

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

MAR 2023

AEH 501

Department of Engineering and Physics

Bachelor of Science Honours Degree in Agricultural Engineering

Agricultural Machinery Management

3 hours (100 Marks)

**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) List and explain 5 reasons for replacing farm machinery at a farm. [10 marks]
- b) Mr Dube has recently acquired a farm from Mr Scott through the land reform program. The acquisition does not include farm equipment. Mr Scott is willing to transfer ownership of his farm equipment to the new owner Mr Dube. Discuss the various options of ownership transfer that are available giving their financial considerations to both parties. [15 marks]

Question 2

- a) Define timeliness costs in farm machinery. [4 marks]
- b) Explain how the following costs vary with increase in machinery size.
  - i. Timeliness costs [2 marks]
  - ii. Ownership costs and [2 marks]
  - iii. Total ownership costs [2 marks]

- c) A 12-row conventional row-crop planter is to be used to plant 180 ha of soya beans with 75-cm row spacing. The soya beans have an anticipated yield of 2.7 t/ha and an anticipated selling price of \$250/t. Assuming a travelling speed of 7 km/hr, calculate:
- Calculate the field capacity and [5 marks]
  - Timeliness cost assuming the farmer works 10-hour days and wants to be assured of a 90% probability of having the required number of good working days. [10 marks]

### Question 3

- a) Explain the circumstances under which a farmer would opt for a short-time rental of machinery among other options. [6 marks]
- b) Job and Arnold purchased a no-till soya bean drill for \$26 000 each paying half. Job used it on his 160 ha field and Arnold on his 80 ha field. Each one of them supplied their own fuel, a driver and a 175 Hp tractor to pull the drill. The average rental rate for tractors is \$0.20 per Hp per hour. The drill can plant at a rate of 2.8 ha/hr. they both agreed on a custom rate of \$40/ha.
- Calculate the cost of drilling per ha if they use their own fuel, and labour. [3 marks]
  - Calculate the tractor charge per ha. [3 marks]
  - Calculate the charge for the use of the drill alone. [6 marks]
  - The amount Job is expected to pay Arnold for the extra area drilled. [7 marks]

### Question 4

Tafadzwa and Ngoni purchased a used combine at \$120 000.00. Tafadzwa uses it to harvest 400 ha and Ngoni 200 ha. They both provide their own fuel and labour. Tafadzwa stores the combine and is responsible for repairs and maintenance.

- Complete table 1 below for the actual costs incurred by Ngoni and Tafadzwa. [20 marks]
- State who is going to be reimbursed and how much. [5 marks]

Table 1

	Total	Tafadzwa	Ngoni
Investment	\$120 000.00	\$60 000.00	\$60 000.00
Annual interest charge @ 5%			
Depreciation @ 10%			
Insurance @ 0.5 %			
Housing @ 0.5%			
Fuels	----	----	----
Combine capacity	6.5 ha/hr	---	----
Accumulated hours	1800	---	---
Accumulated hours at end of life	3000	----	----
Repairs and Maintenance			----
Labour	----	----	
Annual usage (ha)	600 ha		
Cost/ha	\$51	----	----
Cost to each owner (combine)			

### Question 5

- a) Define the following terms:
- i. Payback period, [4 marks]
  - ii. Effective field capacity, [4 marks]
  - iii. Theoretical field capacity, and [3 marks]
  - iv. Material capacity. [3 marks]
- b) A recent Agriculture graduate has been given a 45 ha piece of land by her parents. After clearing the land she considers hiring her neighbours tractor to plough the entire land. The neighbor has a relatively new 3 disc plough which gives a cut of 0.4 m/disc. The tractor driver is instructed to maintain a speed of 4 km/hr. Assuming field efficiency of 70%, calculate:
- i. Theoretical field capacity, [4 marks]
  - ii. Effective field capacity, and [4 marks]
  - iii. Number of hours required to finish ploughing. [3 marks]

### Question 6

A manufacturer produces two types of models M1 and M2. Each model of the type M1 requires 4 hours of grinding and two hours of polishing. Whereas each model of M2 requires 2 hours of grinding and 5 hours of polishing. The manufacturer has two grinders and 3 polishers. Each grinder works 40 hours a week and each polisher works 60 hours per week. Profit on M1 model is \$30 and on M2 model is \$40. Whatever is produced in a week is sold on the market.

- a) Formulate a linear programming model for the two types of models to maximize profit. [10 marks]
- b) Using the graphical method allocate the production capacity to maximize profit. [15 marks]

[AEH 501 Agricultural Machinery Management]

Remaining Salvage Value as a Percentage of New List Price

Age	30-79 hp Tractor			80-149 hp Tractor			150+ hp Tractor			Combine, Forage Harvester		
	200	400	600	200	400	600	200	400	600	100	300	500
1	60%	54%	50%	62%	62%	61%	68%	68%	67%	79%	69%	63%
2	59%	54%	50%	62%	62%	61%	68%	68%	67%	79%	69%	63%
3	54%	49%	46%	57%	57%	55%	61%	61%	59%	67%	58%	52%
4	51%	46%	43%	53%	53%	51%	56%	56%	54%	59%	50%	45%
5	48%	43%	40%	49%	49%	47%	49%	49%	49%	47%	39%	34%
6	45%	40%	37%	46%	46%	43%	46%	46%	45%	42%	35%	30%
7	42%	38%	35%	44%	44%	40%	43%	43%	42%	38%	31%	27%
8	40%	36%	33%	42%	41%	38%	41%	41%	36%	35%	28%	24%
9	38%	34%	31%	39%	39%	35%	39%	39%	34%	31%	25%	21%
10	36%	32%	30%	37%	37%	33%	37%	37%	32%	28%	23%	19%
11	35%	31%	28%	36%	35%	31%	35%	35%	30%	26%	20%	17%
12	33%	29%	27%	34%	34%	29%	33%	33%	28%	23%	18%	15%
13	32%	28%	25%	32%	32%	27%	32%	32%	26%	21%	16%	13%
14	30%	27%	24%	30%	31%	25%	30%	30%	24%	19%	14%	12%
15	29%	25%	23%	29%	29%	24%	29%	29%	23%	17%	13%	10%
16	28%	24%	22%	28%	28%	22%	27%	27%	21%	16%	11%	9%
17	26%	23%	21%	27%	27%	21%	26%	26%	20%	14%	10%	8%
18	25%	22%	20%	25%	25%	20%	25%	25%	19%	13%	9%	7%
19	24%	21%	19%	24%	24%	19%	24%	24%	18%	11%	8%	6%
20	23%	20%	18%	23%	23%	17%	23%	23%	17%	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	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	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
Moldboard plow	2%	6%	12%	19%	29%	40%	53%	68%	84%	101%
Heavy-duty disk	1%	4%	8%	12%	18%	25%	32%	40%	49%	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%	5%	8%	11%	17%	23%	30%	37%	44%	52%
Row crop cultivator	0%	2%	6%	10%	17%	25%	36%	48%	62%	78%
Type of Machine	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%	69%
Combine (pull)	0%	1%	4%	7%	12%	18%	26%	35%	46%	59%
Potato harvester	2%	5%	9%	14%	19%	25%	30%	37%	43%	50%
Mower-conditioner (rotary)	1%	4%	8%	13%	18%	24%	31%	38%	46%	55%
Mower-conditioner (rotary)	1%	3%	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%	66%	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	300	600	900	1,200	1,500	1,800	2,100	2,400	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	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	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%
Stalk chopper	1%	4%	9%	15%	22%	31%	40%	51%	63%	77%
Forage blower	1%	4%	7%	11%	16%	21%	27%	34%	41%	49%
Wagon	1%	1%	4%	7%	11%	16%	21%	27%	34%	41%
Forage wagon	2%	6%	10%	14%	19%	24%	29%	35%	41%	47%

Source: American Society of Agricultural Engineers, 1996.