

EPPAWELA ROCK PHOSPHATE FERTILIZER

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INTRODUCTION

The Eppawela Rock Phosphate deposit which is of igneous "apatite" type was discovered in 1971 at Eppawela in the North Central Province, by the Geological Survey Department. Eppawela is located on the Kekirawa-Talawa road and is almost 175 km from Colombo. Eppawela lies in the Mihintale Electorate and falls within the administrative district of Anuradhapura.

Since 1975, the deposit has been exploited under the District Development Co-operative (DDC) Scheme and was then handed over to State Mining and Mineral Development Corporation (SMMDC) in 1979. The mineral rock samples are crushed in primary and secondary crushers and ground to 100 BS mesh size and are available as Eppawela Rock Phosphate (ERP) fertilizer mixed with or without other fertilizer ingredients, for direct application to a few crops, due to its low solubility.

GENERAL GEOLOGY AND MODE OF OCCURRENCE

The deposit is exposed in the form of six hillocks rising to a maximum altitude of about 250 m amsl, and covering an area of about 150 ha. The surrounding rocks are mainly charnockitic series, granite, granite gneisses and quartzites of pre-Cambrian age (more than 570 million years of age). This deposit has a firm reserve of 30 million tons of Rock Phosphate with an average of 37% P_2O_5 . The inferred reserves

are in the region of 60 million tons. This deposit could easily be utilized for more than 100 years and may be considered as the richest phosphate deposit in the world as it consists of a P_2O_5 content up to 40%. The deposit occurs in the form of a "weathered" and "leached" zone forming the "cappings" of the 6 hillocks extending to depths of 30 to 100 m from the crest of the hillocks.

The Eppawela Phosphate deposit consists of three different forms of apatite. The Chloro-fluro Apatite crystals are of pre-Cambian origin while the Hydroxy Apatite and Carbonate Apatite of secondary origin are much younger in age perhaps some thousands of years.

INTERNATIONAL PRODUCTION

It has been estimated that the total Rock Phosphate reserves in the world are about 87 billion tons, out of which 65.5 billion tons are of sedimentary rocks, 8.6 billion of igneous apatite rocks and 13 billion from offshore deposits. Over 90% of the world phosphate rock production is utilized in Agriculture as direct and/or indirect phosphate fertilizers. The balance is utilized for manufacture of animal feed supplements, detergents, and of P-based chemicals.

Although the world production of Phosphate rock comes from open-pit mining, the underground mining carried out in USSR, Morocco, Tunisia and Jordan accounts for a significant proportion. Although many countries produce Phosphate rock, 70% of the production comes from USA, USSR, Morocco and China. The US production is controlled by private companies while the production in other countries is directly or indirectly managed by state-owned companies. Table 1 shows the world production of Phosphate rock.

Table 1 - World Production of Phosphate Rock
World Production of Phosphate Rock (1000 tons)

	Country	1970	1981	1985	1986	1987
1.	U.S.A.	35,100	52,900	49,408	37,870	40,750
2.	U.S.S.R.	17,800	25,200	33,000	32,000	33,300
3.	Morocco	11,400	19,700	20,737	21,178	20,955
4.	China	1,700	11,500	6,970	11,000	12,150
5.	Jordan	900	4,200	6,067	6,249	6,801
6.	Tunisia	3,000	4,600	4,530	5,951	6,388
7.	Brazil	200	2,800	4,214	4,507	4,403
8.	Israel	1,200	2,400	4,076	3,673	3,798
9.	Togo	1,500	2,200	2,452	2,341	2,644
10.	S. Africa	1,200	3,000	2,420	2,923	2,548
11.	Senegal	-	1,927	2,145	1,982	2,080
12.	Syria	-	-	1,270	1,606	1,986
13.		-	1,480	1,508	1,494	1,376
14.	Egypt	-	-	1,074	1,272	1,110
15.	Algeria	-	-	1,208	1,203	1,073
16.		-	1,423	1,199	825	842
17.	Iraq	-	-	800	800	800
18.	India	-	-	750	760	780
19.	Sri Lanka	-	15	17	14	21
20.	Others	2,730	8,053	4,166	3,722	5,025
	Total	76,730	138,445	145,304	139,057	146,612

A joint F.A.O./U.N working group forecasts that the world demand for phosphate rock may reach 365 million tons by year 2000, assuring an average annual growth rate of 5% while the US Bureau of Mines forecasts that the world demand will reach 200 million tons by year 2000, assuming an average annual growth rate of 2.4%.

LOCAL PRODUCTION

Until 1980 grinding of mineral phosphate rock was done with locally fabricated ball-mill (by Walkers Ltd.). In 1981 an Indian made five roller "Raymond Mill" was installed and since then production has been gradually increased from 14,075 MT in 1980 to 28,000 MT in 1989. The SMMDC wishes to increase the production gradually to 45,000 MT by year 1995.

Eppawela Rock Phosphate (ERP) fertilizer mixed with or without other major fertilizer nutrients such as N and K is being directly applied to tea, rubber and coconut sector while the other crops receive very little ERP. At the moment, no chemical processing or beneficiation is adopted to make ERP a more solublised-P form, due to various reasons, such as high chloride content (0.63-1.1%) and high $Al_2O_3 + Fe_2O_3$ content (6.5-9.0%) that will pose serious manufacturing problems.

A group of local scientists has developed a process of acidulating ERP with hydrochloric acid. The reaction products are mixed with ammonium sulphate to yield a non-hygroscopic product containing almost all P in a water soluble form. A Polish group of scientists has developed a process where finely ground rock phosphate is mixed with elemental sulphur and the mixture is

inoculated, with a sulphur oxidising bacteria. The SMMDC is presently studying the above process in detail with a view to adapting one of these methods for beneficiating ERP to make it more soluble in order to save millions of foreign exchange spent on imported Rock Phosphate (IRP), Triple Super Phosphate (TSP) and Di-Ammonium Phosphate (DAP) fertilizer which are more soluble than the presently produced ERP.

APPLICATION OF EPPAWELA ROCK PHOSPHATE

Eppawela Rock Phosphate fertilizer is mainly used in the fertilizer mixtures of tea, rubber and coconut crops while very little quantity is used in other crops. Tables 2, 3 and 4 show the usage of ERP and IRP in the tea, rubber and coconut sector respectively for the period 1979 to 1989.

Of its P-fertilizer requirement the Tea Sector has used 56-89% ERP despite the 100% recommendation of ERP for both young and mature tea during the period 1985-1989. Di-Ammonium Phosphate (DAP) is being used for tea nursery plants.

This clearly shows that the Tea Sector consumes well over 50% of the total national production of ERP while the balance is consumed by the Rubber and Coconut Sectors. It is to be noted that ERP is applied only for the mature rubber and coconut crops while IRP is applied for the immature stages of these crops.

It is interesting to note that the usage of IRP in the Tea Sector dropped to a minimum level of 1900 MT in 1989, and could have saved millions of rupees of foreign exchange spent on IRP by substituting 100% ERP. For instance, Tea Sector itself could have saved 27.5 million rupees foreign exchange spent for IRP in 1988 and 1989.

TABLE 2 - Usage of Imported Rock Phosphate (IRP) and Eppawela Rock Phosphate (ERP) in the Tea Sector

Year	IRP (MTX10 ³)	ERP (MTX10 ³)	ERP/(IRP+ERP) (%)	ERP/Total ERP Production (%)	Recommend- ation of ERP (%)
1978	20.6	-	-	-	-
1979	9.6	4.3	31	54	100
1980	8.5	5.1	38	36	"
1981	3.2	10.4	77	68	"
1982	3.1	9.9	76	70	"
1983	5.7	8.7	60	55	"
1984	6.4	10.6	62	78	"
1985	7.6	9.6	56	56	"
1986	6.9	8.5	55	57	"
1987	5.5	13.6	71	65	"
1988	4.8	13.0	73	56	"
1989	1.9	15.7	89	56	"

TABLE 3 - Usage of Imported Rock Phosphate (IRP) and Eppawela Rock Phosphate (ERP) in the Rubber Sector

Year	IRP (MTX10 ³)	ERP (MTX10 ³)	ERP/(IRP+ERP) (%)	ERP/Total ERP Production (%)	Recommend- ation of ERP (%)
1978	3.9	-	-	-	-
1979	5.7	2.9	34	37	-
1980	7.0	1.4	17	10	-
1981	3.0	2.7	48	18	50
1982	4.3	2.6	38	19	50
1983	5.0	2.6	34	17	50
1984	5.4	3.7	41	27	50
1985	7.0	3.5	33	20	50
1986	7.5	4.2	36	28	50
1987	6.8	3.4	33	16	50-100*
1988	6.3	3.8	38	17	100
1989	4.7	4.5	49	16	100

* 100% ERP recommendation was given in July 1987

TABLE 4 - Usage of Imported Rock Phosphate (IRP) and Eppawela Rock Phosphate (ERP) in the Coconut Sector

Year	IRP (MTx10 ³)	ERP (MTx10 ³)	ERP/(IRP+ERP) (%)	ERP/Total ERP Production (%)	Recommend- ation of ERP (%)
1978	7.8	-	-	-	-
1979	10.6	0.7	6	9	0
1980	14.3	1.7	11	12	"
1981	6.6	1.4	18	9	"
1982	7.0	1.3	16	9	"
1983	8.6	0.7	8	5	"
1984	13.2	1.1	8	8	"
1985	11.6	0.1	1	0.6	"
1986	9.2	-	-	-	"
1987	9.8	1.5	13	7	"
1988	8.0	2.8	26	12	"
1989	4.4	3.5	44	13	0-50

50% ERP Recommendation was given in November 1989

PHOSPHORUS FIXATION IN SOILS

Fixation of applied P-fertilizer is a well known problem in both tea and rubber soils due to their low pH coupled with the presence of high concentrations of gibbsite and goethite minerals found in tea soils. P-fixation is not considered as a serious problem in coconut soils as the soil pH is higher compared to the above two soil types.

TEA CROP RESPONSE TO APPLIED ROCK PHOSPHATE

Results of long-term field experiments carried out in St. Coombs showed that the tea crop response to applied Rock Phosphate (as IRP/ERP) is restricted to 34-56 kg/ha⁻¹ year⁻¹ P₂O₅ with little or no yield increase over the control which did not receive any P-fertilizer.

PROSPECTS FOR STUDIES ON PHOSPHORUS IN THE NEXT DECADE

Since we have limited available information on the dynamics of soil-P and soil applied P-fertilizer, and their impact on the overall yield of the tea crop, the Tea-Phosphorus research programme launched in 1990 consists of the following lines of investigation:

1. Adsorption/desorption behaviour of applied P-fertilizer in tea soils of different tea growing districts in relation to P-fertilisation. This is extremely important as we do not consider the different soil types, their nature, origin and mineralogy and cropping pattern or crop response to applied P-fertilizer, at present.

2. Tea crop-response to applied P-fertilizer in different tea growing districts at closer intervals of applied P-fertilizer (kg ha^{-1}) since there is a scarcity of such information.
3. Assessment of short, medium and long-term soil P reserves in our acid tea soils is of utmost importance as we have been applying P-fertilizer for a couple of decades.
4. Improvement of soil-P availability by incorporating P-fertilizer into the root zone of the tea bush i.e. 0-15 cm depth as the downward movement of surface applied P-fertilizer in tea soil is very slow.
5. If item 4 proved useful in improving the soil/plant P-availability, soil incorporation of P-fertilizer once a year may be considered due to its long-lasting residual effects.
6. The development of a new strategy for application of P-fertilizer in the first year of pruning following different levels of dolomite fertilizer application, as there is an interaction between dolomite fertilizer and P-fertilizer which would in turn limit the soil/plant P-availability.
7. Does the presently employed method of soil analysis of P guarantee the adequate level/s of P in different soil types. This may have to be coupled with leaf P analysis which would give us a better understanding of P-status in crop because soil P uptake by plant can be limited due to the presence of other soil chemical constituents.

8. Substitution of beneficiated ERP for Di-Ammonium Phosphate in the tea nursery mixture.
9. Improvement of uptake of P by plant material with the help of agronomic practices such as incorporation of organic matter and increase in soil pH, etc. In this context, foliar application of water soluble form of P-fertilizer may play an important role where the adequate levels of soil-exchangeable P are available but not taken up by the plant due to other soil-mineral interactions.
10. Improvement of soil/plant available P by inoculating mycorrhizal-fungi into the major root zone of the tea bush.

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