UNIVERSITY OF SWAZILAND

MAIN EXAMINATION PAPER

PROGRAMME:	BACHELOR OF SCIENCE IN AGRONOMY, YEAR 4
COURSE CODE:	CP 406
TITLE OF PAPER:	SOIL MANAGEMENT
TIME ALLOWED:	TWO (2) HOURS
INSTRUCTIONS:	ANSWER ALL QUESTIONS

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QUESTION 1

Data shown in Figure 1 showed the effect of pH on forms of phosphorus in any given soil.

a. At what pH is element P most available in the soil? Give reasons for your answers.
b. From the data presented, what are the major source(s) of P in the soils?
c. List and discuss at least **five factors** that will affect P forms in these soils
d. Draw a well labelled diagram of how phosphorus nutrient element moves within the soil solum.

(25Marks).

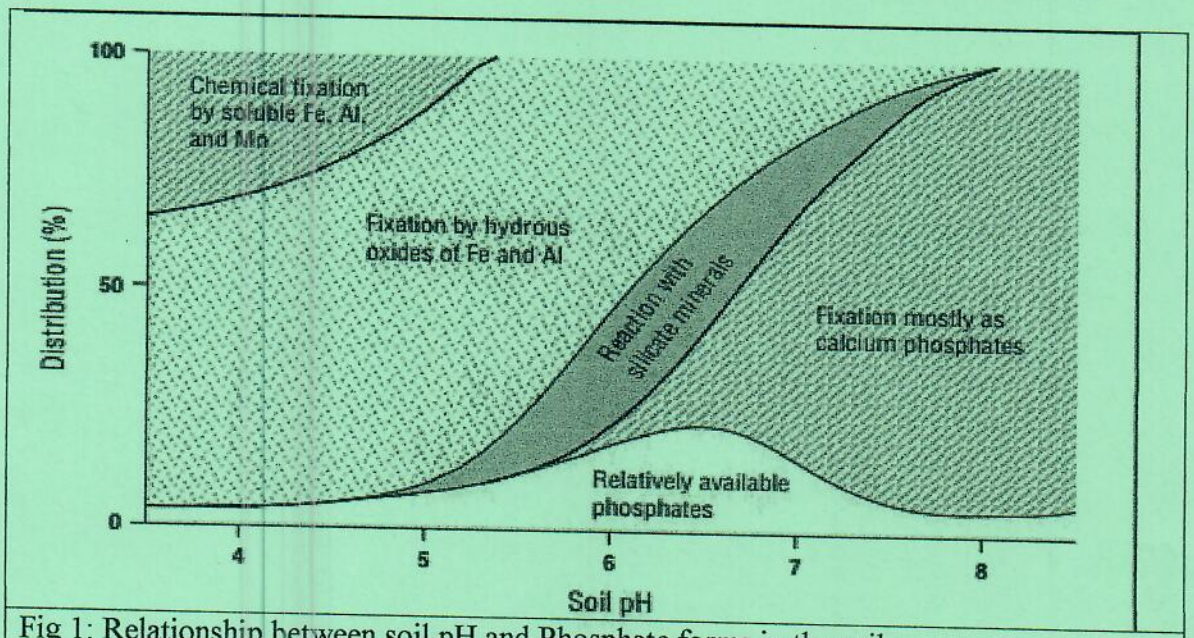

Fig 1: Relationship between soil pH and Phosphate forms in the soil

Question 2:

a. How will cation exchange capacity (CEC), soil texture, exchangeable acidity, and soil organic matter affect lime requirements?
b. Briefly explain how the soil reaction (pH) affects the availability of N, Ca, Mg, Fe, Mn & Zn in soils.
c. Using chemical equations, how will liming materials increase soil pH.
d. Explain how your will manage these soils if they have variable charges.
e. Why does nitrogen fertilization with NH_3 acidify soil?
f. In most soils, deep rooting is more beneficial to a plant's N nutrition than to its P nutrition. Give **four reasons w**hy this is so?

(25 Marks)

QUESTIONS 3

Soil samples were collected randomly from the soil farm of an area of 1000 ha using these factors- slope difference and differences in vegetation. These soil samples were bulked, labelled (inside & outside) and shipped to the laboratory. In the laboratory, these were dried and sieved. The samples were used for determination of the soil pH in water and $CaCl_2$.

a. What sieve size will be most appropriate for the determination of the soil pH in water and $CaCl_2$?
b. Enumerate a step-wise procedure for determining the pH in water and $CaCl_2$.
c. Define both active and reserve acidity. Is there any relationship between these two variables?
d. What is liming? Itemize and discuss **four factors** to be considered in determining a liming program

(25 marks).

QUESTION 4

a. Define the following terms: (i) land evaluation, (ii) land quality, (iii) land use requirements and (iv) land utilization types.
b. In **Tables 1-3**, data are provided of **four soil types/pedons** in Luyengo Campus of the University of Swaziland. The **mean** available Bray-1-P were 3-5 mg/kg; 9-11 mg/kg; 7-10 mg/kg and > 12 mg/kg for profiles I, II, III & IV respectively. Develop criteria and ratings of land use requirements for growing maize (*Zea mays* L.) using the following land qualities: **climate**, **slope**, **fertility** (physical and chemical), & **wetness**.
c. Use the table constructed in question 4b to evaluate the land (i.e. **Profiles I & II**) for the cultivation of maize (*Zea mays* L.).
d. Estimate the organic matter (%) and Delta pH in **Profiles III & IV**. Present your answers in a Table. State the importance of Delta pH in managing these soils for maize production.
e. Identify the major constraints of these soils (i.e. **Profiles I & II**) for maize cultivation from all these **soil types/pedons** and how will you ameliorate these constraints for a successful cultivation of maize.

(25 marks).

Table 1: Description of the sampling sites, Luyengo, Campus

Profile No	Land Use	Parent Materials	Age	Elevation (m)	Physiographic Unit	Slope (%)
I	Forest	Tertiary Rocks	Tertiary	41	Upper slope	4-15
II	Forest	Tertiary Rocks	Tertiary	39	Upper slope	1-2
III	Forest	Sediments	Young	20	Mid-slope	4
IV	Forest	Sediments	Sediments	11	Valley Bottom	2

Table 2: Physical properties of the sites, Luyengo, Campus

Horizons	Depth (cm)	Sand	Silt	Clay	Textural classes	Bulk Density (g/cm^3)
Profile I (Typic Haplustults)						
A1	0-12	61	19	20	SCL	1.25
E	12-37	58	20	22	SCL	1.28
Bt	37-53	56	21	28	SCL	1.28
C	53-90	55	21	28	SCL	1.32
Profile II (Typic Haplustults						
A1	0.-15	57	15	28	SCL	1.21
E	15-45	56	13	31	SCL	1.23
Bt	45-72	50	14	36	SCL	1.23
C	72-100	50	16	34	SCL	1.27
Profile III (Typic Dystrochrepts)						
A1	0-16	73	10	17	SL	1.18
Bw1	16-48	71	8	21	SCL	1.20
Bw2	48-99	70	7	23	SCL	1.22
Profile IV (Typic Udifulvents						
A1	0-14	38	30	32	CL	1.16
C1	14-31	48	17	35	SCL	1.15
C2	31-72	52	18	30	SCL	1.19
C3	72-85	52	13	35	SC	1.21

SCL= Sandy Clay Loam; SL= Sandy Loam; CL= Clay Loam; SC= Sandy Clay

Table 3: Chemical properties of selected pedons in Luyengo, Campus

Horizon	Depth	OC (%)	pHw	$pHCaCl_2$	Ca	Mg	K	Na	PBS (%)	CEC	Exch. Al	ECEC	Exch. Ac	Al. Sat (%)
					---------- Cmol/kg----------					----------Cmol/kg----------				
		---------- **Profile I (Typic Haplustults)** ----------												
A1	0-12	1.15	5.10	3.96	1.65	0.98	0.47	0.28	29.5	11.44	0.60	4.48	1.10	13.39
E	12-37	1.10	4.95	3.88	1.35	0.67	0.32	0.17	27.5	9.12	0.63	3.64	1.13	17.31
Bt	37-53	0.41	4.86	3.84	1.23	0.27	0.16	0.06	18.4	9.37	0.65	2.87	1.15	22.65
C	53-90	0.26	4.44	3.57	0.98	0.19	0.17	0.07	11.8	11.9	0.66	2.66	1.25	24.81
		---------- **Profile II (Typic Haplustults** ----------												
A1	0.-15	1.54	5.16	4.15	1.89	1.12	0.53	0.32	32.7	11.8	0.54	4.78	0.92	11.30
E	15-45	1.31	5.11	4.12	1.53	0.89	0.44	0.26	30.7	10.17	0.59	4.10	0.98	14.39
Bt	45-72	0.54	4.91	4.10	1.43	0.33	0.21	0.22	23.0	9.54	0.61	3.29	1.10	18.54
C	72-100	0.33	4.68	3.82	1.20	0.29	0.30	0.19	16.2	12.20	0.62	3.11	1.13	19.94
		---------- **Profile III (Typic Dystrochrepts)** ----------												
A1	0-16	1.61	5.17	4.23	1.66	1.10	0.45	0.30	32.50	10.8	0.48	4.4	0.89	10.91
Bw1	16-48	1.36	5.12	4.59	1.64	0.57	0.39	0.28	29.80	9.67	0.582	3.82	0.94	13.07
Bw2	48-99	0.41	5.12	4.13	1.30	0.34	0.28	0.22	23.0	9.3	0.55	3.19	1.05	16.87
		---------- **Profile IV (Typic Udifulvents)**----------												
A1	0-14	1.73	5.52	4.90	2.17	1.46	0.65	0.57	33.40	14.50	0.41	3.99	0.74	7.33
C1	14-31	1.45	5.23	4.70	1.97	0.54	0.35	0.35	31.7	10.12	0.44	2.21	0.85	12.12
C2	31-72	0.63	5.11	4.65	1.64	0.58	0.43	0.09	22.3	12.13	0.46	2.12	0.93	13.49
C3	72-85	0.95	5.10	4.36	1.42	0.36	0.39	0.10	21.8	10.41	0.47	1.96	1.01	16.85

pHw= pH-water; PBS = Base saturation percentage; CEC= cation exchange capacity; ECEC= Effective Cation Exchange Capacity; Al. Sat= Aluminium saturation; OC= Organic carbon.