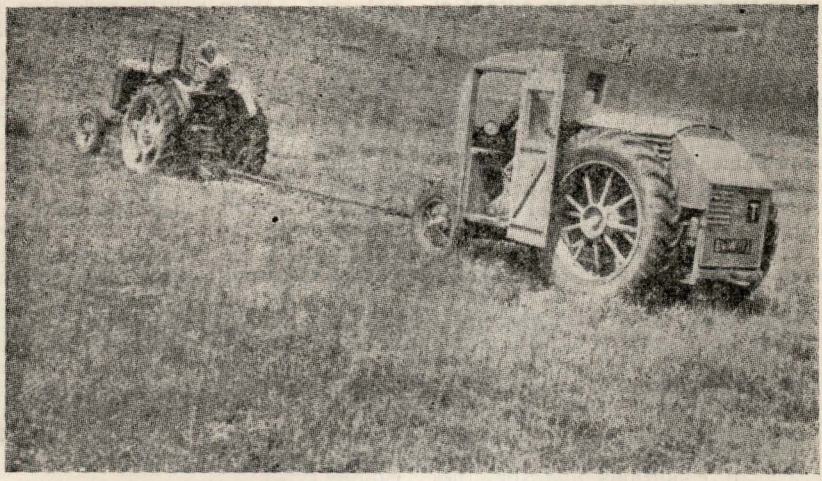
More . . .



. . . . About Tractors

Prepared by R. H. COCHRANE, B.A. (Cantab.,) Lecturer in Agricultural Engineering, Canterbury Agricultural College.

IN RECENT YEARS the controversy over British and American tractors has given rise to a certain amount of confusion due partly to a conflict of interests and partly to a lack of knowledge of the available testing facilities. It is the object of this bulletin to try to establish a firm basis upon which any prospective buyer may assess for himself the merits of the various tractors on the market.

Tractors are tested at the University of Nebraska in the United States, at the Institute for Agricultural Engineering in England and at the aeronautical research laboratories of the Department of Supply and Development in Melbourne in Australia. At each of these centres tractors are submitted to similar testing procedures and the results are published for everyone to see. The results provide a means of assessing the relative merits of the various makes and types on the market.

Care must be taken when comparing tests made at different centres. The U.S. gallon is a different measure to the British one, fuels also differ and the engine used may have been made to a different specification. These factors must be taken into account to obtain a true comparison.

For the purpose of testing, tractor performance can be placed under two headings, engine performance and performance in the field. Under engine performance the power output and the fuel consumption can be measured with accuracy over a wide range of engine speeds. As was pointed out in Bulletin No. 240 of this series, the modern tractor engine delivers power in a number of ways, through the hydraulic mechanism, the power take off, the belt pulley and the drawbar. The most convenient place for measuring the performance of the engine is at the belt pulley. The pulley is coupled by a belt to an electrical or hydraulic absorption dynamometer, prony brake or an equivalent power measuring device.

Canterbury Chamber of Commerce, Agricultural Bulletin, No. 246
January, 1950

Corrections are made for belt slip and as the measurements are made under controlled conditions a high standard of accuracy is to be expected. It is a simple matter, at the same time to take an accurate measure of the consumption of fuel. This is then related to the output of power by a simple calculation.

The power output of an engine is measured in terms of horse power, one horse power being equivalent to 33,000 foot pounds of work per minute. Horse power is given different names when measured at different points. To avoid confusion the most important names will be defined. Brake horse power is the power available at the flywheel or output shaft of an engine. Belt horse power is the power the engine develops measured at the belt pulley. Drawbar horse power is the power available at the drawbar. Rated power of any kind is an arbitrary figure, less than the maximum developed under test. Test conditions are generally more favourable than operational conditions and for this reason, as well as for reasons associated with wear and tear, a figure below the maximum developed under test is named as the rated figure.

The American Society of Agricultural Engineers and the Society of Automotive Engineers have drawn up a standard code rating. Rated belt horse power must not exceed 85 per cent and the rated drawbar horse power must not exceed 75 per cent of the maximum developed under test.

The amount of fuel consumed by an engine should be related to the output of power and not to the passage of time alone. To relate fuel consumption to time alone gives no indication of how the fuel was used. For example, a low fuel consumption would be recorded if an engine were merely allowed to idle for a period. To establish a more exact reading, fuel consumption should be measured in terms of weight and not volume. This is due to the volume occupied by a liquid varying with temperature while the weight remains constant. The results of a fuel test are generally expressed in terms of pounds of fuel consumed per belt horse power hour. This means that so many pounds of fuel must be consumed in order to produce a power output of one horse power at the belt pulley for a period of one hour. Due, however, to the difficulties of interpreting fuel consumption measured by weight into every day terms, the consumption is usually expressed in terms of gallons or fractions of gallon. At Nebraska different carburettor or fuel pump settings are included in the tests.

Tractor performance at the drawbar begin with the contact the final drive mechanism makes with the ground. Bulletin No. 240 outlines the factors which influence the pull obtained. With a little reflection it becomes obvious that it is very difficult to obtain an accurate measurement of drawbar pull, and be certain that the figure obtained will be reproduced under different ground conditions. This is due to the differences in soil type, moisture content, and structure and the effects of these factors on the problem of obtaining a grip on the soil. No two soils are alike, and there is no means of exact classification so as to bring the results to a common denominator of soil conditions. The exact capacity of a tractor in one field is therefore only in approximation to its exact capacity in another field. Under extreme conditions, the variation may be considerable. The discrepancy is greatest with tractors fitted with rubber tyres.

Tractor performance in the field is measured in terms of drawbar pull, to measure it in terms of furrows is to introduce the many variables associated with ploughs and make the results still less useful for general application. Plough bodies vary and a standard body would have to be defined. Draft can be altered considerably by plough adjustments, these are too difficult to assess with any accuracy. Draft also fluctuates with differences in soil and in the depth of ploughing. It is therefore more accurate to measure the field performance of a tractor in terms of its drawbar pull.

Drawbar horse power is obtained as a product of the drawbar pull in pounds and the forward speed in feet per minute divided by 33,000. In the field the speed at which work is done has an important bearing on the quality of the work. It is important therefore to know the pull and the forward speed at which the drawbar horse power is calculated.

Tractors can be tested at the drawbar under conditions which represent as nearly as possible those which are found on the farm and with which farmers are familiar, or they can be tested out on a prepared track. A prepared track makes the conditions under which the tractors are tested more nearly identical by maintaining static surface conditions. In this way the figures arrived at for different tractors are truly comparable with one another. Obviously it is important when using these tests for the

comparison of different tractors to make sure that the type of surface upon which the test took place is stated and make allowances accordingly. It must also be born in mind that a prepared track provides a good grip and a low rolling resistance. On the farm such conditions rarely prevail. The Nebraska tests are based on a prepared track and now in England tests on a prepared track are also included among those made under conditions such as are found on farms.

The excessive slipping of the drive wheel results in a loss of power and with rubber tyres in particular, causes serious wear. The maximum drawbar pull however is only developed when there is a certain amount of drive wheel slip.

The determination of the percentage drive wheel slip at various loads is therefore another important aspect of tractor testing. If it were said to be 3 per cent at a certain load it would mean that at that particular load and under those conditions the drive wheels have to make one hundred and three revolutions in order that the tractor may move forward a distance equivalent to one hundred revolutions of the drive wheels if there were no slip. It is a measure of the efficiency of the grip the final drive mechanism obtains on the ground.

Apart from tests on fuel consumption, drawbar performance and drive wheel slip at varying loads and speeds some indication of stability would be of great use in New Zealand where so much cultivated land is on a slope. In this connexion, a very large safety factor would have to be included to allow for unevenness of surface and for stones. No service of this kind is yet available. When the necessary funds become available Lincoln College staff will be pleased to undertake complete tractor testing in order to provide farmers with an aid in their choice of machine.

Selection is not entirely governed by scientific test procedure. A tractor must be considered in relation to the farm as a whole. The soil and the contours, as well as the type and range of work it is expected to perform are also important. There are a number of general decisions to be made before deciding between different makes. These are: type of fuel; horse power; kind of wheels or tracks; and the range of gears needed.

It is not difficult to become over mechanised on a farm. Before purchasing ask yourself, will the tractor earn money or will it save money? Will it increase the acreage able to be handled by existing labour? Will it increase income by making it possible to do contract work, or will it just tie up capital that could be profitably employed elsewhere?

The possible purchase must be considered from a number of angles. First of all there are the costs, both direct and indirect. Direct costs are made up of initial costs and running costs. Running costs are labour, maintenance, repairs and renewals. The indirect costs are made up of interest on capital invested (which is an annual charge on the machine) and depreciation, which is an estimate due to the lapse of time and not to wear and tear. It is a figure obtained from the new cost, plus capital additions, minus the discard value, divided by the number of years use. It may, in times of rising prices, be less than nil and in times of falling prices be very great. The usual rates estimated at the moment in New Zealand for taxation purposes are as follows: Machinery and plant 7½ per cent of the diminishing value, tractors, headers, cars and trucks 20 per cent of the diminishing value. Indirect costs also include any other equipment required, such as sheds to house the tractor, drums for oil storage, and so on.

Other angles from which the purchase must be considered are annual use, adaptability, technical efficiency of construction and improved performance over existing types. In these last two matters use should be made of the tests outlined above.

To decide between buying or engaging a contractor, make an inventory of the total estimated cost of operating the machine for one year. Depreciation, maintenance, repairs, housing, interest on capital invested, insurance, fuel, supplies and wages would be included. The cost of working per hour decreases as the machine is used more often. More implements may increase the use of the tractor. Plot the cost of operating against the number of hours worked. The cost per hour diminishes by increasingly small stages as more hours are worked. Somewhere on the graph is the price you would be prepared to pay for contract work. If the number of hours work per year you have for the machine is more than the number of hours associated on the graph with the price you are prepared to pay, then it is more profitable to buy a machine; if it is not, then, if other economic factors are favourable it is more profitable to hire a machine. If it is decided that the tractor is really needed then

there remains the choice between makes.

Examine the tractor from the point of view of the operator—its operation such as manoeuvrability, turning circle, ease of steering and vision backwards and forwards. Is the seat comfortable and is it easy to mount and dismount? Can the operator stand to drive, and is there enough leg room when seated? What about noise, vibration, and fumes? Is there sufficient platform space to be able to carry tools, shackles, chains, etc? What safety measures are there and what about brakes? Will they hold the tractor, plus a load, on a reasonable slope? How long does it take to pull up from maximum forward speed? What equipment goes with the standard model? The pulley and power take off may be extra. What provision is there for mounting implements? If they are to be directly attached what kind of fitting is there and how does the lift work? If you intend to buy two kinds of wheels, how easy is it to change wheels? Is there provision for back axle weights and can they easily be fitted? How high is the drawbar from the ground and is it swinging or fixed? Note whether the dimensions of the bar are suitable for your implements. Is there an adequate waterproof sheet to cover the engine?

You, as operator of the machine, will be called on to service it. Obtain the instruction book, see what you will be expected to do, at all the various service periods, and try to estimate how easy or difficult your job will be. Small things, like whether or not you are able to use a large enough drum under the oil drain to take all the oil during a change, increase in importance with the number of times they are done.

Note the capacity of the fuel tank and estimate if you will be able to do a day's work without refuelling, say at two-thirds throttle. Could spillage from the tanks cause fire by dripping on to a hot exhaust or cause damage to a magneto or battery? How easily does the engine start and what alternative methods are there to manual methods? Lastly, look at the tool kit that goes with the standard model, and see if the tools are adequate for all the jobs you will be called on to do. Does the tool kit include a wheel puller if one is necessary for changing the wheels, and are any special tools needed for the spark plugs or for track adjustment?

Having decided to buy a certain make, go to the nearest reputable dealer who has adequate aquipment. With him you will be able to arrange a demonstration on your farm before finally purchasing and later on you will be easily able to obtain spares, repairs and advice when required.

Copies of this Bulletin may be obtained from the Secretary, Canterbury Chamber of Commerce, P.O. Box 187, Christchurch.

ELLESMERE GUARDIAN PRINT