AAE 320 Fall 2022 **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___ Dairy is by far the most important agricultural sector in Wisconsin, making up about half of the agricultural economy in the state.

b) T_X_ F___ Wisconsin is nationally important not only in dairy and forage production, but also in processing vegetables, cranberries and ginseng.

2 pts each c) T_X_ F___ Based on USDA definitions, Wisconsin has lots of small farms, but few have enough sales to make a living as full-time farmers.

d) T_X_ F___ Based on class discussion, farms are a relatively unconsolidated part of the food system compared to input suppliers, processors, and grocery stores.

e) T_X_ F___ The farmer's share of money spent on food by consumers is usually small, with most of the spending on food going to other parts of the food system.

2) (10 pts.) You own a farm that sells carrots to local markets. This table reports how many pounds of carrots you can harvest per bed as you vary the inches of irrigation water you apply.

Water (inches)	Carrots (pounds)	Marginal Product	Value of Marginal Product
10	1200	--	--
12	1600	200	20
14	1800	100	10
16	1900	50	5

-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.

2 pts *MP = ΔQ/ΔX = (1600 – 1200) / (12 – 10) = 400/2 = 200*

b) Carrots sell wholesale for $0.10 per 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.

2 pts *VMP = P x MP = 0.1 x 200 = 20*

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

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

d) If the fixed and variable cost to apply one inch of irrigation water to a bed is $15, how much irrigation water should you apply? (You may need to interpolate between entries.)

2 pts *VMP = r halfway between 12 and 14 inches of water, so 13 inches of water*

3) (12 pts.) You have a corn field next to a stream and wetland that you want to plant a buffer strip around so field runoff no longer enters the water directly. You plant this buffer area each year in corn, though it yields poorly. You want to examine planting grass and shrubs as a buffer and no longer till and plant corn there. You spend $900 per acre to grow corn in the area. It yields only 100 bushels per acre on average. You expect a corn price of $7 per bushel over the next few years. The annualized cost to plant and maintain the buffer strip is $80 per acre each year. Each year, a USDA program will pay you $100 per acre to put in the buffer.

a) Use the information given above to conduct a partial budget analysis of this conversion of part of the field from growing corn to a buffer strip 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? **$100/ac** USDA payment		Additional Costs What new costs will be added? **$80/ac** to plant and maintain buffer strip	
Costs Reduced What costs will be eliminated? No longer plant corn for **$900/ac**		Revenues Reduced What revenues will be lost? Lose corn yield from area converted 100 bu/ac x $7/bu = **$700/ac**	
Total Benefits	100+900= **$1,000**	Total Costs	80+700= **$780**
		Total Benefits – Total Costs = Net Benefit	1000–780 = **$220**

1.5 pts each for these four entries for 6 total pts

1 pt for each calculation, 3 pts total

b) Based on your results, considering only the money earned, is installing the buffer strip to convert the land from corn a profitable change? Briefly explain.

Yes, the net gain is $220 per acre, so it is worth installing the buffer strip in terms of profit

4) **(3 pts.)** If anhydrous ammonia fertilizer is $1,400/ton and is 82% nitrogen, how much does it cost per pound of nitrogen?

$$\frac{\$1{,}400}{1 \text{ ton of Fert}} \times \frac{1 \text{ ton of Fert}}{2{,}000 \text{ pounds of Fert}} \times \frac{1 \text{ pound of Fert}}{0.82 \text{ pounds of N}} = \$0.85 \text{ per pound}$$

2 pts if correct process, but wrong number

5) (18 pts.) Potato yield as a function of the nitrogen fertilizer rate is $Q = 300 + 1.3N - 0.002N^2$, where Q is total hundredweight (cwt) of potatoes harvested per acre and the nitrogen fertilizer rate N is pounds of nitrogen applied per acre. The potato price is \$10 per cwt and the price of nitrogen is \$0.90 per pound.

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

4 pts	Set up:	$\pi(N) = 10(300 + 1.3N - 0.002N^2) - 0.9N$
4 pts	FOC:	$d\pi/dN = 10(1.3 - 0.004N) - 0.9 = 0$
4 pts	Solve FOC:	$10(1.3 - 0.004N) = 0.9$ $1.3 - 0.004N = 0.9/10 = 0.09$ $1.3 - 0.09 = 1.21 = 0.004N$ $N = 1.21 / 0.004 =$ **302.5** pounds per acre
2 pts	SOC:	$d^2\pi/dS^2 = 10(-0.004) = -0.04 < 0$ passes SOC for maximum

- *2 pts partial credit for FOC if they have the wrong Set Up but correct FOC for their profit*
- *2 pts partial credit if they have the correct process for solving FOC but get the wrong answer due to algebraic error*

a) At the nitrogen rate you derived in part a, what is the potato yield (cwt per acre)?

$Q = 300 + 1.3N - 0.002N^2 = 300 + 1.3(302.5) - 0.002(302.5)^2 = 510.2$ cwt per acre

- *Answers can vary depending on how they round. Look for the right process.*

b) Besides the cost of nitrogen, other costs are \$4000/acre. What are net returns (\$ per acre)?

$\pi = 10(510.2) - 0.9(302.5) - 4000 = \$5102 - \$272.25 - \$4000 = \$829.75$

- *Answers can vary depending on how they round. Look for the right process.*

6) (10 pts.) Turkeys fed these corn and soybean meal rations are at market weight in 120 days.

Corn (lbs)	Soybean Meal (lbs)	Marginal Rate of Technical Substitution	
8.0	7.9	If Corn is Y	If Corn is X
11.5	5.9	1.75	0.571
14.0	4.9	2.5	0.400
17.0	4.1	3.75	0.267

1 pt total

-½ pt for 1st error, up to -1 pt

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.

1 pt total

MRTS = $-\Delta Y/\Delta X$
Do it one of these two ways, depending on if Corn is X or Y
If Corn = Y: MRTS = –(11.5 – 8.0)/(5.9 – 7.9) = 3.5/2.0 = 1.75
If Corn = X: MRTS = –(5.9 – 7.9)/(11.5 – 8.0) = 2.0/3.5 = 0.571

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.)

2 pts

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

c) If corn cost \$0.12/lb and soybean meal costs \$0.30/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.)

4 pts total, 2 pts per input

If Corn = Y: MRTS = $-\Delta Y/\Delta X = r_x/r_y = 0.30/0.12 = 2.5$
*Occurs on the table at **Corn = 14.0 pounds** and **Soybean meal = 4.9 pounds***

If Corn = X: MRTS = $-\Delta Y/\Delta X = r_x/r_y = 0.12/0.30 = 0.40$
*Occurs on the table at **Corn = 14.0 pounds** and **Soybean meal = 4.9 pounds***

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

2 pts

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

7) (21 pts.) soybean yield is $Y = 30 + 5K - 0.1K^2 + 40S - 0.2S^2 + 0.1KS$, where Y is soybean yield in bushels per acre, K is pounds of potassium fertilizer per acre and S is thousands of seeds planted per acre. The soybean price is \$14 per bushel, the potassium price is \$0.60 per pound and the soybean seed price is \$0.8 per thousand.

What is the profit maximizing amount of potassium (K) and seeds (S) to use to grow corn (Y)?
(Note: you will not need to convert prices to set up the profit function, nor calculate yield or revenue at the optimal values for K and S.)
Be sure to check the second order conditions.

4 pts Set up: $\pi = 14(30 + 5K - 0.1K^2 + 40S - 0.2S^2 + 0.1KS) - 0.6K - 0.8S$

6 pts FOCs:
$d\pi/dK = 14(5 - 0.2K + 0.1S) - 0.6 = 0$
$d\pi/dS = 14(40 - 0.4S + 0.1K) - 0.8 = 0$

8 pts total Solve FOCs:
$14(5 - 0.2K + 0.1S) = 0.6$ There are multiple solution paths.
$5 - 0.2K + 0.1S = 0.6/14 = 0.043$ This is one way to solve it.
$5 - 0.043 + 0.1S = 0.2K$
$4.957 + 0.1S = 0.2K$
$K = 24.785 + 0.5S$ Substitute this into the 2nd FOC

$14(40 - 0.4S + 0.1K) = 0.8$ First simplify the 2nd FOC
$40 - 0.4S + 0.1K = 0.8/14 = 0.057$
$40 - 0.4S + 0.1(24.8 + 0.5S) = 0.057$
$40 - 0.4S + 2.48 + 0.05S = 0.057$
$42.48 - 0.35S = 0.057$
$42.48 - 0.057 = 42.42 = 0.35S$
$S = 42.42/0.35 =$ **121.2** thousand seeds per acre

4 pts if right method but algebra error

$K = 24.785 + 0.5S$
$K = 24.785 + 0.5(121.2) =$ **85.4** pounds per acre

SOC:
$d^2\pi/dK^2 = 14(-0.2) = -2.8 < 0$ passes
$d^2\pi/S^2 = 14(-0.4) = -5.6 < 0$ passes
3 pts $d^2\pi/dKdS = 14(+0.1) = 1.4$
$(-2.8)(-5.6) - (1.4)^2 = 13.7 > 0$ passes

8) (16 pts.) ***Based on material covered in class***, are these True or False? Mark your answer.

2 pts each

a) T_X_ F___ Historically, farmers go through multi-year periods of output prices below costs, with below average returns on their management time and assets.

b) T_X_ F___ Based on the dairy budgets discussed, the full cost of production is about $5,000/year per cow, so a 200 cow dairy has a $1 million cost.

c) T___ F_X_ Agricultural supply is non-responsive (inelastic) to price declines because farmers lack key information and the technology to respond.

d) T___ F_X_ Over-use of nitrogen on corn is relatively obvious because the corn looks "too good to be true".

e) T_X_ F___ Each year, U.S. farmers grow about 1/3 of the world's total corn production and 1/3 of the world's total soybean production.

f) T___ F_X_ Hypoxic zones in Lake Michigan from excess fertilizer use have caused widespread contamination of drinking water wells in Wisconsin.

g) T___ F_X_ The hypoxic zones in Lake Michigan from excess fertilizer use have caused widespread contamination of drinking water wells in Wisconsin.

h) T_X_ F___ Nitrogen is a key nutrient that plants need to grow, but can also get into surface and ground water and cause environmental and health problems.