PRODUCTIVITY IN THE FERTILIZER INDUSTRY: PHALABORWA PHOSPHATE ROCK

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Introduction

The term 'productivity' is usually understood to mean the ratio of output to input.

Output can be goods or services. For the purposes of this paper, it is phosphate rock, of a quality that is suitable for use in the local fertilizer industry. Inputs include manpower, machinery, chemicals, energy, water and raw materials in the form of phosphate bearing ores.

To simply quote productivity indices, eg. tons of phosphate rock produced per ton of ore mined, per man-hour, or per MWh, is meaningless. These indices have to be compared, either to the indices of a competitor, or to those of the same company in previous years.

Unfortunately, no two phosphate rock producers in the world operate under sufficiently similar conditions to make comparisons between competitors meaningful.

Table 1 illustrates the diversity of the phosphate ore deposits that constitute Foskor's main competitors on the world market.

Foskor has the lowest head grade, and consequently the highest ore to product ratio.

In the USA, USSR and South Africa the ores are relatively low-grade and require extensive beneficiation, eg. crushing, screening, milling, flotation and drying. In most of the North African mines beneficiation involves only screening, washing and drying.

Some sedimentary deposits are soft, unconsolidated sands and are easily mined by draglines. The igneous deposits and some sedimentary deposits require hard rock mining methods, ie. drilling and blasting.

Foskor's market environment

For the reasons mentioned above, it is meaningless to compare conventional productivity indices between Foskor and other phosphate mines. What counts in the final analysis is whether Foskor can supply its product, firstly to the domestic consumers and secondly to consumers abroad at competitive prices. Since phosphate rock is a very cheap bulk commodity, transport costs feature very largely in the delivered cost of phosphate rock. Foskor has to contend with much higher shipping costs than its competitors, as well as much higher railage costs to port, since all its competitors are situated within less than 200 km from harbours. Transport costs insulate the domestic market from imports to a large extent, but they also constitute a major hurdle to phosphate rock exports from Phalaborwa.

When a consumer purchases phosphate rock, he does not buy only in terms of delivered cost per ton of P_2O_5 ratio, which in turn determines the sulphuric acid consumption per ton of phosphoric acid manufactured.

Impurities such as Al_2O_3 and Fe_2O_3 influence the gypsum crystallisation process, which in turn determines the phosphoric acid filtration rate and rates of scaling in the plant, and hence often the phosphoric acid production rate.

The SiO_2 to F ratio and the C1 content of the rock determines the corrosion rate of the stainless steel in the phosphoric acid plant.

The MgO content has a profound effect on the phosphoric acid viscosity and the hygroscopicity of granulated fertilizers. The carbonate content and to some extent the organic carbon content determine foaming conditions. Crystal structure of the apatite and particle size influence the reaction rate during the manufacture of phosphoric acid and superphosphates.

TABLE 1. Characteristics of major phosphate ore deposits.

Country	Area	Ore Type	Waste: Ore Ratio	Type of Mine	Head Grade % P_2O_5	Ore: Product Ratio
USA	Florida	Sedimentary	1,5-5,3	Open-cast	9 - 14	3 - 5
Morocco	Youssoufia	Sedimentary	0,32	Underground	30	1,18
	Bu-Craa	Sedimentary	5,0	Open-cast	31,5	1,6
Togo	Hahotoe	Sedimentary	3,5	Open-cast	28	1,9
Jordan	El Hassa	Sedimentary	2,6	Open-cast	29	1,6
USSR	Kola	Igneous	0,03	60% Surface 40% Underground	15	3,1
RSA	Phalaborwa	Igneous	0,05	Open-cast	7	6

A customer thus effectively purchases the most economical rock which is suitable for his process and his end product range, ie. he considers not only the lowest cost per unit of P_2O_5 contained in the rock, but also the grinding rate, the sulphuric acid consumption, the ease of processing, the effective plant capacity, and the effects of impurities on the quality of his products.

For the above reasons being competitive in a particular market involves more than the lowest price per ton of rock. In Europe, for instance, Foskor's 86BPL rock and Kola's 85BPL rock can command delivered prices of 35% to 45% above that of certain grades of Florida and Moroccan rock, because of the purity of the igneous rock types.

Productivity indices at Foskor

Because of the considerable differences amongst the various phosphate ore deposits and, resulting therefrom, amongst the phosphate rock types produced, it is more meaningful to plot the productivity indices of a given company over a period of time, than to compare indices amongst companies. This paper gives such an analysis for Foskor. In order to eliminate the distortions caused by inflation, all financial figures were converted to 1975 Rands.

Productivity of Capital Employed

Capital per ton of ore processed

Figure 1 shows the capital employed (deflated to reflect constant 1975 Rands) per annual ton of ore processed.

FIG 1. Deflated capital (constant 1975 rands) employed per annual ton of ore processed.

Between 1974 and 1977 Foskor's production capacity was increased by 180%, mainly in order to support the phosphoric acid export drive of the local fertilizer industry. A further expansion in 1981 took Foskor's capacity to 3,3 million tons of phosphate rock per annum, or 240% above the 1974 capacity.

Over the period 1975 — 1985:

- Fixed asset application dropped from R7,40/ton of ore to R4,10/ton of ore which is an *80,5% increase* in productivity.
- Operating assets applied increased from R1,60/ton to R2,10/ton, which represents a *23,8% decrease* in productivity.
- Total assets applied decreased from R9,00/ton to R6,20/ton, which is a *45,2% increase* in productivity.

Between 1980 and 1985 the phosphate rock held in stock at Phalaborwa increased from 490 000 tons to almost 1 million tons. Between 1981 and 1985 domestic sales dropped by 12% due to the severe and prolonged drought, and the phosphoric acid export market collapsed, causing a drop of 34% in sales in this market sector, but it was more economical to increase stocks than to decrease production.

This loss in sales has been largely negated by a concerted effort to develop overseas markets for phosphate rock, and the productivity of capital employed has begun to increase again.

Labour Productivity

Figure 2 illustrates the labour productivity in terms of labour cost in constant 1975 Rand per ton of ore processed.

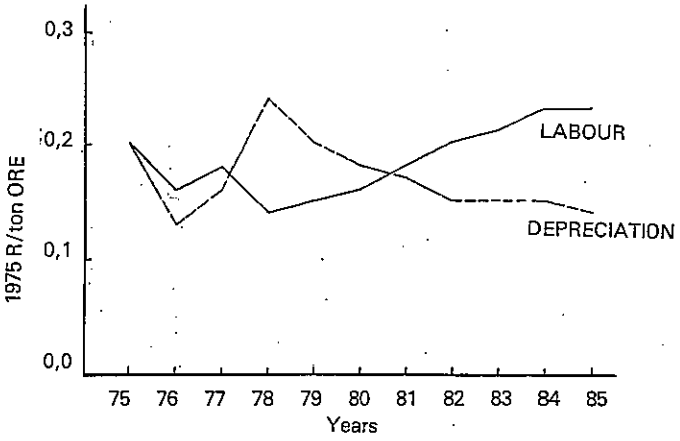

FIG 2. Productivity indices labour and depreciation 1975 - 1985.

The rapid expansions of 1974 to 1979 led to a significant increase in labour productivity, but the slump thereafter, coupled with labour cost increases in excess of the inflation rate in some years led to a rapid decline in labour productivity.

The export drive, coupled with a programme to improve productivity have reversed the trend and labour productivity figures are beginning to improve. Due to Foskor's geographical location vis-a-vis Lebowa and Gazankulu, the company has done its best to provide work and not to retrench staff in these recessionary times. The decline in labour productivity from 1975 to 1985 amounts to 13,7%.

Figure 2 also illustrates the effect of depreciation charges per ton of ore processed over the 11 year

period. Forkos practices straight-line depreciation over 20 years, ie. the curve should slope downwards. The sudden rise in 1978 is due to the large expansions at that time.

Production Cost and Overheads

Figure 3 contains data on the contribution of overheads and direct production cost to total cost. Labour cost is also plotted in order to put its contribution in perspective.

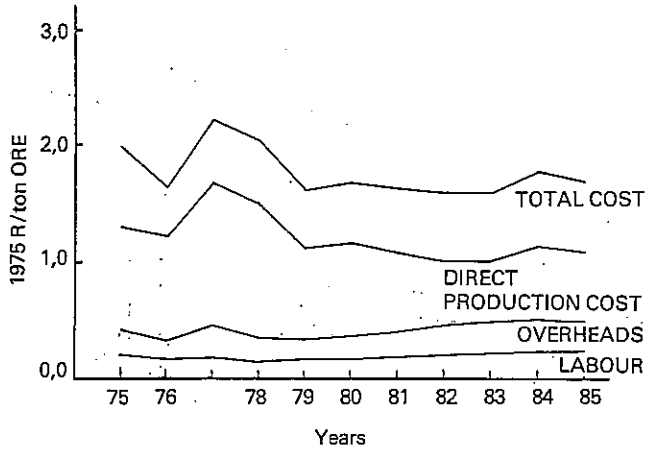

FIG. 3 Cost productivity indices 1975 - 1985.

Overheads showed a gradual rise from 1980 to 1984, reflecting initially the reduced market due to the drought and the recession, and in more recent times, the classification of Foskor as an industry of strategic significance, thereby necessitating increased expenditure on security. A concerted programme to cut costs and improve productivity has recently reversed this trend. Over the entire period of 11 years the productivity of overhead costs has declined by 12,1%.

Direct production cost increased sharply in 1976/1977 when new plant was being commissioned, and the cost of chemicals rose sharply. Increases in efficiency gradually brought the production cost down until 1983, when the rapid fall in the value of the rand caused a sharp rise again, due to the imported reagents used in the phosphate flotation process. This was largely contained and reversed in 1985 by technical innovations that further increased the plant efficiency. The downward trend is still continuing. Over the period 1975-1985 the increase in productivity of production cost was 20%, and that of total cost was 18%.

Domestic sales price

Foskor was formed in 1951 by the government, through the Industrial Development Corporation, for the express purpose of making South Africa independent of phosphate rock imports. This goal was achieved in 1969/1970 since when no imports have been necessary.

Table 2 and Figure 4 give the history of the f.o.r. Phalaborwa price, of phosphate rock for domestic fertilizer use.

TABLE 2. Domestic price history of Phalaborwa phosphate rock.

Year	South African Inflation Rate	F.o.r. Phalaborwa Price	
		Current	Constant 1975
	%	R/t	
1970	3,2	10,13	15,42
1971	5,7	10,13	14,93
1972	6,53	10,63	14,69
1973	9,5	11,50	14,50
1974	11,6	11,50	12,82
1975	**13,5**	**15,00**	**15,00**
1976	11,14	15,00	13,33
1977	11,24	18,50	14,94
1978	10,1	20,65	15,17
1979	13,1	22,50	14,54
1980	13,8	22,50	12,53
1981	15,2	22,50	10,63
1982	14,7	24,50	10,01
1983	12,3	30,00	11,02
1984	11,6	31,80	10,33
1985	15,2*	35,00	10,18
1986	17,0*	45,00	11,36

* – estimated

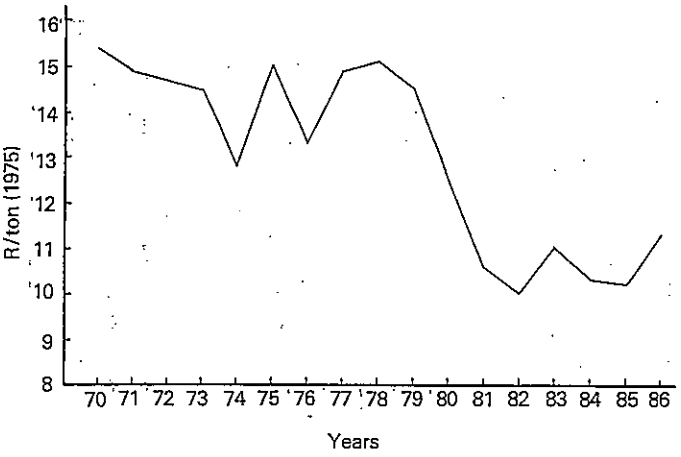

FIG 4. Domestic price of phosphate rock (in 1975 Rand/ton F.O.R. Phalaborwa).

Like the rest of the fertilizer industry, Foskor was subject to price control for most of this period, and, as is evident from the statistics, was seldom kindly treated by the government price controller. Until 1981 the price was often held constant for two and even three years at a time, irrespective of the inflation rate, which frequently put the company under considerable strain.

Until 1978 the price was usually allowed to snap back to a more or less constant real value after a couple of years, but then the government launched a concerted campaign to reduce the inflation rate and Foskor experienced a precipitous and near-disastrous decline in the real price of its product. The return on investment plunged to 2,8%, interest rates soared, and the loans that were needed to finance the expansions in 1976 and

1979/1980 could merely be serviced, and not redeemed! Indeed, further borrowings were necessary, and Foskor acquired a heavy debt burden.

Price control was lifted, in the case of the rest of the fertilizer industry, in 1984, and in Foskor's case, in 1985. The company is now slowly creeping back to a more realistic pricing structure and healthier financial prospects.

Over the period 1970 to 1985 the sales price productivity index rose by 35,7%.

Conclusion

The most demanding measure of productivity is whether a company can compete in a free market environment.

In the case of a cheap bulk commodity like phosphate rock, the domestic market is protected by a transport cost barrier, which is higher the further inland the delivery point is situated. Table 3 compares the delivered price at various points in the country for various sources of phosphate rock.

The figures in Table 3 were calculated on an exchange rate of R1,00 = \$0,55 and on a P_2O_5 content basis only, i.e. no allowances were made for any other advantages that the Phalaborwa rock may have over the sedimentary rock types.

Foskor's closest competitor is Togo, at the Richards Bay plant. Conservatively estimated, Foskor could raise its f.o.r. Phalaborwa price by 35% before Togo rock would become competitive at Richards Bay.

The transport cost barrier works both ways, however, and it was not easy for Foskor to establish itself on the overseas market. The details are confidential, but at the current exchange rate between the rand and the United States dollar, Foskor can compete successfully, and realise prices abofe the current domestic price.

TABLE 3. Delivered price of phosphate rock to South African fertilizer factories from various sources in R/ton of rock (1986)

Delivery point	Source				
	Foskor	Togo	Florida	Jordan	Morocco
	R/t				
Phalaborwa	47,90	110,80	116,10	121,10	120,40
Richards Bay	70,10	85,70	91,00	96,00	95,30
Sasolburg	79,30	119,70	125,00	130,00	129,20
Potchefstroom	80,10	122,00	127,30	132,30	131,50