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A STUDY IN THE COSTS OF OPERATING COMBINE HARVESTERS AND ONE MAN PICK-UP BALERS IN YORKSHIRE 1949.

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The information on which this report is based was collected during the summer and autumn of 1949 from farmers in the three Ridings of Yorkshire by MR. I. G. SIMPSON.

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Combine Harvesters.

Records of the operation of twenty combine harvesters during the 1949 harvest were obtained, seven in the West Riding, ten in the North Riding and three in the East Riding. Table I shows that half of the combines were twelve-foot cut self-propelled machines. The other ten combines were of various types. In the following tables these have been divided into a number of groups for ease of presentation. These groups contain very small numbers of combines; they are too small to justify using them to compare the costs and performance of the different types of combine.

TABLE I

Types of Combine and Year of Purchase.

Year of Purchase.	Type of Combine					
	12 foot Cut	8 foot Cut			5 - 6 foot cut	
	Bagger Self-Propelled.	Tank Self-Propelled.	Bagger Self-Propelled.	Bagger Tractor Drawn.	Bagger Tractor Drawn.	Tank Tractor Drawn.
1942	-	-	-	-	2	-
1943	1	-	-	-	-	-
1944	1	-	-	2	-	-
1945	-	-	-	-	-	-
1946	2	-	-	-	-	1
1947	2	1	-	-	-	-
1948	3	-	1	1	2	-
1949	1	-	-	-	-	-
Total	10	1	1	3	4	1

Only two of the machines were equipped with grain tanks.

Table II records the operating cost per hour, per acre and per ton of all grain threshed. Cost per hour is total cost over the season divided by the total number of hours the combine was in use. Man Labour is charged at a standard rate of 2/5d per hour. It includes the time spent preparing the machine for work, regular maintenance work and time spent on repairs. The saving of labour on the tanker machines is shown, one man being required to operate the combine, while two or three men are needed on the other types of machines.

Tractors have been charged at 3/- per ~~head~~ hour. Fuel is charged at the actual prices paid. Some of the owners of self-propelled combines made a considerable saving (about 4d. gallon) by buying petrol in bulk at wholesale prices. Sundries chiefly consists of license and insurance charges on the self-propelled combines. The very high repair cost on the eight foot cut self-propelled bagger combine is due to an engine replacement. Depreciation is charged at a written down rate of 15%. No initial allowance is made for time spent in moving a combine from farm to farm or for other additional expenses where contract work is undertaken. Time taken moving from field to field on one farm is included.

TABLE II

COMBINE OPERATING COSTS PER OPERATING HOUR, PER ACRE AND PER TON OF GRAIN THRESHED.

✱Class of Combine	12' Cut S.P. Bagger	8' Cut S.P. Tanker	8' Cut S.P. Bagger	8' Cut T.D. Bagger	6' Cut T.D. Tanker	5'-6' Cut T.D. Bagger	Average of All Types.
Number in Group.	10	1	1	3	1	4	20
Costs per Hour	£ s d	£ s d	£ s d	£ s d	£ s d	£ s d	£ s d
Man Labour	5 11	3 8	5 3	6 5	3 6	5 10	5 9
Tractor	-	-	-	3 0	3 0	3 0	1 2
Fuel	3 7	1 11	2 9	1 11	9	1 11	2 9
Oil & Grease	4	11	2	5	2	1	4
Sundries	7	5	7	-	-	-	4
Repairs	3 5	7	17 3	5 2	1 1	3 7	4 2
Depreciation	14 4	14 3	18 4	15 3	11 9	13 4	14 4
Total Cost per Hour.	1 8 2	1 1 9	2 4 4	1 12 2	1 0 3	1 7 9	1 8 10
Total Cost per Acre.	1 5 3	1 3 5	2 2 7	1 8 8	18 4	1 6 9	1 6 6
Total Cost) per Ton) of Grain)	1 3 1	†	2 2 10	1 4 3	18 2	1 4 11	1 4 5

✱ S.P. = Self-propelled. T.D.= Tractor Drawn.

† Weight of grain not available.

While depreciation is undoubtedly an item of cost, it is one that it is difficult to assess accurately. The length of life of a combine depends on the soundness of construction, the use it receives per year and the care taken in maintenance. For these reasons it is impossible to assess with confidence the length of life, nor consequently the annual depreciation in advance. Other difficulties arise. New developments may cause existing machines to be become obsolescent. The rise in price of new combines means that the older combines carry a disproportionately low depreciation charge. A machine costing £910 in 1942 cost £1290 in 1949, and the depreciation charge does not therefore cover the money needed to replace the machine. The standard depreciation rate of 15% is an arbitrary figure and makes no allowance for the number of hours worked per year, which is one of the main factors in the length of life of the machine. Theoretically, the depreciation charge on a written down basis plus the cost of repairs should come to a constant figure each year. In practice this is seldom so. The cost of repairs and renewals is liable to vary considerably from year to year. Numerous factors cause this variation, many of them outside the farmer's control. For the above reasons the inclusion of repairs and depreciation in the costs in Table II give a distorted impression when comparing the costs of different machines in one year. Table III has been constructed to give the direct operating costs (total costs less depreciation and repairs). While these figures do not show significant differences between the different types of combines, they are useful to compare with the performance of individual machines.

TABLE III

DIRECT OPERATING COSTS

(COSTS LESS DEPRECIATION AND REPAIRS)

Type of Combine	Direct Operating Cost	
	Per Acre.	Per Ton of Grain
	£ s d	£ s d
12' Cut S.P.Bagger	10 0	8 7
8' Cut S.P.Tanker	7 5	+
8' Cut S.P.Bagger	8 5	8 6
8' Cut T.D.Bagger	10 10	8 5
6' Cut T.D.Tanker	6 9	6 8
5'-6' T.D.Bagger	11 2	10 7

+ Weight of grain not available.

Table IV deals with various factors affecting running cost. Acreage combined per foot of cut indicates how fully the machine is used. It is often stated that a combine should be able to deal with 25-30 acres per foot of cut. If so, most of the machines costed dealt with acreages considerably below their full capacity. Nine combines dealt with less than 15 acres per foot of cut - one of them 32½ acres. Only 165 acres of the corn combined by this machine were on the owner's farm, 224 acres were combined on contract; it also includes 70 acres of clover seed combined after the corn harvest. There may be scope for farmers combining low acreages per foot of cut to lower their operating costs by contracting to combine their neighbour's corn.

The acreage combined per hour is surprisingly similar for all the machines. The exceptional season may partly account for this. The small machines with a large drum in relation to width of cut have had an advantage in the heavy crops. The highest speed per acre was achieved by a 5'9" cut machine. This was the only machine costed which was designed throughout specifically for British conditions.

The maintenance: operational ratio is the ratio of total man hours spent on routine maintenance (e.g. greasing up) field repairs and moving from field to field to the hours the combine was in use. Thus for approximately every $3\frac{3}{4}$ hours combining one man spent an hour on maintenance and similar tasks.

TABLE IV

SOME FACTORS AFFECTING COMBINE COSTS.

	Type of Combine			
	12' Cut Self-Propelled	8' Cut Self-Propelled	8' Cut Tractor Drawn	5'-6' Cut Tractor Drawn
Acres combined per foot of cut.	17.9	18.6	21.3	17.7
Acres combined per hour.	1.10	0.98	1.24	1.01
Fuel Consumption per hour, Gallons	1.92	1.34	1.31	1.15
Maintenance: Operational Ratio	3.95	3.62	3.29	3.84

Table V deals with acreages of crops combined, their yield and the speed at which they were combined. Section A gives the average figures for all combines costed, Section B only for the 12 foot cut combines. The list of seven crops indicates the versatility of the combine. Wheat was combined at a slower rate than barley. This as partly due to a larger proportion of laid wheat than laid barley and to the heavier yield of wheat. Several of the combine owners also cut some of their crops with a binder. Oats were most frequently cut by binder. The reasons given for this were preference for less mature straw, loss from shelling when combining and ease of storage in stack. in spite of these objections nearly 400 acres of oats were combined. When crops were grown for seed the binder was often preferred to avoid the necessity of thoroughly cleaning out the combine before using it on seed crops and to secure the grain in better condition. Where labour was available, the binder might be used in order to keep on top of the harvest.

TABLE V

ACREAGE COMBINED OF DIFFERENT CROPS.

YIELD OF CROPS AND SPEED OF COMBINING.

Section A. All combines.

Crop	Acreage Harvested by Combines.	Yield per Acre (cwts)	Acres Combined per hour.	Cwts.of Grain Threshed per hour
Barley	1760	25.1	1.1	27.4
Wheat	887	27.8	0.9	25.8
Oats	398	17.2	1.2	20.1
Rye	90	22.5	0.7	17.2
Peas	183	12.5	1.4 †	17.5 †
Beans	15	12.0	1.3	15.7
Clover	74		1.7	

† after windrowing.

TABLE V

Section B. 12 ft. cut Combines.

Crop	Yield per Acre (cwts)	Acres combined per hour.	Cwts.of grain threshed per hour.
Wheat	28.8	0.9	27.3
Barley	26.5	1.0	27.9
Oats	18.8	1.1	20.8
Peas	11.3	1.2 †	15.2 †
Rye	23.6	0.8	20.0

† - After windrowing.

Table VI shows total costs for grain harvesting on each farm. These costs refer only to cereal crops (wheat, Barley, oats and rye). On one farm (3) some of the barley was cut with a binder and picked up by the combine from the windrow. The greater speed of combining when corn was windrowed almost offset the extra cost of cutting with the binder. The object was to get an improved sample. However, the farmer did not consider the improvement justified the extra expense. He will not windrow next year. On farm 19 two rounds were cut with a binder in each field and the sheaves put through the combine.

The cost of combining varied from 18s. 6d. to £2. 5. 8d. per acre. The main reasons for the variation have already been explained.

Haulage is the cost of moving grain from the combine to the farmstead. The cost varies according to length of haul and yield per acre. Haulage was usually done by a team of three to five men working a third to a half of the combine working time. On one farm with a tanker combine, one man was able to haul all the grain and relieve the combine driver at meal times.

On most farms 4 bushel sacks were hired; the grain was often threshed straight into these sacks and weighed on the combine. Some farmers used two bushel Ministry of Agriculture sacks. The general opinion was that they would not stand more than two or three years' usage. As they cost 1/9d each, depreciation is a considerable item. In many farms grain was sold straight from the combine, but seven out of the fifteen farmers dressed their grain before selling. Two of these had their own driers. One farm possessed a drier which was not used this season and two farmers had grain dried on contact.

The average cost of dressing was 10/10d per ton. Five farmers possessed dressers but not driers. Three of these were new dressing machines costing from £400-£600 each, two were old hand-operated machines. The new dressers involve considerable additional outlay. They did not show appreciably lower costs than the old dressers but reduced labour requirements at a critical season. Wheat was dried on three farms and oats on one. This added approximately £1 per acre to the costs. Total costs vary from £1. 3. 10d to £3.13. 3d. per acre and from £1. 2. 0. to £3. 5. 6d. per ton. While some of these differences are due to the varying condition of the crops and to the fact that some farmers were able to sell their corn without dressing or drying, these costs show that there is considerable scope for improvement in the operation of some of the combines.

TABLE VI

TOTAL GRAIN HARVESTING COSTS.

Combine Code No.	Grain Harvesting Costs per Acre												Total Grain Harvesting Costs per ton		
	Cutting with Binder.			Combining.			Haulage			Sack Hire & Dressing.			Drying			Total					
	£	s	d	£	s	d	£	s	d	£	s	d	£	s	d	£	s	d	£	s	d
1A		-		1	9	10		4	10		4	4		-		1	19	0	1	11	6
1B		-		1	7	0		7	5		5	6		-		1	19	11	1	1	10
5		-			18	6		5	0		1	8		-		1	5	2	1	10	1
6		-		1	1	9		4	10		4	0		-		1	10	7	1	8	5
8A		-		1	5	10		3	5		1	10		-		1	10	1	1	12	11
11		-		1	0	10		9	6		2	7		-		1	12	11	1	5	2
12		-		1	3	10		3	11		14	6		-		2	2	3	1	13	1
14		-		2	1	11		2	1		8	4		-		2	12	4	2	12	5
16		-		1	12	3		5	1	1	3	4		-		3	0	8	2	5	2
15		-		1	3	3		4	1		12	2		-		1	19	6			
8B		-		2	2	6		3	5		1	10		-		2	7	9	2	7	10
7		-		1	1	0		13	0		1	8		-		1	15	8	1	7	4
18		-		2	5	8		2	4		11	10		-		2	18	6	2	14	10
2		-		1	5	0		6	1		19	11		-		2	11	0	1	14	8
3		5	2		15	11		2	6			11		-		1	4	6	1	3	0
3		-			19	7		3	1		1	2		-		1	3	10	1	2	0
20		-		1	11	10		3	10		3	10		-		1	19	6	2	1	7
19		4	9	1	15	11		11	0	1	1	7		-		3	13	3	2	3	3
5		-			18	6		5	0		1	8	1	5	0	2	10	0	2	19	10
12		-		1	3	10		3	11		2	4		19	1	2	9	2	1	18	7
14		-		2	1	11		2	1	1	3	3				3	5	4	3	5	6
16		-		1	12	3		5	1		2	9	1	3	2	3	3	3	2	6	11
15		-		1	3	3		4	1		2	1		16	10	2	6	3			
Average Cost (excluding drying cost)																2	2	6	1	16	1

(Note: Grain was dried on farms 5, 12, 16 and 15. On these farms the cost where grain was dried is shown at bottom of the table; similarly on farm 14 only part of grain was dressed. The cost including dressing is at foot of the table).

One Man Pick-up Balers.

Fourteen of the fifteen farmers whose combines were costed owned one man pick-up balers. On the other farm straw was baled on contract. Ten of the fourteen farmers owning balers kept records of working costs of their balers. These balers included seven International 50 T. and two New Holland Balers, both ram balers driven by a separate engine, two Allis-Chalmers roll up balers, and one Lorant baler. Except for the Lorant baler bought in 1946, all the balers were bought either in 1948 or 1949.

Table VII gives the average cost of operating per hour for the International and New Holland balers which are similar in design. The costs for the Allis-Chalmers and Lorant baler have not been included in this section because of the small number involved. The cost per operating hour has been calculated on the same basis as the combine costs. Baler band and depreciation together account for over two thirds of the total costs.

TABLE VII

AVERAGE OPERATING COST PER HOUR, 7 ENGINE DRIVEN RAM BALERS.

	£	s	d
Man Labour		3	9
Tractor		3	0
Petrol		2	3
Baler Band		11	11
Oil and Grease			3
Repairs		1	8
Depreciation		13	4
Total Cost	1	16	2

The balers included in the costs above baled an average of 98 acres of hay and 245 acres of straw making a total of 343 acres per baler. The hay was baled at an average speed of 1.05 and straw at 1.97 acres per hour. The petrol consumption of the balers averaged 1.05 gallons per hour. The maintenance : operational ratio (calculated as for the combines) came to 4.65.

Most of the farmers used their balers both for hay and straw baling. Two of the seven farms baled no hay. The farms with balers were largely arable and it was generally clover hay that was baled. There is less chance of the leaf being knocked off when this crop is baled. Most of the farmers were satisfied with the performance of the balers when baling hay. Some considered that in a less favourable season the risk of weather damage might be lessened by sweeping to the stack, by which they thought they could clear their fields more quickly. With the high density ram balers it was considered that the hay should be quire as dry, if not drier than when stacking loose. The speed of baling hay varied considerably from 0.72 to 1.75 acres per hour. This is mainly due to varying yields; the throughput per hour varied only from 2.14 to 2.38 tons per hour. Table VIII gives the average cost of baling and stacking hay for five of the seven engine driven ram balers.

TABLE VIII

AVERAGE COST OF BALING AND STACKING HAY.

5 ENGINE DRIVEN RAM BALERS

	£	s	d
Cost of Baling per Acre	1	1	8
Cost of Haulaging and Stacking Bales per acre.		8	11
Total Cost per Acre.	1	10	7
Total Cost per Ton	1	0	11

The farmers usually baled all the straw left behind the combines The speed of baling varied according to the weight of straw; the range was from 1.11 acres to 3.04 acres per hour. The throughput per hour was rather lower than with hay varying from 1.42 to 2.16 tons per hour. The speed of baling was on all farms above that of combining; a baler could generally keep pace with two combines and it would seem that the balers costed have a capacity rather above that required on the farms where they were used. One engine driven ram type baler baled 693 acres and another 492 acres in a season, while a power take off baler totalled 320 acres. Straw balers were usually collected by similar sized gangs to those used for hauling grain from the combine; the two jobs were frequently done alternately. Table IX gives the cost of baling and stacking straw where the seven engine driven ram balers were used.

TABLE IX

AVERAGE COST OF BALING AND STACKING STRAW.

7 ENGINE DRIVEN RAM BALERS.

	£	s	d
Cost of Baling per acre		18	0
Cost of hauling and stacking bales per acre.		7	9
Total Cost per Acre	1	5	9
Total Cost per Ton	1	6	9

Mechanised Corn Harvesting.

The costs for combining and harvesting for each farm are presented together in table X. It is important to note that these costs do not include an allowance for overhead costs or for extra expenses involved in contract work. These extra expenses may be considerable, especially when the machines are working some distance from the farm but are difficult to assess. Another item not included is extra work put in by the farmer for supervision, for special journeys to collect spares and items as telephone calls to dealers.

TABLE X

TOTAL CORN HARVESTING COSTS PER ACRE.

	Code No.	Grain Harvesting £	s	d	Straw Harvesting £	s	d	Total £	s	d
	2	2	14	2	1	11	5	4	5	7
	5	1	5	2		13	9	1	18	11
	6	1	10	7		19	8	2	10	3
	7	1	15	8	1	11	8	3	7	4
	8A	1	6	11		13	8	2	0	7
	8B	2	7	9		13	8	3	1	5
	11	1	12	11	1	15	4	3	8	3
	12	1	13	1	1	12	0	3	5	1
	16	3	0	8	2	7	7	5	8	3
	18	2	18	6	1	8	6	4	7	0
	19	3	13	3	1	6	0	4	19	3
+	12	2	9	2	1	15	4	4	4	6
+	16	3	3	3	2	7	7	5	10	10
+	5	2	10	0		13	9	3	3	9

+ Grain dried after combining.

How do these costs compare with the traditional methods of cutting with a binder and threshing from the stack? No comparative costs for 1949 are readily available. Costs collected from various parts of the country in 1947, a fine harvest but with poor yields, and 1948 a catchy harvest with good yields, suggest that costs of between £4.10. 0. to £6.12.0. per acre for harvesting and threshing corn are usual. One one of the farms included in this report harvesting cost £5. 11. 0., and on another £4.19. 0d., the remainder were below £4. 6. 0. per acre. It is difficult to draw a conclusion from such data but the majority of farms costed show a saving on traditional methods, though by no means as large as is sometimes imagined. Even when costs of mechanised harvesting are high they may be justified if they aid a farmer to balance his labour requirements over the seasons. Even so when two men are needed on the combine, four hauling grain and straw, one baling and possibly one or two dressing or drying grain, total labour requirements are considerable.

Only seven of the fifteen farms costed had dressing or drying equipment, and few had bulk storage capacity. Most of the farmers were able to sell their grain shortly after harvesting. Where this was not done it was possible to store grain without drying owing to the exceptional harvest conditions. In future harvests when weather conditions are less favourable, combines more numerous and the demand for grain possibly less, farmers may be forced to equip themselves with drying and storage plant. This will decrease the advantage of the combine over the binder and increase considerably the capital outlay. Figures of £10 a ton for the erection and installation of a ventilated bin storage and drying system of 150 tons capacity (including buildings), or £2,000 for a 2000 quarter standard drier and storage plant (excluding buildings)* are quoted. A possible alternative is to use the combine on an acreage well below its full capacity and use it only when conditions are most

* Report in "Agriculture" of a conference on grain drying at Maidstone, June 1949.

favourable. Starting combining an hour later in the morning may mean the moisture percentage of the grain is 3% lower.[H] The problem of storage will still remain and if it is not solved the farmer may well find that his bargaining power as a seller is less effective than when he had his grain safely in stack with no urgency to dispose of it.

As the number of combines and pick-up balers increases they will tend to be used more on medium and small farms. Many of the combines and balers costed in this study were working below their full capacity. If a combine owner is able to avoid drying by under utilising his combine, it may pay him to do so. There would, however, at first sight seem to be scope for more combining and baling to be done on contract. This would enable the combine and baler owners to utilise their machines more fully while meeting the small farmers' needs. This would appear to apply more especially to balers. A baler can handle a large acreage, and it can often deal with straw from two combines, it is fairly easily transported from farm to farm and there is less urgency in harvesting the straw than the grain. An arable farmer can benefit by baling for farmers growing a larger acreage of hay.

A combine is less easily transported from farm to farm. It is essential to have it available at the critical period when the grain is fit. The cost per acre of combining on contract varies from 50/- to 80/-. While the additional costs may justify this charge, it is well above that of operating the combines on their owner's farms. This high cost at once tends to bring the total harvesting cost above the equivalent cost for harvesting with a binder. The problem of storage and drying is even more acute for the small farmer. In addition he would have to have the resources available to harvest his own corn if the combine owner is delayed by the weather or the demands of his own harvest.

[H] N.I.A.E. Record, Spring 1949, Grain Drying and Storage on the Farm.

SUMMARY.

1. This report is based on records of the operation of 20 combine harvesters and ten one-man pick-up balers during 1949.

2. The average cost per hour of combining was £1. 8.10, the cost per acre combined £1. 6. 6. and the cost per ton of grain threshed £1. 4. 5.

3. The majority of combines costed dealt with a corn acreage considerably below their full capacity.

4. There was no significant difference between the speed at which the large and small combines were operated.

5. Seven different crops were combined. More barley was combined than any other crop.

6. Total cost of harvesting grain including windrowing, combining, haulage, sack hire and dressing averaged £2. 2. 6. per acre and £1. 16. 1. per ton.

7. The average cost of operating seven engine ram type one-man pick-up balers was £1. 16. 2. per hour. The cost of baling and stacking averaged £1.10. 7. per acre for hay crops and £1. 6. 9. per acre for straw.

8. These balers have a capacity in excess of that required by most of the farmers who operated them.

9. The total cost of corn harvesting using a combine for the corn and pick-up baler fpr the straw varied from £5. 8. 3. to £1.18.11.per acre. On most farms it was appreciably lower than if the corn was stacked in the sheaf and threshed from the stack. But combined corn must be marketed immediately after harvest unless the farmer is prepared to incur the additional cost of storage.

10. There is scope for an increase in the use of pick-up balers for contract work. The advantages in connection with the increased use of combines for contract are less than for balers, especially from the hirer's point of view.