what else would they do?*

b) As discussed regarding the More-On Principle, many agricultural production processes are inelastic at or near optimal input levels so that large input changes imply small output changes. As a result, a wide range of input levels will seem consist with profit maximization, especially once natural variability is taken into account from weather, soil and other factors. Below, two hypothetical production functions are plotted. Mark which production function is inelastic.



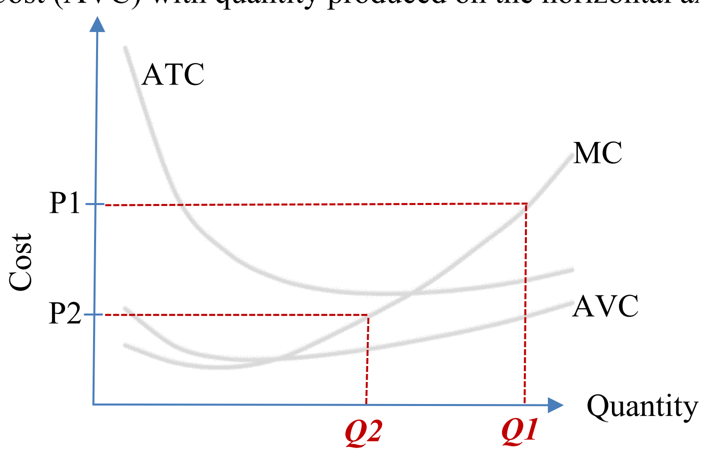

☐ This plot shows an inelastic production process.




*This one because at near optimal input levels, large changes in the input will have small effects on output*

■ This plot shows an inelastic production process.

c) The figure below 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.




*MC is the supply curve down to where MC intersects the AVC at min AVC*

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 farm should produce (or supply) at price P1, **label it Q1**.
b) Show the quantity the farm should produce (or supply) at price P2, **label it Q2**.