BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

AEH 501

Department of Engineering and Physics

Bachelor of Science Honours Degree in Agricultural Engineering

Agricultural Machinery Management

3 hours (100 Marks)

MAR 2024

Instructions:

1. This paper contains 6 questions
2. Answer any **FOUR** questions, each of which carries 25 marks

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Question 1

a) Explain some of the reasons a farmer would consider going for a short time rental of farm equipment among other options. [5 marks]
b) Discuss some of the considerations likely to influence your choice of acquiring farm machinery services. [10 marks]
c) Explain the advantages and disadvantages of custom hiring as a way of acquiring machinery services. [10 marks]

Question 2

a) Explain the factors affecting effective field capacity. [5 marks]
b) Given the following data:

Area to be ploughed	120 ha
Soil resistance	3.62 N/m/cm-depth
Operating speed	8 km/hr
Field efficiency losses	18%
Depth of ploughing	10 cm

i. Calculate the work rate if 40 hours are available per week. [2 marks]
ii. Calculate the swath of the implement, [2 marks]
iii. Calculate the draft force (N), [2 marks]
iv. The drawbar power required (Kw). [2 marks]

c) A self-propelled combine with a 12-row corn head for 75 cm row spacing travels at 5km/h while harvesting maize yielding 12 t/ha. Losses proportional to area total to 5.2 minutes per hectare and are primarily due to unloading grain from the combine. Neglecting any other losses, calculate:

(i) the field efficiency and [5 marks]

The effective field capacity on:
(ii) an area basis, and [4 marks]
(iii) material basis. [3 marks]

Question 3

A farmer purchased a 35 hp wheel type tractor at a total costs of $15000 and a 3 bottom plough with 30 cm bottom at $1500. The fuel consumption of the tractor is 12 l/hr at a plough speed of 5 km/hr.

For tractor: economic life = 10 years
Annual operating hours = 600 hrs
For plough life = 8 years
Interest = 10%
Annual operating hours = 200 hrs

a) Calculate the area ploughed per hour. [5 marks]
b) Determine the cost of ploughing. [20 marks]

Question 4

i. Explain the six big losses associated with overall equipment availability. [6 marks]
ii. The following data in table 1 was extracted form a yoghurt packaging line at a dairy farm.

Table 1:

Item	Data
Shift length	8 hours
Breaks	(2) 15 minutes (1) 30 minutes
Downtime	47 minutes
Ideal cycle time	5.0 s
Total count	3 854 packets
Rejects	85 packets

Calculate:

a) The machine availability [5 marks]
b) Machine performance [5 marks]
c) The quality factor [5 marks]
d) Overall equipment effectiveness [4 marks]

Question 5

a) Explain the considerations for leasing farm equipment as a way of acquiring machinery service. [8 marks]
b) A grain storage company bought a new grain dryer for $100 000.00, with all funds paid out when the machine is acquired. Over each of the next five years, the machine is expected to require $10 000.00 annual operational costs and will generate $50 000.00 of payments from customers. Calculate the payback period. [5 marks]

c) Wadzanai and Matilda purchased a used S670 John Deere combine jointly, each paying half of the purchase cost of $ 120 000. The combine is used for 900 ha. 600 ha by Wadzanai and 300 by Matilda . Both provide for their own fuel and labour, and repair costs are divided equally. The custom rate is at $75/ha.
    i. A calculate the cost of using this combine for extra activities. [4 marks]
    ii. Calculate the extra ha that will be used by Wadzanai above his 50% share. [4 marks]
    iii. How much is Wadzanai expected to pay Matilda for the extra usage of his share. [4 Marks]

Question 6

a) State four considerations for the replacement of manual labour by farm machinery. [4 marks]

b) Discuss the pros and cons of purchasing used equipment as opposed to new equipment. [8 marks]

c) Suppose a farmer plants 150 ha of cotton per year with an average yield of 3000 kg/ha. Currently the farmer has his cotton picked by hand by seasonal labourers at a cost of $0.011/kg of cotton picked. The cost includes rations and transport. The farmer intends to continue producing cotton in future and is now considering replacing seasonal laborers with a cotton picker. A new cotton picker costs $6 000 and after a useful life of 5 years he should be able to sell it for $2 000. The variable costs of the cotton picker are $1.50/ha, but because cotton has to be picked twice by the cotton picker, they effectively amount to $3/ha. The mechanical picker also causes yield and quality losses of $24/ha. Assume an interest rate of 12% on capital investment and 2% of TIH.

i. Is the replacement of labor by a cotton picker economically justifiable at the present scale of production? [8 marks]

ii. Calculate the minimum scale of production that will make the replacement justifiable. [5 marks]

Appendix

[AEH 501 Agricultural Machinery Management]

Remaining Salvage Value as a Percentage of New List Price

	30–79 hp Tractor			80–149 hp Tractor			150+ hp Tractor			Combine, Forage Harvester		
Annual Hours	200	400	600	200	400	600	200	400	600	100	300	500
Age												
1	65%	60%	56%	69%	68%	68%	69%	67%	66%	79%	69%	63%
2	59%	54%	50%	62%	62%	61%	61%	59%	58%	67%	58%	52%
3	54%	49%	46%	57%	57%	56%	55%	54%	52%	59%	50%	45%
4	51%	46%	43%	53%	53%	52%	51%	49%	48%	52%	44%	39%
5	48%	43%	40%	50%	49%	49%	47%	45%	44%	47%	39%	34%
6	45%	40%	37%	47%	46%	46%	43%	42%	41%	42%	35%	30%
7	42%	38%	35%	44%	44%	43%	40%	39%	38%	38%	31%	27%
8	40%	36%	33%	42%	41%	41%	38%	36%	35%	35%	28%	24%
9	38%	34%	31%	40%	39%	39%	35%	34%	33%	31%	25%	21%
10	36%	32%	30%	38%	37%	37%	33%	32%	31%	28%	23%	19%
11	35%	31%	28%	36%	35%	35%	31%	30%	29%	26%	20%	17%
12	33%	29%	27%	34%	34%	33%	29%	28%	27%	23%	18%	15%
13	32%	28%	25%	33%	32%	32%	27%	26%	25%	21%	16%	13%
14	30%	27%	24%	31%	31%	30%	25%	24%	24%	19%	14%	12%
15	29%	25%	23%	30%	29%	29%	24%	23%	22%	17%	13%	10%
16	28%	24%	22%	28%	28%	27%	22%	21%	21%	16%	11%	9%
17	26%	23%	21%	27%	27%	26%	21%	20%	19%	14%	10%	8%
18	25%	22%	20%	26%	25%	25%	20%	19%	18%	13%	9%	7%
19	24%	21%	19%	25%	24%	24%	19%	18%	17%	11%	8%	6%
20	23%	20%	18%	24%	23%	23%	17%	17%	16%	10%	7%	5%

Remaining Salvage Value as a Percentage of New List Price

Machine Age	Plows	Other Tillage	Planter, Drill, Sprayer	Mower, Chopper	Baler	Swather, Rake	Vehicle	Others
1	47%	61%	65%	47%	56%	49%	42%	69%
2	44%	54%	60%	44%	50%	44%	39%	62%
3	42%	49%	56%	41%	46%	40%	36%	56%
4	40%	45%	53%	39%	42%	37%	34%	52%
5	39%	42%	50%	37%	39%	35%	33%	48%
6	38%	39%	48%	35%	37%	32%	31%	45%
7	36%	36%	46%	33%	34%	30%	30%	42%
8	35%	34%	44%	32%	32%	28%	29%	40%
9	34%	31%	42%	31%	30%	27%	27%	37%
10	33%	30%	40%	30%	28%	25%	26%	35%
11	32%	28%	39%	28%	27%	24%	25%	33%
12	32%	26%	38%	27%	25%	23%	24%	31%
13	31%	24%	36%	26%	24%	21%	24%	29%
14	30%	23%	35%	26%	22%	20%	23%	28%
15	29%	22%	34%	25%	21%	19%	22%	26%
16	29%	20%	33%	24%	20%	18%	21%	25%
17	28%	19%	32%	23%	19%	17%	20%	24%
18	27%	18%	30%	22%	18%	16%	20%	22%
19	27%	17%	29%	22%	17%	16%	19%	21%
20	26%	16%	29%	21%	16%	15%	19%	20%

Accumulated Repair Costs as a Percentage of new List Price

Type of Machine	Accumulated Hours	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
Two-wheel drive tractor		1%	3%	6%	11%	18%	25%	34%	45%	57%	70%
Four-wheel drive tractor		0%	1%	3%	5%	8%	11%	15%	19%	24%	30%

Type of Machine	Accumulated Hours	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
Moldboard plow		2%	6%	12%	19%	28%	40%	53%	68%	84%	101%
Heavy-duty disk		1%	4%	8%	12%	18%	25%	32%	40%	48%	58%
Tandem disk		1%	4%	8%	12%	18%	25%	32%	40%	49%	58%
Chisel plow		3%	8%	14%	20%	28%	36%	45%	54%	64%	74%
Field cultivator		3%	7%	13%	20%	27%	35%	43%	52%	61%	71%
Harrow		3%	7%	13%	20%	27%	35%	43%	52%	61%	71%
Roller-packer mulcher		2%	5%	8%	12%	16%	20%	25%	29%	34%	39%
Rotary hoe		2%	6%	11%	17%	23%	30%	37%	44%	52%	61%
Row crop cultivator		0%	2%	6%	10%	17%	25%	36%	48%	62%	79%

Type of Machine	Accumulated Hours	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
Corn picker		0%	2%	4%	8%	14%	21%	30%	41%	54%	68%
Combine (pull)		0%	1%	4%	7%	12%	18%	26%	35%	46%	59%
Potato harvester		2%	5%	8%	14%	19%	25%	30%	37%	43%	50%
Mower-conditioner		1%	4%	8%	13%	15%	24%	31%	38%	46%	55%
Mower-conditioner (rotary)		1%	2%	6%	10%	16%	23%	31%	41%	52%	64%
Rake		2%	5%	8%	12%	17%	22%	27%	33%	39%	45%
Rectangular baler		1%	4%	9%	15%	23%	32%	42%	54%	68%	80%
Large square baler		1%	2%	4%	7%	10%	14%	18%	23%	29%	35%
Forage harvester (pull)		1%	3%	7%	10%	15%	20%	26%	32%	38%	45%

Type of Machine	Accumulated Hours	300	600	900	1,200	1,500	1,800	2,100	2,40	2,700	3,000
Forage harvester (SP)		0%	1%	2%	4%	7%	10%	13%	17%	22%	27%
Combine (SP)		0%	1%	3%	6%	9%	14%	19%	25%	32%	40%
Windrower (SP)		1%	2%	5%	9%	14%	19%	26%	35%	44%	54%
Cotton picker (SP)		1%	4%	9%	15%	23%	32%	42%	53%	66%	79%

Type of Machine	Accumulated Hours	100	200	300	400	500	600	700	800	900	1,000
Mower (sickle)		1%	3%	6%	10%	14%	19%	25%	31%	38%	46%
Mower (rotary)		0%	2%	4%	7%	11%	16%	22%	28%	36%	44%
Large round baler		1%	2%	5%	8%	12%	17%	23%	29%	36%	43%
Sugar beet harvester		3%	7%	12%	18%	24%	30%	37%	44%	51%	59%
Rotary tiller		0%	1%	3%	6%	9%	13%	18%	23%	29%	36%
Row crop planter		0%	1%	3%	5%	7%	11%	15%	20%	26%	32%
Grain drill		0%	1%	3%	5%	7%	11%	15%	20%	26%	32%
Fertilizer spreader		3%	8%	13%	19%	26%	32%	40%	47%	55%	63%

Type of Machine	Accumulated Hours	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
Boom-type sprayer		5%	12%	21%	31%	41%	52%	63%	76%	88%	101%
Air-carrier sprayer		2%	5%	9%	14%	20%	27%	34%	42%	51%	61%
Bean puller-windrower		2%	5%	9%	14%	20%	27%	34%	42%	51%	61%
Stalk chopper		3%	8%	14%	20%	28%	36%	45%	54%	64%	74%
Forage blower		1%	4%	9%	15%	22%	31%	40%	51%	63%	77%
Wagon		1%	4%	7%	11%	16%	21%	27%	34%	41%	49%
Forage wagon		2%	6%	10%	14%	19%	24%	29%	35%	41%	47%

Source: American Society of Agricultural Engineers, 1996.