ROTHAMSTED RESEARCH

The Use of Electricity in Agriculture

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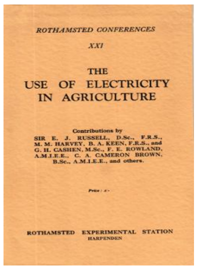

Grinding Experiments

Rothamsted Research

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GRINDING EXPERIMENTS

For a test of medium powered engines and motors a convenient farm operation is the grinding of barley. A Bamford 2C combined grinding and crushing mill is being used, and the two sources of power are :

(1) A General Electric Company 5 h.p. portable farm Drumotor ;

(2) A Bamford 6 b.h.p. portable diesel engine.

The comparisons are less straightforward than for threshing. In the first instance a series of experiments was made, using electric power only, to study the effect of the additional variable factors on the results. These measurements showed that the factors having most influence were changes in quality and moisture content of the barley, the rate of feed to the grinding plates, and the degree of fineness of the ground product.

The first factors can only be made negligible by working with a uniform sample of barley, and uniformity is more easily obtained the smaller the quantity of barley required. The manual controls on the mill make possible a wide range of grinding rate and degree of grinding, but there is no certainty that either of these factors would remain constant for any one setting of the appropriate control, e.g., the feeding rate depends to some extent on the amount of barley in the hopper, on the speed of the mill which governs the reciprocation of the shaker, and may be affected by foreign material in the barley. Any change in the feeding rate would be detected by weighing, at intervals, the output per minute : the degree of grinding, however, can only be judged roughly be feel, and changes could occur which would only be discovered afterwards on completion of a sieving analysis : but even if the fineness of grinding did remain constant during a measurement, the necessity of slackening off the plates before the feed ceases precludes exactly the same setting being used in the succeeding experiment.

These considerations suggest that experiments lasting long enough to provide an accurate overall power measurement were inadvisable, and that it would be desirable to obtain the power requirement for a given grinding rate and degree of fineness over a *short* period of time—of the order of one minute. A number of such observations would then provide the relationship between the three quantities being considered.

In practice the procedure is to alternate the motor and engine in experiments lasting about one hour.

The mill is set to give the required grinding rate which is afterwards maintained approximately constant. Then for one setting of the grinding plates the output per minute and a sample for the sieving analysis is taken : at the same time observations are made

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on the power requirement: the fineness of grinding is then altered and the measurements repeated. This process is continued until a number of observations have been obtained.

Afterwards the other power unit is used for a similar experiment, and the comparison repeated for different grinding rates.

It may be mentioned that the power requirement for the motor is found by timing the meter disc revolutions: for the engine a device is used which enables the fuel consumption to be measured over periods of the order of one minute.

The resulting data thus show, for a series of grinding rates, the variation in electricity and fuel consumptions with fineness of grinding.

This method of working has the advantage that the power units can be compared under identical conditions, and over a range of power output, since from the efficiency curve of the motor the output of the motor can be calculated. The measurements made so far should be regarded as of a preliminary nature. They show that for an output of 5 h.p., for example, the fuel consumption by the diesel engine amounts to 2.30 pints per hour (or an equivalent of 0.49 lb. of fuel per b.h.p. hour). At this output the motor requires an electricity consumption of 4.6 units per hour. Hence 10 kW hours are equivalent to 5.0 pints of the diesel fuel used in our experiments; account must also be taken of the lubricating oil which, according to manufacturers' directions, will amount to ½ gallon in 100 hours.

CALCULATION OF COSTS (GRINDING)

The same methods of costing described for the threshing experiments have been followed.

The following estimates have been adopted:

Bamford engine—Life 10 years, depreciation 15%, maintenance 5% of £73.

Drumotor—Life 20 years, depreciation 7½%, maintenance 2% of £37 10s.

Circuit—Life 25 years, depreciation 7½%, maintenance 2½% of £5.

The motor engine is assumed to work for 500 hours per annum. Electricity has again been taken as 1.42d. per unit.

The price of diesel fuel per gallon depends on the size of the drums in which it is delivered and ranges, for the oil we have used, from 5½d. per gallon for a 500-gallon drum to 1s. 2½d. per gallon for a 5-gallon drum. The price for a 40-gallon drum, 8¼d. per gallon, has been taken, as this is the most common size for farms. Lubricating oil has been charged at the same price as for the tractor. The summarized figures are given in Table 5.

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Table 5

Charges for one hour's grinding.

(6 h.p. diesel ; 5 h.p. drumotor ; each at 5 h.p. output)

	Electrical equipment d.	*Diesel* d.
Fuel+Oil ; or Electricity . .	6.55	2.52
Overheads	1.74	5.50
Total	8.29	8.02

This table shows, for our conditions and with the assumptions made above, that the total costs when using a diesel engine are slightly cheaper than those for a drumotor.

Had the cost of electricity been 1.36d. per unit instead of 1.42d., the cost of the two forms of power would have been the same. But in view of the preliminary nature of our experimental results and the somewhat arbitrary assumptions necessarily made in various overhead items of cost, it is fairer to say that at present there seems little to choose between the 6 h.p. diesel and the 5 h.p. electric motor.

Finally it is desired to emphasize one point in connection with the costings results shown in Tables 4 and 5. It will be observed that while electrical equipment has the lesser overheads, it has the higher charges for power consumption.

These two items work in opposite directions. For a small number of hours of work per year, the extra cost of electricity over fuel is not enough to offset the lower overhead charges for the electric motor, and the total cost per hour for the electricity motor is less than for the engine. With increase in the number of hours of work this advantage progressively diminishes and is ultimately reversed.

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