AAE 320 Fall 2021 **Exam #1** **Name: ________KEY______________**

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

a) T___ F_X_ The number of dairy herds in Wisconsin has finally begun to increase because of shifts in consumer demand due to the pandemic.

b) T___ F_X_ Based on how the USDA classifies farms, most Wisconsin farms are now large, with more than $1 million in agricultural sales annually.

c) T___ F_X_ Compared to other Midwestern states, Wisconsin agriculture has become homogenous – mostly cows and pigs, corn and wheat.

d) T___ F_X_ Because of the pandemic, farms now receive a much larger share of consumer spending on food – almost 40% on average for all food.

e) T_X_ F___ Compared to agricultural inputs, food processing, and grocery retailing, farming is still relatively unconsolidated.

2) (10 pts.) You manage a small fruit farm. This table reports how many bags of apples are picked, sorted, bagged and ready for sale in one day with different numbers of workers.

Workers Hired	Bags/Hour	Marginal Product	Value of Marginal Product
3	600	--	--
5	800	100	500
7	880	40	200
9	910	15	75

½ pt for 1st error, up to 1 pt per column

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 = (800 – 600) / (5 – 3) = 200/2 = 100

b) Apples sell for $5/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 = 5 x 100 = 500

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

VMP = r or value of the marginal product equal the price of the input

d) If wages, taxes, materials, etc. cost you $200 per day to hire a worker, what is the profit maximizing number of workers to hire? (You may need to interpolate between entries.)

VMP = r at 7 workers, so hire 7 workers

3) (10 pts.) You have a corn field that keeps eroding a small ditch during heavy rains. You till and plant this ditch area each year anyway, even though it yields poorly. You want to examine planting a grass waterway in the ditch area and no longer tilling and planting corn. You spend $500 per acre to grow corn in the ditch area. It yields only 120 bushels per acre on average. You expect a corn price of $4 per bushel over the next few years. You would spend $300 per acre to plant and maintain a grass waterway, including the cost of cutting and baling grass hay. Each year you could make 4 large round bales per acre and sell them for $100 per bale.

a) Use the information given above to conduct a partial budget analysis of this conversion of the ditch from growing corn to a grassed waterway that you make hay from by filling in the table below. Do calculations on a $ per acre basis. Show your calculations in the space provided.

Benefits		Costs	
Additional Revenues What new revenue will be generated? 4 bales/ac x $100/bale = $400 per acre		Additional Costs What new costs will be added? $300 per acre for grass waterway	
Costs Reduced What costs will be eliminated? $500 per acre to grow corn		Revenues Reduced What revenues will be lost? 120 bu/ac x $4/bu = $480 per acre	
Total Benefits	$900	Total Costs	$780
		Total Benefits – Total Costs = Net Benefit	$900 – $780 = $120

b) Based on your results, considering only the money earned, is switching the persistent ditch from corn to a grassed waterway a profitable change? Briefly explain.

Yes, the net gain of $120 per acre, so it is worth switching in terms of profit

4) (3 pts.) If liquid urea ammonium nitrate (UAN) fertilizer is $320/ton and is 28% nitrogen, how much does it cost per pound of nitrogen?

$$\frac{\$320}{\text{1 ton of Fert}} \times \frac{\text{1 ton of Fert}}{\text{2,000 pounds of Fert}} \times \frac{\text{1 pound of Fert}}{\text{0.28 pounds of N}} = \$0.57 \text{ per pound}$$

5) (17 pts.) Soybean yield as a function of seeding rate is $Q = 30 + 0.8S - 0.004S^2$, where 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 \$12 per bushel and the price of seeds is \$0.4 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. **<u>Check the second order condition</u>**.

Set up: $\pi(S) = 12(30 + 0.8S - 0.004S^2) - 0.4S$

FOC: $d\pi/dS = 12(0.8 - 0.008S) - 0.4 = 0$

Solve FOC: $12(0.8 - 0.008S) = 0.4$
$0.8 - 0.008S = 0.4/12 = 0.0333$
$0.8 - 0.0333 = 0.7667 = 0.008S$
$S = 0.7667 / 0.008 =$ <u>95.84 = 95.84 thousand seeds per acre</u>

SOC: $d^2\pi/dS^2 = 12(-0.008) = -0.096 < 0$ passes SOC for maximum

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

$Q = 30 + 0.8S - 0.004S^2 = 30 + 0.8(95.84)N - 0.004(95.84)^2 = 69.9$ bushels per acre

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

$\pi = 12(69.9) - 0.4(95.84) - 800 = \$838.80 - \$38.34 - \$800 = \$0.46$

6) (10 pts.) Chickens fed these corn and soybean rations are at market weight in 60 days.

Corn (lbs)	Soybean Meal (lbs)	Marginal Rate of Technical Substitution	
		If Corn is Y	If Corn is X
5.0	7.9		
7.5	5.4	1.0	1.00
9.6	4.0	1.5	0.67
11.6	3.0	2.0	0.50

One version or the other, not both

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 = Y: $MRTS = -(7.5 - 5.0)/(5.4 - 7.9) = 2.5/2.5 = 1.0$

If Corn = X: $MRTS = -(5.4 - 7.9)/(7.5 - 5.0) = 2.5/2.5 = 1.0$

One version or the other, not both

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

$MRTS = -\Delta Y/\Delta X = \text{price ratio } r_x/r_y$

c) If corn cost \$0.08/lb and soybean meal costs \$0.14/lb, what is the profit maximizing level of each to feed? (Note: if it is between rows in the table, use the average of entries.)

If Corn = Y: $MRTS = -\Delta Y/\Delta X = r_x/r_y = 0.14/0.08 = 1.75$
Occurs between last two rows, so
Corn = ½(9.6 + 11.6) = <u>10.6 pounds</u>
Soybean meal = ½(4.0 + 3.0) = <u>3.5 pounds</u>

If Corn = X: $MRTS = -\Delta Y/\Delta X = r_x/r_y = 0.08/0.14 = 0.571$
Occurs between last two rows, so
Corn = ½(9.6 + 11.6) = <u>10.6 pounds</u>
Soybean meal = ½(4.0 + 3.0) = <u>3.5 pounds</u>

d) If the cost of soybean meal increased and corn cost did not change, the economically optimal soybean meal would decrease, but would economically optimal <u>corn</u> increase or decrease?

<u>Corn would increase</u> to offset the deceases in soybean meal – there is imperfect substitution between the two inputs that implies a tradeoff between them

7) (20 pts.) Corn yield is $Y = 30 + 20N - 0.1N^2 + 3S - 0.2S^2 + 0.1NS$, 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 \$5 per bushel, the price of nitrogen fertilizer is \$0.5 per pound, and the price of seeds is \$4 per thousand.

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

Set up: $\pi = 5(30 + 20N - 0.1N^2 + 3S - 0.2S^2 + 0.1NS) - 0.5N - 4S$

FOCs:
$d\pi/dN = 5(20 - 0.2N + 0.1S) - 0.5 = 0$
$d\pi/dS = 5(3 - 0.4S + 0.1N) - 4 = 0$

Solve FOCs:

There are multiple solution paths. This is one way to solve it.

$5(20 - 0.2N + 0.1S) = 0.5$
$20 - 0.2N + 0.1S = 0.5/5 = 0.1$
$20 - 0.1 + 0.1S = 0.2N$
$19.9 + 0.1S = 0.2N$
$N = 99.5 + 0.5S$ — Substitute this into the 2nd FOC

First simplify the 2nd FOC

$5(3 - 0.4S + 0.1N) = 4$
$3 - 0.4S + 0.1N = 4/5 = 0.8$
$3 - 0.4S + 0.1(99.5 + 0.5S) = 0.8$
$3 - 0.4S + 9.95 + 0.05S = 0.8$
$12.95 - 0.35S = 0.8$
$12.95 - 0.8 = 12.15 = 0.35S$
$S = 12.15/0.35 =$ **<u>34.7</u>** or 34.7 thousand seeds per acre

$N = 99.5 + 0.5S$
$N = 99.5 + 0.5(34.7) =$ **<u>116.85</u>** or 116.9 pounds per acre

SOC:
$d^2\pi/dN^2 = 5(-0.2) = -1.0 < 0$ passes
$d^2\pi/S^2 = 5(-0.4) = -2.0 < 0$ passes
$d^2\pi/dNdS = 5(+0.1) = 0.5$
$(-1)(-2) - (-0.5)^2 = 2 - 0.25 = 1.75 > 0$ passes

8) (14 pts.) *Based on material covered in class*, are these True or False? Mark your answer.

a) T_X_ F___ Based on the corn and soybean budgets discussed in class, land and variable inputs like fertilizer and seed are the largest cost categories.

b) T_X_ F___ Based on the dairy budgets discussed in class, feed and labor are the largest cost categories.

c) T___ F_X_ A farm needs more than 500 dairy cows before annual spending reaches more than $1million.

d) T_X_ F___ Periods of negative margins (prices below the cost of production) are common in farming, as are periods of positive margins.

e) T_X_ F___ The hypoxic (dead) zones have become common around the world and agricultural nutrient losses to water is one of the causes.

f) T___ F_X_ Private well contamination by nitrates is rare in Wisconsin because of unusually strong regulations on farmer fertilizer and manure management.

g) T_X_ F___ Wisconsin Nutrient Management Plans are strategies to help farmers maximize their returns from nutrients while protecting water quality.

9) (3 pts.) Based on the "Nitrogen and Agriculture" materials covered in class, which of the following are reasons Wisconsin farmers must develop nutrient management plans for their farm (Mark all that apply)

- ■ They are large livestock farms
- ■ They receive incentive payments from the USDA to adopt conservation practices
- ■ They want to claim the Farmland Preservation Tax credit
- □ They have wind turbines and/or manure digesters on their farm
- □ They grow potatoes or cranberries for federal food sharing programs
- □ All of the above

10) (3 pts.) Based on Mitchell's More-On Principle as discussed in class, which of the following contribute to farmers using extra inputs (putting a little more on)?
(Mark all that apply)

- ■ No observable effects from over use, but readily apparent effects from under use
- ■ Yield response becomes inelastic (non-responsive) to many inputs near optimal levels
- ■ Relatively high level of yield variability from factors other than the applied inputs
- □ Widespread lack of information on appropriate input use levels
- □ Recommendations from Extension and land-grant University researchers
- □ All of the above