Appendix -1. Fertilizer sales (ton) by product and year from 1980-81 to 2002-03 in Bangladesh

Year	Urea	TSP	SSP	DAP	MOP	Gypsum	Zinc	AS	Others	Total
1980-81	559.766	215.061	-	41.736	45.204	-	183	-	13.229	875.179
1981-82	518.775	208.478	-	48.518	44.836	-	810	-	7.906	829.323
1982-83	629.068	205.999	-	73.161	50.400	393	498	-	8.889	968.418
1983-84	708.070	260.730	-	93.831	63.222	1.267	745	-	1.196	1.129.081
1984-85	831.801	345.670	-	403	69.271	1.379	1.217	-	10.480	1.260.221
1985-86	794.496	297.415	-	53	59.867	3.269	706	-	178	1.155.987
1986-87	915.019	335.659	-	-	65.850	2.824	1.353	-	238	1.320.943
1987-88	1.029.077	390.159	-	-	86.139	1.390	1.639	6.796	-	1.515.191
1988-89	1.135.062	415.993	-	-	94.172	60.745	2.800	93	173	1.709.38
1989-90	1.369.237	479.767	718	-	118.663	67808	5.180	1.785	18	2.043.176
1990-91	1.323.937	514.761	12.120	-	149.761	101.782	2.743	2.763	211	2.107.538
1991-92	1.533.481	456.672	36.201	-	137.135	115.334	3.805	4.797	-	2.287.425
1992-93	1.547.407	407.002	119.828	2.010	126.083	108.140	722	4.992	-	2.316.184
1993-94	1.578.955	234.185	170.608	28.675	103.875	86.051	5.200	10.036	97	2.217.682
1994-95	1.748.459	122.947	533.485	1.837	154.240	77.161	-	2.491	-	2.640.620
1995-96	2.045.535	111.095	596.881	-	155.881	103.577	1.029	8.692	-	3.022.690
1996-97	2.119.883	72.629	525.285	-	219.302	86.611	1.161	11.692	-	3.036.563
1997-98	1.872.725	62.382	473.295	6.778	193.496	113.430	661	8.716	-	2.732.483
1998-99	1.902.024	170.247	362.370	38.633	210.784	128.215	269	12.418	-	2.824.924
1999-00	1.996.135	235.623	209.270	101.718	232.185	168.036	912	25.028	-	2.968.907
2000-01	2109,725	399.400	139,000	90,000	124,000	102,000	3,000	10,200	-	-
2001-02	2251,892	341,000	123,000	87,677	247,920	61,821	-	---		-
2002-03	2,239,236	328,000	129,722	118,471	278,000	39,190	-	-	-	-

Source: Monthly report FDI-11 and ATDP/IFDC and MOA, MMIS

Appendix –2. Nutrient compositions (%) of different chemical fertilizer

Source	Formula	N	P	K	S	Zn	Mn	Ca	Mg	B	Mo					
Urea	$CO(NH_2)_2$	46	-	-	-	-	-	-	-	-	-					
Ammonium Sulphate	$(NH_4)_2SO_4$	21	-	-	24	-	-	-	-	-	-					
Triple Super Phosphate	$Ca(H_2PO_4)_2$	-	20	-	1.3	-	-	14	-	-	-					
Single Super phosphate	$Ca(H_2PO_4)_2$ + $CaSO_4.2H_2O$	-	8	-	12	-	-	20	-	-	-					
Diammonium phosphate	$(NH_4)_2HPO_4$	18	20	-	-	-	-	-	-	-	-					
Muriate of Potash	KCl	-	-	50	-	-	-	-	-	-	-					
Potassium sulphate	K_2SO_4	-	-	42	18	-	-	-	-	-	-					
Magnesium sulphate	$MgSO_4.H_2O$	-	-	-	1.3	-	-	-	9.5	-	-					
Zinc sulphate, Monodydrate	$ZnSO_4.H_2O$	-	-	-	18	36	-	-	-	-	-					
Zinc sulphate, Heptahydrate	$ZnSO_4.7H_2O$	-	-	-	18	23	-	-	-	-	-					
Zinc oxide	ZnO	-	-	-	-	78	-	-	-	-	-					
Managanese sulphate	$MnSO_4.H_2O$	-	-	-	21	-	36	-	-	-	-					
Gypsum	$CaSO_4.2H_2O$	-	-	-	18	-	-	33	-	-	-					
Ammonium molybdate	$(NH_4)_6Mo_7O_{24}.2H_2O$	6.8	-	-	-	-	-	-	-	-	54					
Solubor	$Na_2B_80_{13}.4H_20$	-	-	-	-	-	-	-	-	20	-					
Borax	$Na_2B_40_7.10H_20$	-	-	-	-	-	-	-	-	10.5	-					
Boric acid	H_3BO_3	-	-	-	-	-	-	-	-	17	-					

Appendix –3. Trends in fertilizer nutrient use in selected South and Southeast Asian countries (kg/ha/yr).

Country	1973	1978	1983	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Bangladesh	18	33	48	73	93	98.9	103	100	98	108	115	126	134.6	140.5	161.7	156.3
China	64	108	184	262	265	282	308	306	264	309	280	260	263.3	264.7	269.2	256.6
India	17	30	46	65	69	71	75	72	73	80	85	90	95.4	99.0	106.4	98.6
Indonesia	26	39	75	113	109	78.2	83	78	86	85	80	70	71.5	85.9	78.9	73.8
Korea DPR	177	345	345	338	407	416.2	403	387	390	376	300	90	85.6	78.6	136.0	175.5
Malaysia	58	77	116	151	164	130.9	134	130	126	158	160	162	164.6	184.9	190.4	187.8
Mayanmar	4	9	16	8	9	7.5	8	9	15	17	17	17	17.5	16.9	15.8	20.0
Nepal	-	-	-	-	-	30.9	15	20	25	30	32	35	36.2	40.9	28.6	25.6
Pakistan	21	44	59	83	91	90.4	90	102	101	102	110	115	121.0	117.3	129.5	135.1
Philippines	35	41	46	65	68	59.4	48	55	61	65	70	75	81.7	62.8	74.1	73.1
R. of Korea	338	392	331	441	441	454.1	454	466	474	467	480	500	515.6	453.9	425.8	407.3
Sri Lanka	58	72	87	97	106	90.1	93	96	112	113	110	110	110.5	123.3	136.0	128.9
Thailand	10	16	25	39	39	50.7	41	50	58	61	70	75	80.5	89.5	97.2	86.1
Viet Nam	41	52	64	68	83	87.8	116	135	134	174	190	200	204.3	254.5	265.3	285.3
Australia						24.3	25	25	30	35	40	45	45.6	47.0	48.9	47.7
Japan						348.2	250	255	260	270	275	280	286.0	268.7	272.7	298.8
New Zealand						89.5	90	110	120	140	150	160	169.0	172.6	186.0	255.5

Source: Selected Indicators of Food and Agriculture Development in Asia-Specific R140egion (1991-2001), RAP Publication: 2002/19, Bangkok, October 2002.

Appendix 4: Nutrient concentration in different organic manure/material

Manure	Moisture (%)	N (%)	P (%)	K (%)	S (%)
Cowdung (fresh)	60±6.0	0.5±0.05	0.15±0.15	0.5±0.05	
Cowdung (decomposed)	35±3.5	1.2±0.12	1.0±0.1	1.6±0.16	0.13±0.01
Farmyard manure	67±6.7	1.6±0.16	0.83±0.08	1.7±0.17	0.56±0.06
Poultry manure	55±5.5	1.9±0.19	0.56±0.06	0.75±0.07	1.1±0.11
Compost (rural)	40±4.0	0.75±0.07	0.6±0.06	1.0±0.1	-
Compost (urban)	40±4.0	1.5±0.15	0.6±0.06	1.5±0.5	-
Compost (water hyacinth)	70±7.0	1.5±0.15	0.8±0.08	3.0 ±0.3	-
Mustard oilcake	15±1.5	5.0±0.5	1.8±0.18	1.2±0.12	-
Linseed oilcake	15±1.5	5.5±0.55	1.4±0.14	1.2±0.12	-
Sesame oilcake	15±1.5	6.2±0.62	2.0±0.2	1.2±0.12	-
Groundnut oilcake	-	7.0±0.7	1.5±0.15	1.3±0.13	-
Pressmud	55±5.5	1.85±0.18	0.13±0.02	0.54±0.05	0.56±0.06
Bone meal (raw)	8±0.8	3.5±0.35	9±0.9	-	-
Bone meal (steamed)	7±0.7	1.5±0.15	10±1.0	-	-
Dried blood	10±1.0	11±1.1	1.1±0.11	0.7±0.07	-
Fishmeal	10±1.0	7±0.70	3.5±0.35	1.0±0.10	-

Appendix 5: Nutrient concentration in green manure and crop residues

Green manure/ crop residues	Moisture (%)	N (%)	P (%)	K (%)	S (%)
Dhaincha	80±8	0.7±0.07	0.4±0.04	0.4±0.04	0.2±0.02
Mungbean	70±7	0.8±0.08	0.2±0.02	0.5±0.05	0.3±0.03
Blackgram	70±7	0.8±0.08	0.2±0.02	0.5±0.05	0.3±0.03
Cowpea	70±7	0.7±0.07	0.15±0.01	0.5±0.05	-
Sunhemp	70±7	0.7±0.07	0.12±0.01	0.5±0.05	-
Rice straw	30±3	0.4±0.04	0.1±0.01	1.5±0.15	-
Wheat straw	20±2	0.5±0.05	0.3±0.03	0.9±0.09	-
Sugarcane leaves	20±2	1.0±0.1	0.5±0.05	1.4±0.14	-

Appendix-6. Inoculant and seed requirement of different legumes.

Crop	Seed rate (kg/ha)	Inoculum rate	
		g/kg seed	kg/ha
Lentil	30	50	1.5
Chickpea	50	40	2.0
Mungbean	30	50	1.5
Blackgram	30	50	1.5
Cowpea	40	40	1.6
Grasspea	50	40	2.0
Groundnut	50	30	1.5
Soybean	60	20	1.2

Appendix 7. Interpretation for soil test values based on critical limits

A: Loamy to Clayey Soils of Upland Crops

Nutrient element*	Very Low	Low	Medium	Optimum	High	Very high
N (%)	≤ 0,09	0.091-0.18	0.181-0.27	0.271-0.36	0.361-0.45	>0.45
P (µg/g soil) (Olsen method)	≤ 7.5	7.51-15.0	15.1-22.5	22.51-30	30.1-37.5	>37.5
P (µg/g) (Bray & Kurtz method)	≤ 5.25	5.25-10.5	10.51-15.75	15.76-21.0	21.1-26.25	>26.25
S (µg/g) soil	≤ 7.5	7.51-15.0	15.1-22.5	22.51-30	30.1-37.5	>37.5
K (meq/100g)	≤ 0.09	0.091-0.18	0.181-0.27	0.271-0.36	0.361-0.45	>0.45
Ca (meq/100g)	≤ 1.5	1.51-3.0	3.1-4.5	4.51-6.0	6.1-7.5	>7.5
Mg (meq/100g)	≤ 0.375	0.376-0.75	0.751-1.125	1.126-1.5	1.51-1.875	>1.875
Cu (µg/g)	≤ 0.15	0.151-0.3	0.31-0.45	0.451-0.6	0.61-0.75	>0.75
Zn (µg/g)	≤ 0.45	0.451-0.9	0.91-1.35	1.351-1.8	1.81-2.25	>2.25
Fe (µg/g)	≤ 3.0	3.1-6.0	6.1-9.0	9.1-12.0	12.1-15.0	>15.0
Mn (µ/g)	≤ 0.75	0.756-1.5	1.51-2.25	2.256-3.0	3.1-3.75	>3.75
B (µg/g)	≤ 0.15	0.151-0.3	0.31-0.45	0.451-0.6	0.61-0.75	>0.75
Mo (µg/g)	≤ 0.075	0.076-0.15	0.151-0.225	0.226-0.30	0.31-0.375	>0.375

Nutrient Element*	Critical limit	Method of extraction
N (%)	0.12	Kjeldahl method
Organic C(%)	C:N=10:1	Wet oxidation method
P (µg/g)	10.0	Modified Olsen method (Neutral + Calcareous soils)
P (µg/g)	7.0	Bray & Kurtz method (Acid soils)
S (µg/g)	10.0	Calcium dihydrogen phosphate extraction
K (meq/100g)	0.12	N NH_4OAc method
Ca (meq/100g)	2.0	N NH_4OAc method
Mg (meq/100g)	0.5	N NH_4OAc method
Zn (µ/g)	0.6	DTPA extraction
Fe (µg/g)	4.0	DTPA extraction
Mn (µg/g)	1.0	DTPA extraction
B (µg/g)	0.2	Calcium chloride extraction
Mo (µg/g)	0.1	NH_4-oxalate extraction

indicates total status for N and available status for others

B: Sandy Soils for Upland Crops

Nutrient element*	Very Low	Low	Medium	Optimum	High	Very high
N (%)	≤ 0.075	0.076-0.15	0.151-0.226	0.227-0.30	0.31-0.375	>0.375
P (µg/g) (Olsen method)	≤ 6.0	6.1-12.0	12.1-18.0	18.1-24.0	24.1-30.0	>30.0
P (µg/g soil) (Bray & Kurtz method)	≤ 5.25	5.25-10.5	10.51-15.75	15.76-21.0	21.1-26.25	>26.25
S (µg/g)	≤ 6.0	6.1-12.0	12.1-18.0	18.1-24.0	24.1-30.0	>30.0
K (meq/100g)	≤ 0.06	0.061-0.12	0.121-0.18	0.181-0.24	0.241-0.3	>0.3
Ca (meq/100g)	≤1.5	1.51-3.0	3.1-4.5	4.51-6.0	6.1-7.5	>7.5
Mg (meq/100g)	≤ 0.375	0.376-0.75	0.751-1.125	1.126-1.5	1.51-1.875	>1.875
Cu (µg/g)	≤ 0.15	0.151-0.3	0.31-0.45	0.451-0.6	0.61-0.75	>0.75
Zn (mg/g)	≤ 0.375	0.376-0.75	0.751-1.125	1.126-1.5	1.51-1.875	>1.875
Fe (µg/g)	≤ 2.25	2.26-4.5	4.51-6.75	6.76-9.0	9.1-11.25	>11.25
Mn (µg/g)	≤ 0.75	0.756-1.5	1.51-2.25	2.256-3.0	3.1-3.75	>3.75
B (µg/g)	≤ 0.12	0.121-0.24	0.241-0.36	0.361-0.48	0.481-0.6	>0.6
Mo (µg/g)	≤ 0.045	0.046-0.09	0.091-0.135	0.136-0.18	0.181-0.225	>0.225

Nutrient Element*	Critical limit	Method of extraction
N (%)	0.10	Kjeldahl method
Organic C(%)	C:N=10:1	Wet oxidation method
P (µg/g)	8.0	Modified Olsen method (Neutral + Calcareous soils)
P (µg/g)	7.0	Bray & Kurtz method (Acid soils)
S (µg/g)	8.0	Calcium dihydrogen phosphate extraction
K (meq/100g)	0.08	N NH_4OAc method
Ca (meq/100g)	2.0	N NH_4OAc method
Mg (meq/100g)	0.5	N NH_4OAc method
Zn (µ/g)	0.5	DTPA extraction
Cu (µg/g)	0.2	DTPA extraction
Fe (µg/g)	3.0	DTPA extraction
Mn (µg/g)	1.0	DTPA extraction
B (µg/g)	0.16	Calcium chloride extraction
Mo (µg/g)	0.06	NH_4-oxalate extraction

indicates total status for N and available status for others

C: Loamy to Clayey Soils of Wetland Rice Crops

Nutrient element*	Very Low	Low	Medium	Optimum	High	Very high
N (%)	≤ 0.09	0.091-0.18	1.181-0.27	0.271-0.36	0.361-0.45	>0.45
P (µg/g) (Olsen method)	≤ 6.0	6.1-12.0	12.1-18.0	18.1-24.0	24.1-30.0	>30.0
P (µg/g) (Bray & Kurtz method)	≤ 3.75	3.76-7.5	7.6-11.25	11.26-15.0	15.1-18.75	>18.75
S (µg/g)	≤ 9.0	9.1-18.0	18.1-27.0	27.1-36.0	36.1-45.0	>45.0
K (meq/100g)	≤ 0.075	0.076-0.15	0.151-0.225	0.226-0.30	0.31-0.375	>0.375
Ca (meq/100g)	≤ 1.5	1.51-3.0	3.1-4.5	4.51-6.0	6.1-7.5	>7.5
Mg (meq/100g)	≤ 0.375	0.376-0.75	0.751-1.125	1.126-1.5	1.51-1.875	>1.875
Cu (µg/g)	≤ 0.15	0.151-0.3	0.31-0.45	0.451-0.6	0.61.0.75	>0.75
Zn (µg/g)	≤ 0.45	0.451-0.9	0.91-1.35	1.351-1.8	1.81-2.225	>2.25
Fe (µg/g)	≤ 3.0	3.1-6.0	6.1-9.0	9.1-12.0	12.1-15.0	>15.0
Mn (µg/g)	≤ 0.75	0.756-1.5	1.51-2.25	2.256-3.0	3.1-3.75	>3.75
B (µg/g)	≤ 0.15	0.151-0.3	0.31-0.45	0.451-0.6	0.61-0.75	>0.75
Mo (µg/g)	≤ 0.075	0.076-0.15	0.151-0.225	0.226-0.30	0.31-0.375	>0.375

Nutrient Element*	Critical limit	Method of extraction
N (%)	0.12	Kjeldahl method
Organic C(%)	C:N=10:1	Wet oxidation method
P (µg/g)	8.0	Modified Olsen method (Neutral + Calcareous soils)
P (µg/g)	5.0	Bray & Kurtz method (Acid soils)
S (µg/g)	10.0	Calcium dihydrogen phosphate extraction
K (meq/100g)	0.12	N NH_4OAc method
Ca (meq/100g)	2.0	N NH_4OAc method
Mg (meq/100g)	0.5	N NH_4OAc method
Zn (µ/g)	0.6	DTPA extraction
Cu (µg/g)	0.2	DTPA extraction
Fe (µg/g)	4.0	DTPA extraction
Mn (µg/g)	1.0	DTPA extraction
B (µg/g)	0.2	Calcium chloride extraction
Mo (µg/g)	0.1	NH_4-oxalate extraction

indicates total status for N and available status for others

Appendix 8. Location specific and yield goal basis fertilizer recommendation for crops based on soil test values.

For example: Crop-Wheat (High Yield Goal; HYG) = 4.5 $\pm$ 0.45 t/ha

Location: Village .....Upazila ..... District .....

Soil analysis	**Soil test value**	**Soil test value interpretation (App. 7A)**	**Range of values used within the interpretation class (App. 7A)**
Texture	Loam	-	-
Total-N (%)	0.1	Low	0.091-0.18
Available P (µg/g)	18	Medium	15.1-22.5
Exchangeable K (meq/100g)	0.15	Low	0.091-0.18
Available S (µg/g)	10	Low	7.51-15.0
Available Zn (µg/g)	1.0	Medium	0.91-1.35
Available B (µg/g)	0.2	Low	0.151-0.3

Step-1 : Consult the Appendix 7A to see the position of given soil test value within the range of the interpretation class.

Step-II: Consult the Table 1 under wheat (page # 73) to see the range of fertilizer nutrient recommended for the same soil test value interpretation class.

Step-III: Compute the exact fertilizer nutrient required for making the recommendation following the formula given below:

$$F_r = U_f - \frac{C_i}{C_s} \times (S_t - L_s)$$

Where

$\mathbf{F_r}$ = Fertilizer nutrient required for given soil test value

$\mathbf{U_f}$ = Upper limit of the recommended fertilizer nutrient for the respective STVI class

$\mathbf{C_i}$ = Units of class intervals used for fertilizer nutrient recommendation

$\mathbf{C_s}$ = Units of class intervals used for STVI class

$\mathbf{S_t}$ = Soil test value

$\mathbf{L_s}$ = Lower limit of the soil test value within STVI class

Example:
N (kg/ha) = $120 - \frac{40}{0.09} \times (0.1-0.091)$

= $120 - \frac{40}{0.09} \times (0.009) = 120 - \frac{(40}{9}\ 0.9) = 120 - \frac{36}{9}$

= 120 — 4 = 116 kg N/ha

= 116 x $\frac{100}{46}$ = 252.24 kg Urea/ha

P (kg/ha) = $20 - \frac{10}{7.5}\ (18-15.1) = 20 - \frac{10}{7.5} \times 2.9$

= 20 — 3.9 = 16.1 kg P/ha

= 16.1 X $\frac{100}{20}$ = 80.5 kg TSP/ha

K (kg/ha) = $90 - \frac{30}{0.09} \times (0.15 - 0.091)$

= $90 - \frac{30}{0.09} \times (0.059) = (90 \cdot \frac{30x5.9}{9})$

= 90 — 19.7 = 70.3 kg k/ha

= 70.3 x $\frac{100}{50}$ = 140.6 kg KCI/ha

S (kg/ha) = $15 - \frac{5}{7.5} \times (10 - 7.51) = 15 - 1.66$ = 13.3 kg S/ha

= 13.34 x $\frac{100}{18}$ = 74.11 kg Gypsum/ha

Zn (kg/ha) = $1.3 - \frac{1.3}{0.45} \times (1.0-0.91) = 1.3 - \frac{1.3}{0.45} \times 0.09 = 1.3-0.26$

= 1.04 kg Zn/ha = 1.04 x $\frac{100}{36}$ = 2.9 kg Zinc sulphate, monohydrate/ha

B (kg/ha) = $0.6 - \frac{0.3}{0.15} \times (0.2 - 0.151)$

= $0.6 - \frac{0.3}{0.15} \times (0.049) = 0.6 - 0.098$ = 0.502 kg B/ha

= 0.502 x $\frac{100}{17}$ kg Boric acid/ha = 2.95 kg Boric acid/ha

Note:

When zinc sulphate is used there is also sulphur supplied (approximately 18% S in $ZnSO_4.H_2O$). Thus if 2.9 kg of zinc sulphate is used

$$\frac{2.9 \times 18}{100} = 0.52 \text{ kg of S will be added per hectare}$$

Thus the requirement from the example above can be reduced to (13.34 – 0.52) = 12.82 S/ha. The new calculation for sulphur from gypsum would then be

$$\frac{100 \times 12.82}{18} = 71.2 \text{ kg gypsum/ha}$$

The Final Recommendation

From the above example, the final recommendation would be

Nutrient (kg/ha)	**Fertilizer (kg/ha)**	**Fertilizer/Nutrient Ratio**
N = 116	Urea = 252.2	2.17
P = 16.1	TSP = 80.5	5.00
K = 70.3	MP = 140.6	2.00
S = 13.34	Gypsum = 71.2	5.56
Zn = 1.04	Zinc sulphate, = 2.9 monohydrate	2.79
B = 0.502	Boric acid = 2.95	5.88

Appendix 9. Site specific fertilizer recommendation for crops and cropping patterns on the basis of soil test, yield goal and rationales

Example 1: Boro (MV)-Fallow-T.Aman (MV)

Soil Analysis Interpretation	Texture	pH	N %	P (µg/g)	K (meq/100 g)	S (µg/g)	Zn (µg/g)
	Silt loam	7.0	0.08	11	0.17	12	3.0
		Neutral	Very Low	Low	Medium	Low	Very high

Crops and Yield Goal	Fertilizer recommendation (kg/ha)				
	N	P	K	S	Zn
Boro (HYG) 6.0±0.6 (t/ha)	158	18	38	11	-
Fallow	-	-	-	-	-
T.Aman (HYG) 5.0±0.5 (t/ha)	105	7	24	11	-

Example 2: Mustard (MV) - T.Aus (MV)- T.Aman (MV)

Soil Analysis Interpretation	Texture	pH	N %	P (µg/g)	K (meq/100)	S (µg/g)	Zn (µg/g)	B (µg/g)
	Silt loam	7.0	0.08	11	0.17	12	3.0	0.4
		Neutral	Very Low	Low	Low: *for Upland Crops* Medium: *for rice*	Low	Very high	Medium

Crop and Yield Goal	Fertilizer recommendation (kg/ha)					
	N	P	K	S	Zn	B
Mustard (HYG) 2.0±0.2 (t/ha)	140	30	75	23	-	0.4
T.Aus (HYG) 3.5±0.35 (t/ha)	60	6	15	8	-	-
T.Aman (HYG) 5.0±0.5 (t/ha)	105	7	24	11	-	-

Appendix 10. Symbols and Atomic Weights of Some Elements

Element	Symbol	Atomic Weight	Element	Symbol	Atomic Weight
Aluminum	AI	26.98	Magnesium	Mg	24.30
Boron	B	10.81	Manganese	Mn	54.94
Calcium	Ca	40.08	Molybdenum	Mo	95.94
Carbon	C	12.01	Nitrogen	N	14.01
Chlorine	CI	35.453	Oxygen	O	16.00
Cobalt	Co	58.94	Phosphorus	P	30.98
Copper	Cu	63.55	Potassium	K	39.102
Fluorine	F	19.00	Silicon	Si	28.09
Hydrogen	H	1.008	Sodium	Na	22.99
Iodine	I	126.92	Sulfur	S	32.06
Iron	Fe	55.85	Zinc	Zn	65.38

Appendix 11. Useful Chemical Conversion Factors

N x 1.22 = NH_3	HNO_3 x 0.22 = N
P x 2.29 = P_2O_5	H_3PO_4 x 0.32 = P
P_2O_5 x 0.44 = P	$Ca_3(P0_4)_2$ x 0.20 = P
K x 1.20 = K_2O	KCI x 0.52 = K
K_20 x 0.83 = K	K_2SO_4 x 0.45 = K
Ca x 1.40 = CaO	$CaSO_4$ x 0.29 = Ca
MgO x 0.60 = Mg	$MgCO_3$ x 0.28 = Mg
S x 3.00 = SO_4	H_2SO_4 x 0.33 = S
SO_4 x 0.33 = S	$CaSO_4$ x 0.24 = S

Some useful conversion factors

1 sqm	= $1x10^{-4}$ha	1 ha	= 10,000 sqm
1 kg	= 2.2046 pounds	1 Ib	= 0.4535 kg

Kg/ha x 0.892	= pound/acre
Pound/acre x 1.121	= kg/ha

Appendix 12. Classification of Soils on the Basis of Organic Matter Content and Cation Exchange Capacity

Class	Organic Matter (%)	Cation Exchange Capacity (meq/100 g)
Very high	>5.5	>30
High	3.5-5.5	16-30
Medium	1.8-3.4	7.6-15
Low	1.0-1.7	3-7.5
Very low	<1.0	<3

Appendix 13. Classification of Soils on the Basis of Potassium Bearing Minerals in the Clay Fractions

Class	Mica in clay fraction (%)	Mica intensity ratio (100/002)
High	>30	>4
Medium	20-30	2-4
Low	<20	<2

Appendix 14. Classification of Soils on the Basis of soil pH values

pH	Soil reaction class
<4.5	Very strongly acidic
4.6-5.5	Strongly acidic
5.6-6.5	Slightly acid
6.6-7.3	Neutral
7.4-8.4	Slightly alkaline
8.5-9.0	Strongly alkaline
>9.0	Very strongly alkaline

Source: SRDI

Appendix 15. Classification of Land Type

Highland	:	Land which is above normal flood-level
Medium highland	:	Land which normally is flooded up to about 90 cm deep during the flood season
Medium lowland	:	Land which normally is flooded between 90 and 180 cm deep during the flood season
Lowland	:	Land which normally is flooded between 180 and 300 cm deep during the flood season
Very lowland	:	Land which normally is flooded above 300 cm during the flood season

Appendix 16. Available forms of plant nutrients

Nutrient	**Available forms**	**Sources**
Carbon	CO_2	Air
Hydrogen	H_2O	Water
Oxygen	H_2O	Air, Water
Nitrogen	NH_4^+,NO_3^-	Soil, Fertilizers
Phosphorus	$H_2PO^-_4$, HPO_4^{2-}, PO_4^{3-}	Soil, Fertilizers, Minerals
Potassium	K^+	Soil, Fertilizers
Sulphur	SO_4^{2-},SO_3^{2-}	Soil, Fertilizers
Calcium	Ca^{2+}	Soil, Fertilizers
Magnesium	Mg^{2+}	Soil, Fertilizers
Iron	Fe^{2+},Fe^{3+}	Soil, Fertilizers
Manganese	Mn^{2+},Mn^{4+}	Soil, Fertilizers
Zinc	Zn^{2+}	Soil, Fertilizers
Copper	Cu^+,Cu^{2+}	Soil, Fertilizers
Boron	H_3BO_3, $B_40_7^{2-}$, $H_2B0_3^-$	Soil, Fertilizers
Molydenum	MoO_4^{2-}	Soil, Fertilizers
Chlorine	Cl^-	Soil, Fertilizers