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AN INVESTIGATION INTO THE COSTS OF TRACTOR WORK AND PERFORMANCE IN DEVON & CORNWALL.

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1. INTRODUCTORY.

Probably the most important change on the technical side of farming which has taken place in recent years has been the substitution of tractor power for horse power. In the inter-war years the number of work horses on farms in this country had declined very considerably, largely as a result of the decline in arable cultivation generally, but on the larger farms tractors were being substituted for horses as a source of motive power.

The South West was no exception to this changing feature of farm organisation. Between 1919 and 1939 the number of agricultural horses in Devon and Cornwall declined from 55087 to 39345, a fall of 28.6%. To some extent this loss in horse power had been made good by the introduction of tractor power to farms. In 1939 there were some 2000 wheel type tractors suitable for field work in these two counties. The doubling of the tillage acreage and other food production requirements of the years immediately following 1939 called for considerable changes in farm organisation. Between 1939 and 1947 the number of tractors increased five fold, while the number of work horses further declined by nearly 10,000 - from 39345 in 1939 to 29206 in 1947, a fall of 24%. There is little doubt that even with some reversal of the war time production policy and the return to livestock production, the tractor will become a permanent and important piece of capital equipment and the chief source of motive power on the farms of Devon and Cornwall.

Not all farms have a tractor, not even all the larger farms, and not all jobs on the farm can best be carried out with tractor power, but great advances have been made in the design and construction of tractors for farm work so that they can now perform most of the jobs of the farm previously done by horses, and enable them to be done much more rapidly. With increased tasks and a diminishing labour force, this speeding up of work is an important factor in efficient farm organisation. The following account, which has been confined to the cost of operating tractors, has been written largely for those members of certain Young Farmers Clubs in the counties of Devon and Cornwall who co-operated with this Department in an investigation into the costs and performance of operating tractos on their farms.

2. NUMBER AND TYPES OF TRACTORS COSTED.

Altogether some 40 Young Farmers, representing 10 Clubs, dispersed over the two counties agreed to co-operate. Most of the Clubs were visited and given a talk by a member of the University's Agricultural Economics Department's Staff.

Table 1. Location of Co-operating Farms.

	No.of farms	No.of tractors costed
North Devon	6	7
East Devon	6	7
South Devon	1	1
West Cornwall	5	6
Mid Cornwall	3	3
East Cornwall	8	8
Total	29	32

A log book for each tractor was supplied by the University, a specimen of which is attached to the end of this report. For various reasons a number of co-operators failed to complete the records for the period covered by the investigation, the year 31st Jan 1946 to 1st Feb 1947.

The average size of farms included in this investigation is 164 acres. which is considerably above the average of the farms in these two counties and in general represents the larger arable type of farm. The sample does, however, include 5 farms of less than 100 acres, the smallest being just 32 acres. Seven of the 29 farms operated two tractors so that the second tractor on 4 farms was not costed.

The year 1946/47 was abnormal as far as tractor work was concerned, adverse weather conditions prevailed throughout a greater part of the summer and autumn of 1946 and many operations were undertaken by horse teams which, with more normal climatic conditions would have been done by tractor. In several instances the tractor was "laid up" in its garage for two to three weeks at a time because fields were too sodden for tractors to get on them.

A list of the tractors costed and their classification is given in Table 2.

Table 2 Classification of tractors costed

Light		
David Brown	1	
Allis Chalmers "B"	2	
Total		3
Medium		
Fordson	20	
Massey Harris 102 Jun	2	
Massey Harris 102 Sen	1	
Allis Chalmers W c	1	
Allis Chalmers W F	1	
Case	1	
International W 4	1	
Total		27
Heavy		
Field Marshal	1	
Case L.A.	1	
Total		2

The majority of the tractors on these farms are of a medium type, with the Fordson (including the Standard and Major types) predominating. The method of classification adopted has been largely that of draw-bar horse power, but some attention has been given to the kind and type of work undertaken by the tractor. The number of tractors in the light and heavy classes is very small and the classification has been made with the object of indicating the types of tractors comprising the whole sample rather than to measure the difference in operational costs as between these groups.

Table 3 Capital cost, age etc of tractors costed.

	Light	Medium	Heavy
Number of tractors	3	27	2
Average purchase price (including additions)	£301	£234	£487
Average age at 1.2.46	3 yrs 2 mos	4 yrs 8 mos	1 yr
Average hours worked	715	811	933

The average purchase price of the tractors includes any capital additions such as power take off, belt pulley, rubber tyres, or steel wheels, whether purchased with tractor or at a later date. All the light tractors and about one half of the medium tractors were on pneumatics, or had had them fitted. One of the heavy tractors was on pneumatics, while the other had had pneumatics fitted on the two rear wheels during 1947.

3. ANALYSIS OF COSTS

The summarised costs of operating the 32 tractors (exclusive of drivers wages) included in this investigation are set out in Table 4.

Table 4 Cost per tractor and per working hour. 32 tractors year ending 1.2.47 (excluding drivers wages).

Number of tractors	32
Average hours worked	815
Average fuel consumption	1.01 gals per hour

COSTS:		Per Tractor £. s. d.	Per Hour s. d.	Per Cent %
Fuel:	Gals			
Petrol	51.4	4 18 6	- 1.5	4.8
T.V.O.	806.4	34 3 2	- 10.3	33.0
Lubricating oils	26.0	6 12 10	- 2.2	6.4
Total		45 14 6	1 2	44.2
Depreciation		29 10 1	- 9.4	28.5
Maintenance				
Servicing		3 19 9	- 1.0	3.9
Repairs		22 18 6	7.0	22.1
Total		26 18 3	- 8.0	26.0
Sundries		1 7 4	- 0.3	1.3
Total Cost		103 10 2	2 7.7	100.0

The average cost per tractor for this group of 32 tractors amounted to £103.10.2d. for the year, while the cost per working hour averaged just under 2/8d. Total cost varied considerably as between tractors, the result of differences in hours worked, the repair bills and the age of the tractor with its resultant affect on the amount of depreciation cost. The highest cost was £164. 18. 2d. for a medium tractor working 1137 hours - an old tractor with a fairly high repair bill - while the lowest cost, £45.15.5d. was incurred by a light tractor working only 306 hours. Fuel is the largest item of expense if all tractors are considered as a group, the remaining cost being mainly equally divided between depreciation and repairs. As between individual tractors, however, the contribution of individual items to the total cost varied considerably, with some tractors the largest item of cost was represented by depreciation, while with others it was repairs, but more frequently the largest item of cost was fuel, particularly with the medium class tractors.

Fuel Costs averaged £45.14.6d. per tractor, or 1/2d per hour. The total cost of fuel per tractor largely depends upon the number of hours worked and the unit cost of fuel, while the cost per hour will be largely determined by the rate of fuel consumption. The relevant data relating to fuel cost and consumption are set out below:-

	Consumption per hour gals	Price per gal s d
Petrol	0.07	1 11
T.V.O.	1.01	10.6
Lubricants	0.03	5 1

The consumption of fuel per hour varied considerably as between tractors, even as between tractors of the same make and type. Over all tractors consumption of fuel generally ranged between $\frac{3}{4}$ and $1\frac{1}{2}$ gals per hour with an average of 1 gal per hour. Allowing for the small number of tractors in the light and heavy groups, compared with the medium group, there are indications that fuel consumption per hour is somewhat higher for the medium type tractors. On the other hand the initial capital cost of the medium class tractors was lower than that of the other groups.

The fuel consumption per hour will, to some extent, be influenced by the kind of work done. It has not been possible to analyse the types of work done in any great detail, or to measure the fuel consumption of the different classes of work. These variations in fuel consumption as between tractors are reflected in the cost per hour for fuel (including lubricants) which ranged from 8d per hour at the one extreme to 1/8d per hour. The cost of lubricants varied between 1d and 4d per hour.

Depreciation Cost has been calculated on the basis of $22\frac{1}{2}\%$ per annum on the diminishing value. This method tends to give a high depreciation in the first few years of the tractors life with a corresponding low depreciation in later years. It is generally assumed that as depreciation diminishes so the repair bill increases giving a fairly balanced aggregate each year.

The average depreciation per tractor for the sample studied was £29.10.0. or 9½d per hour. As between tractors the cost of depreciation ranged from £4.5.10d. to just under £100. These two extremes represents a 13 year old medium class tractor and a new heavy class tractor respectively. The cost of depreciation per hour ranged from 1d to 2/2d.

Repairs and maintenance costs include the cost of spare parts and labour (farm as well as garage) on repair work. Service costs cover time spent on general maintenance such as re-fueling, greasing, putting water in radiator and any minor adjustments. Unlike depreciation costs which are in the nature of capital charges, repair and maintenance costs are "running" costs and depend to a large extent on the amount of work done. In other words repair bills should only increase with age in so far as age represents an accumulation of work done. Since this analysis refers to only one year in the working life of these tractors, it is not a particularly accurate measurement of the repair and maintenance cost. For the year to which these records relate any particular tractor may have incurred a large repair bill while the next tractor may have incurred no charge for repairs. A study of the repair bills on individual tractors included in this sample indicates that this is the position.

Repair costs per tractor (excluding servicing) ranged from 7/9d to £87.14.0., while the cost per hour ranged from less than 1d to as much as 2/3d. Some adjustment of repair charges designed to level out these yearly fluctuations would appear desirable, but it is difficult to devise a satisfactory method without possessing much more data than is available. It is, therefore, left to the individual owner of a tractor to make his own adjustment. The average repair charge for the whole group of 32 tractors should represent fairly approximately the size of the repair bill which may be expected for the average tractor over its average life. Some increase of repair bills with age is to be expected. Even so, efficient and regular maintenance and good driving can do much to reduce repair bills and to ensure economical operation and a longer working life to the tractor. The amount of time recorded as spend in "servicing" on some farms in this investigation was very small indeed.

Sundry Costs. Under this heading is included the cost of the annual road licence, and any expenses such as compulsory Third Party Insurance. Scarcely one of these tractors carried a comprehensive policy. In fact quite a number of tractors appear to have incurred no costs under this general heading.

4. WORK DONE.

Hours worked per tractor. It has already been indicated that the number of hours worked averaged 815 for the 32 tractors studied. The smallest number of hours worked was 306 while at the other extreme one tractor worked for a total of 1596 hours. Nine tractors averaged less than 600 hours of work in the year while 7 exceeded 1000 hours.

The effect of the number of hours worked on cost is shown by reference to the data presented in Table 5.

Table 5. Effect of hours worked on cost per tractor per annum and per hour of work. 32 Tractors.

Hours worked	No. of Tractors	Cost					
		Per tractor			Per hour		
		£	s	d	£	s	d
Below 600 hours	9	78	4	11		3	2
600 - 1000 hours	16	101	7	6		2	6
Over 1000 hours	7	140	12	1		2	3

As would be expected the cost per tractor increases with an increase in the number of hours worked. The cost per hour, however, tends to decline with an increase in the hours worked. The reason for this is that with the method adopted for calculating the depreciation charge, the cost of this item is not related to the amount of work done, but to the age and original capital cost of the tractor. Consequently the more hours a tractor works, the lower will be the cost per hour represented by depreciation and vice versa.

Actually in the group of tractors studied, not only does the cost of depreciation decline with an increase in the number of hours worked, but there is also a tendency for fuel and repair costs per hour to decline. This result, however, may be entirely fortuitous.

Types of work done. Not only is the cost of tractor work affected by the amount of work done, but also by the kind of work which a tractor does. Thus, theoretically, more fuel is required for field work compared with belt work, and it is generally assumed that heavy cultivations require a higher rate of fuel consumption compared with light work. Contours and the kind and state of the soil will also influence work performance.

A detailed analysis of the types of work done by these tractors has not been undertaken since it is not possible with the data available to measure the fuel consumption of tractors according to the various operations performed. A general classification of the work undertaken has, however, been attempted under the headings field work, belt work, haulage work. The data are summarised below:

Table 6. Classification of work done. 32 Tractors.

	Av. number of hours worked.	Per cent of total.
Field work	580	71.1
Haulage work	171	21.0
Belt work	64	7.9
	815	100.0

Field work includes operations such as ploughing, cultivating, harvesting, etc. Haulage work covers dung haulage, milk carrying, haulage of fodder crops to stock etc., while belt work includes threshing, sawing and driving farm machinery.

The analysis reveals considerable variations in the proportion of the various classes of work undertaken as between individual tractors. Thus 4 tractors were used more for belt and haulage work than they were for field work, while 6 tractors were used very little for belt or haulage work. Three tractors had no pulley fitted for doing belt work.

The sample is not large enough and the information not sufficiently complete to attempt to assess the effect of the class of work on fuel consumption and cost. It can be said, however, that with this group of tractors the correlation between type of work and fuel consumption is not too obvious. This may, of course, be the result of the classification adopted. "Field work" covers a very wide range of operations from heavy ploughing to dragging light harrows or rolling grass field.

Seasonal distribution of tractor work. An analysis of the seasonal distribution of total work done by this group of tractors has been made and the results are given in Table 7.

Table 7. Distribution of total tractor work for year ending 1st Feb 1947. 32 tractors.

	Average Hours worked per tractor.	Percentage of total.
February 1946	49	6.0
March	88	10.8
April	138	16.9
May	60	7.4
June	43	5.3
July	90	11.1
August	72	8.8
September	62	7.6
October	86	10.5
November	44	5.4
December	33	4.0
January 1947	50	6.2
	815	100.0

Approximately 27% of the total work by this group of tractors was done during the months of March and April. The latter was a particularly good month for field work. In fact there was scarcely a day during the whole month when cultivations could not be undertaken. Hay making in July and potato and root lifting and autumn cultivations in October are reflected in the greater number of hours worked in those months.

The average tractor in this group worked as little as 33 hours in one winter month with a maximum of 138 hours in the busiest month. Individual tractors, however, show considerable variation in this respect. The highest number of hours worked in a single month was 266, while several tractors worked for more than 200 hours in this same month (April). On the other hand, some tractors did no work for several weeks at a time particularly during November and December.

APPENDIX 1.

Estimated number of tractors of different types owned by Occupiers of Agricultural Holdings, Agricultural Contractors and County War Agricultural Executive Committees.

		3 & 4 wheeled tractors.	Tracklayers.	1 & 2 wheeled tractors.
Cornwall.	1939	893	9	*
	1944	2830	75	256
	1946	3768	159	406
Devon.	1939	1291	29	*
	1944	5032	176	385
	1946	6219	336	533
Dorset.	1939	849	6	*
	1944	2167	40	100
	1946	2710	113	189

* Not stated.

APPENDIX 2.

Distribution of Farms by size of Farm.

Size of farm	Cornwall	Devon	Dorset
	Number	Number	Number
5-25 acres	4300	3600	980
25-100 "	4510	6370	1360
100-300 "	1856	3936	1028
300-700 "	80	202	274
over 700 "	2	8	42
Total	10,748	14,116	3,684
	Acres	Acres	Acres
Total area of crops and grass	613,490	1,119,040	420,410

Week-Ending 194

TRACTOR COST RECORD

	JOB	FIELD	CROP	WORKING HOURS	SERVICING HOURS	T.V.O. GALLS	PETROL GALLS	OIL (PINTS)		REPAIRS			
								ENGINE	GEAR	REPLACEMENTS	COST £	s	d
SUNDAY													
MONDAY													
TUESDAY													
WEDNESDAY													
THURSDAY													
FRIDAY													
SATURDAY													
TOTAL													