MACHINERY SELECTION BY COSTING ANALYSIS

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Abstract

A costing method with standards which are continuously brought up to date to compare relative costs, is described. Special emphasis is placed on the high cost of under-utilization. Depending on the situation of the individual, examples are given to illustrate which operation would be cheaper to mechanize and how to choose a machine to suit the particular circumstances.

Introduction

In this paper a method of costing is briefly discussed and an explanation is given of how, by means of graphs, the costings are applied by the Experiment Station with specific emphasis on the extravagance of under-utilization of equipment.

Method

For any costing exercise to have a meaning, all stages must be costed against a pre-determined set of standards. Options of different machines compiled by separate persons cannot be readily compared, as different standards might have been involved. Even where the standards are not absolutely correct, the end results from a single compiler would still be valid for comparisons and would highlight the difference in the options. Of course, standards should be as accurate as possible and should periodically be brought up to date to be realistic.

A costing system differentiates between fixed costs and variable costs.

Fixed costs include the price of the basic unit (at new value), accessories, interest on capital, insurance and depreciation. These fixed costs are, in effect, what it costs to own the article, whether it is used or not. The more it is used, the more it produces, the lower its rate of ownership (e.g. per year or per ton). If it is not used at all, the cost per hour, for example, becomes an absurdity.

A typical calculation is given in Table 1 for an annual utilization of a tractor varying from 75 to 2 500 hours. Note how the total fixed cost per hour decreases from 1 093 to 131 cents as utilization increases. At 1 200 hours per year, which is normal for a hard working tractor, the ownership cost would be 163 cents per hour. Under-utilization thus results in rapidly increasing hourly ownership costs. The life of the tractor in this example, is taken as 6 000 hours, therefore the life in years will vary according to the annual utilization.

Variable costs include fuel, oil, wear-and-tear, emoluments of operator and maintenance and repair. It is especially necessary that consistent and practical standards be used when calculating variable costs. Table 1 also shows the calculation of variable costs for different annual operating hours.

Fuel consumption is taken from various test reports for engines of similar output. Oil and grease are taken at 10c/hour, while tractor tyres are expected to last for 3 000 hours.

It is difficult to set a realistic standard for maintenance and repairs because this item is influenced by factors such as operator care and the standard of maintenance. After considering various arguments, 75% of the purchase price of a tractor is at present considered as being a reasonable amount to be spent on maintenance and repairs during the life of the

TABLE 1

Tractor: 60 kW, 2-wheel drive — **Costing an agricultural tractor (excluding the operator)** — Life: 5 years or 6 000 hours

Life in years (x)		80	60	12	8,6	6,7	5,0	3,75	3,0	2,4
Hours/annum		75	100	500	700	900	1 200	1 600	2 000	2 500
CAPITAL INVESTMENT										
Price of basic unit	Item 1	8 800	8 800	8 800	8 800	8 800	8 800	8 800	8 800	8 800
Added accessories	2	500	500	500	500	500	500	500	500	500
TOTAL INVESTMENT 'I'	R 3	9 300	9 300	9 300	9 300	9 300	9 300	9 300	9 300	9 300
Deduct tyre value	4	545	545	545	545	545	545	545	545	545
Deduct resale value	5	3 255	3 255	3 255	3 255	3 255	3 255	3 255	3 255	3 255
AMOUNT TO BE DEPRECIATED	R 6	5 500	5 500	5 500	5 500	5 500	5 500	5 500	5 500	5 500
FIXED COSTS (Ownership)										
Interest formula: 'I' $(\frac{x+1}{2x}) \times 12\%$	7	565	567	605	623	642	670	707	744	791
Licence, insurance (e.g. 2% of 'I')	8	186	186	186	186	186	186	186	186	186
Depreciation (Item 6 ÷ life in years)	9	69	92	458	642	826	1 100	1 467	1 833	2 292
TOTAL FIXED COSTS PER ANNUM	R 10	820	846	1 249	1 451	1 654	1 956	2 360	2 763	3 269
TOTAL FIXED COSTS PER HOUR	cents 11	1 093	846	250	207	184	163	148	138	131
VARIABLE COSTS (Operating)										
Fuel, 8,5ℓ/h, 15c/ℓ, variable hrs/yr	12	96	128	638	893	1 148	1 530	2 040	2 550	3 188
Oil and grease at 10 c/h	13	8	10	50	70	90	120	160	200	250
Tyres, part of 3 000 hour life	14	14	18	91	127	163	218	291	363	454
Maintenance and repairs, 75% 'I' ÷ years	15	87	116	581	814	1 047	1 395	1 860	2 325	2 906
TOTAL VARIABLE COST PER ANNUM	R 16	205	272	1 360	1 904	2 448	3 263	4 351	5 438	6 798
TOTAL VARIABLE COST PER HOUR	cents 17	272	272	272	272	272	272	272	272	272
TOTAL FIXED AND VARIABLE COSTS/ANNUM	R 18	1 025	1 117	2 609	3 355	4 102	5 219	6 711	8 201	10 067
TOTAL FIXED AND VARIABLE COSTS/HOUR	cents 19	1 366	1 117	522	479	456	435	419	410	403
HOURLY OPERATOR COSTS AT R1 200/ANNUM	cents 20	1 600	1 200	240	171	133	100	75	60	48

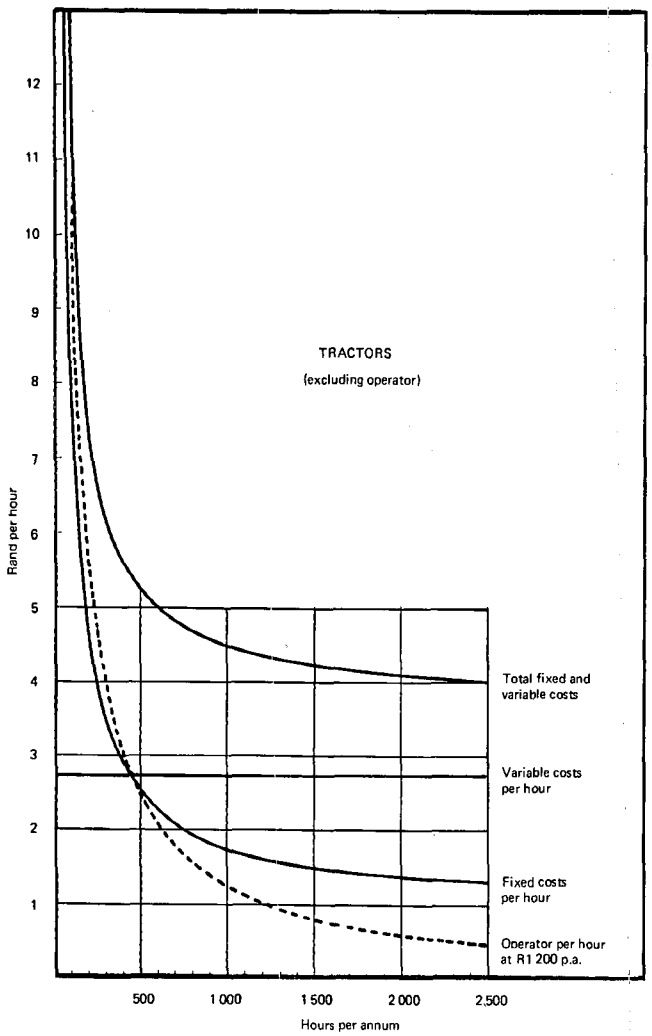

FIGURE 1 Theoretical cost per hour of tractors (excluding operator).

machine. This assumes that all repair work is done by an outside agent at commercial rates. For the first year or so this may appear to be excessive but it does even out as the unit ages.

Unlike fixed costs, variable costs do not vary according to annual utilization. As can be seen from the example in Table 1 this cost stays constant at 272 cents per hour.

The cost of the operator was not included in the calculations for Table 1 and Fig. 1. If, however, the operator is fully utilized on the operation being costed, he could be included as a fixed cost. If this is not the case he could well be considered as a variable on a cost per hour basis.

Total costs are derived by adding fixed and variable costs as in Table 1. The results are shown graphically in Fig. 1. Fig. 2 shows a set of working graphs for tractors varying in price from R7 000 to R10 500 and includes the operator. The maximum life, unlike the theoretical figures used in Table 1 and Fig. 1, has been limited to seven years. This life is then used when calculating the Interest and Depreciation.

Costing specific types of agricultural machines

In costing machinery and implements, other than the tractor discussed in the foregoing section, the approach is the same, with minor adjustments as given below.

Implements

Apart from the fact that trailed and 3-point implements are rarely used for more than 300 hours a year and maintenance factors differ substantially between the various types, they are costed in the same manner as a tractor. Some examples of average costs are detailed in Figs. 3 and 4.

The annual utilization of implements does, of necessity, tend to be low. One implement may be capable of handling a large area over the year but not in the time dictated by the crop or climate.

Harvesting machinery

Cane cutters and slewing grab loaders are even more sensitive to under-utilization than tractors and implements. These highly specialised tools cannot be channeled, to make up for low job-utilization, anywhere other than in their designed field. Figs. 5 and 6 show costs for a wholestick cutter (e.g. Sasex) and a slewing grab loader, both without a tractor.

Choice of machine systems from costing graphs

The value of the costing graphs will be explained by discussing a few typical case studies made by the specialist advisory service of the Experiment Station for cane growers.

Different loaders

A choice often has to be made between a relatively cheap (R4 500) fixed type loader of low output, or a more expensive (R6 000) slewing type machine operating at a higher loading rate. Each machine is mounted on a tractor costing R9 000 and handling 15 000 tons* a year.

Fixed boom loader

Assuming that the output of this loader is 15 tons per operating hour, 15 000 tons would require 1 000 hours per year. Fig. 6 gives a cost of R1,45 per hour for the loader and Fig. 2 a cost of R5,30 for the tractor. This is a total loading cost of R6,75 per hour, which, at 15 tons per hour, gives 45 cents per ton.

Slewing boom loader

Output is taken as 25 tons per hour, and 15 000 tons would thus require 600 hours per year. From the same graphs as above, costs of R2,90 and R7,10 are found for the loader and tractor respectively, a total of R10,00 per hour which is 40 cents per ton.

The more expensive loader would thus be slightly cheaper

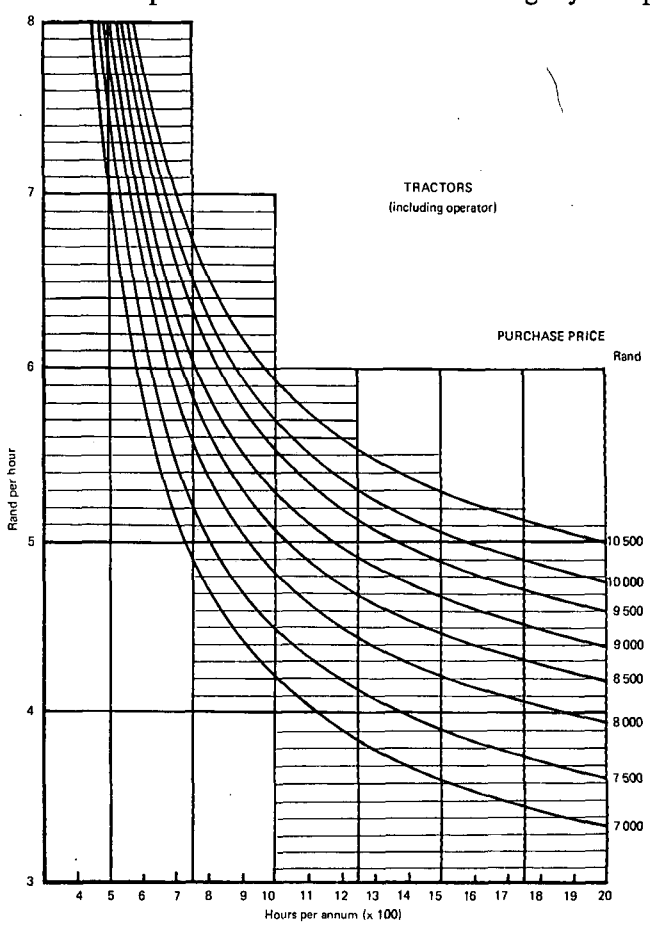

FIGURE 2 Cost per hour of tractors (including operator).

* 1 ton = 1 000 kg

to operate per ton and would get the work done much faster (three hours per day compared with five hours per day for the fixed boom loader).

At higher annual tonnages, this difference becomes even more pronounced. Working an eight hour day (1 600 hours per year), the fixed boom loader should handle 120 tons per day, i.e. 24 000 tons per year at a total cost of R5,90 per hour R4,60 + R1,30) or 39 cents per ton. For the same tonnage, the slewing loader should cost R7,20 per hour (R5,30 + R1,90), or 30 cents per ton taking only five hours a day.

At 15 000 tons per annum, both the above loaders still operate at an acceptable cost per ton. The smaller producer, with, say, 7 500 tons per annum, faces a very different picture. The fixed beam loader would require 500 hours and the cost would be more than 75 cents per ton. The slewing loader would be so under-utilized that its cost per ton would be unrealistic.

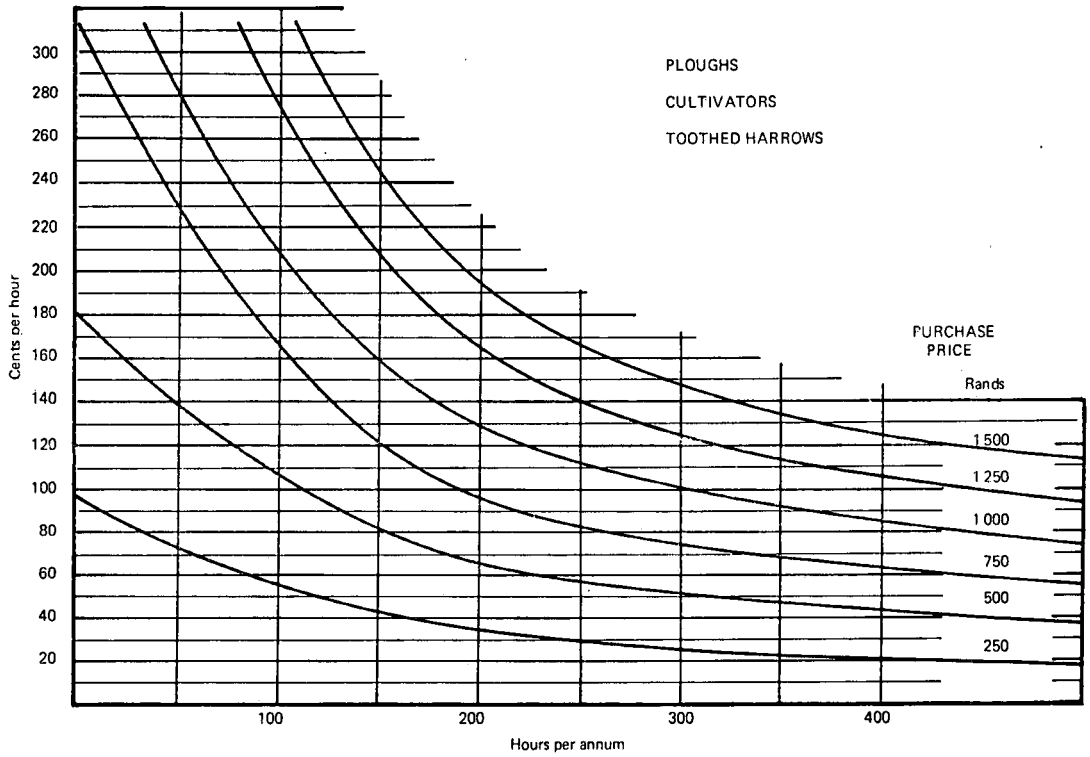

FIGURE 3 Cost per hour of ploughs, cultivators, and toothed harrows.

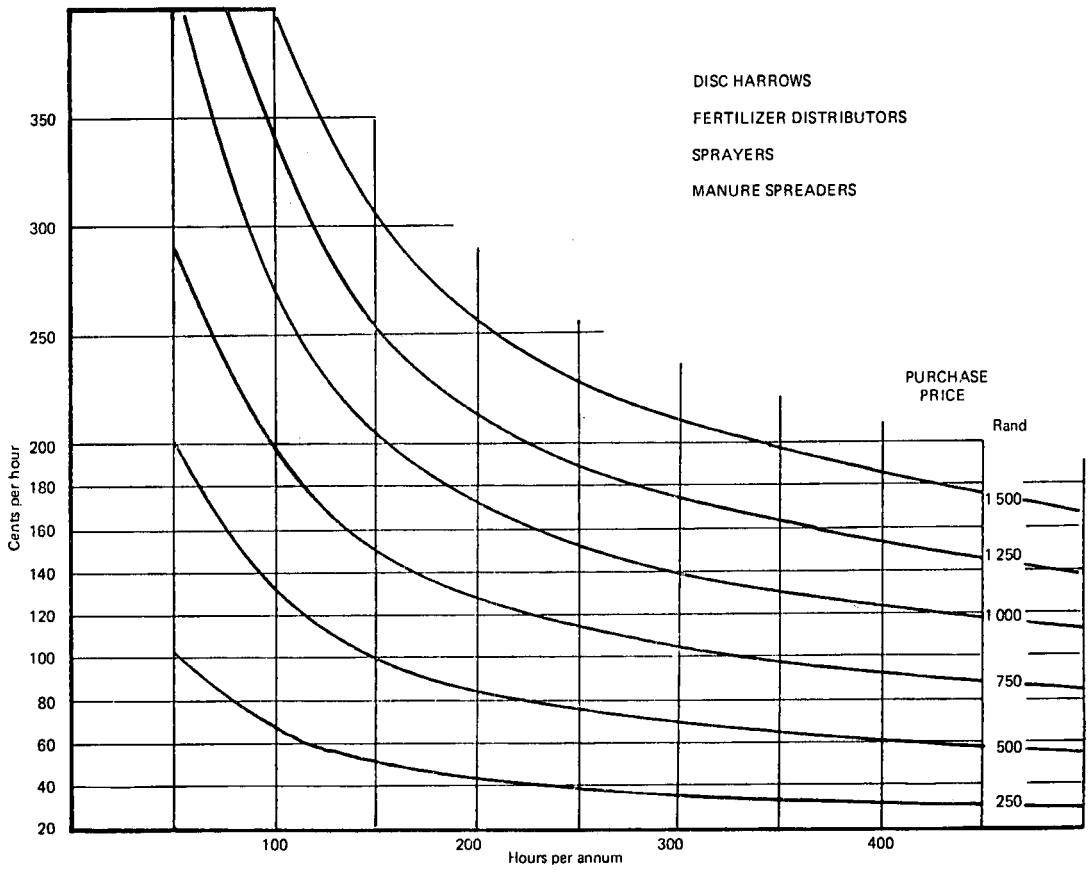

FIGURE 4 Cost per hour of disc harrows, fertilizer distributors, ploughs and manure spreaders.

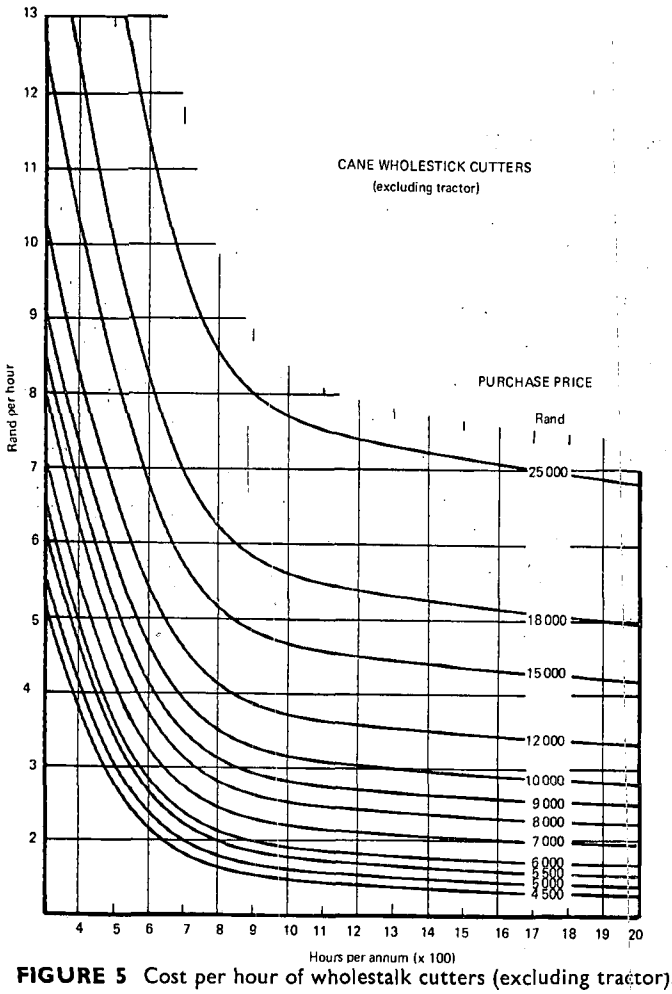

FIGURE 5 Cost per hour of wholestalk cutters (excluding tractor).

The only way of reducing the cost to the smaller operator is to have a removable loader or one of such a configuration that the tractor could be used for other work as well.

Mechanical cutting

Instead of mechanical loading, a producer could mechanize his cutting operation, save labour and still contain costs. This would be possible when combining cutters such as the Sasex with hand stacking and self-loading trailers. These machines are easily unhitched and the tractor can be used for transport or other work, making the costs to the smaller producers still acceptable.

Example: Assuming that the tractor operates for 1 000 hours per year, its costs would be R5,30 per hour. That of the cutter (at R8 500) would vary from R8,15 to R2,75 per hour for 300 to 1 000 hours per year respectively (see Fig. 5). Cutting at a rate of 25 tons per hour, the total cost would be 54 cents per ton for 7 500 tons per year, or 32 cents per ton for 25 000 tons per year.

It would be cheaper for a grower cutting 7 500 tons per year to cut mechanically rather than to load mechanically. Adding the costs of manually cut or stacked cane to the above figures will not alter the conclusion.

The same tractor and driver used for cutting can also be used to transport the cane with a self loading trailer. This is quite feasible because cutting should require two hours per day or less, leaving ample time for transport. In this case, for average stacks of 4 tons, and a 1 km distance from a loading zone, cycle time should be about 30 minutes and the daily quota could be delivered within five to six hours.

Conclusion

The above is only a brief example of the applicability of the costing graphs. The choice of a specific machine system, whether harvesting or loading, or a combination of both which could include transportation should, however, not be based simply on economics. Each farming enterprise will have specific requirements which must always be considered in conjunction with the cost per ton figure.

When deciding on a particular machine, it is necessary to consider the rest of the system. A choice between loaders or cutters must also take cognizance of factors such as availability and type of labour and of implements already on the farm.

The graphs in the figures offer a quick method to assist with the choice of individual machines and to compare various elements of systems, or complete systems. They also illustrate very clearly the disadvantages of under-utilization of machines.

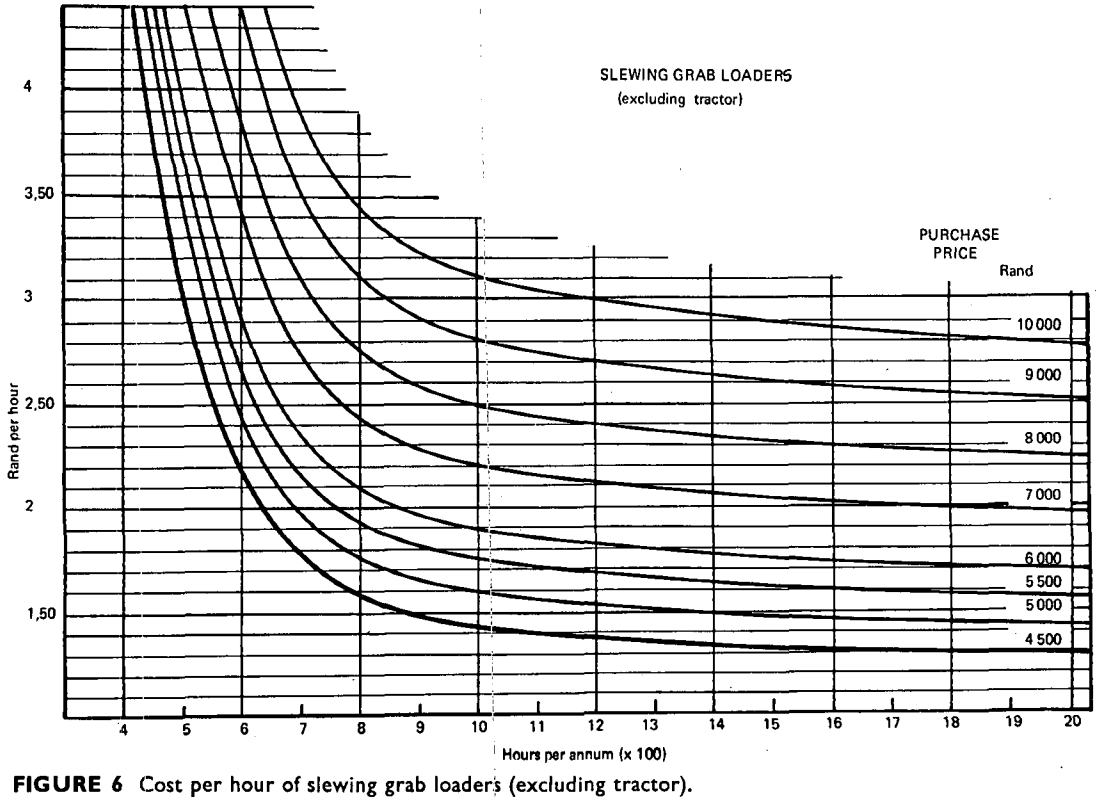

FIGURE 6 Cost per hour of slewing grab loaders (excluding tractor).