The elusive thing called horse-power

F. R. Stanley
THIS ELUSIVE THING
Called
HORSE-POWER.

By F. R. STANLEY*

At the last Perth Royal Show, a farmer accompanied by his young son was deeply immersed in a discussion with a tractor salesman. The youngster eyed the display machine carefully as his elders discoursed on belt horse-power and drawbar horse-power. Finally he said, "What ARE all these horse-power things Dad—I can't see 'em?"

I felt at the time that the boy's question was one that many adults might well have asked.

Horse-power is something that does not show—in fact it is something so elusive that the average tractor-buyer has to take someone else's word for its existence and its measure.

How many of my readers—even tractor-owners of many years standing—could have answered the boy's question with any degree of confidence?

Possibly most of you know that the standard horse-power is the power needed to lift 33,000 lb. one foot in one minute or in other words it is 33,000 foot-pounds per minute—but how many of you know how it is applied in giving the drawbar horse-power of your tractor?

I have seen many attempts made to explain this in simple, layman's language but cannot recall any better explanation than that given by Mr. John McClelland when writing in "Stock and Land" a few years ago. I have taken the liberty of reprinting portion of his article as he has given an explanation which is clearer and more concise than anything I could hope to write. He says:

This is no realm of the mighty mathematician or of the highly trained engineer; it is a simple field open to everyone who can multiply 2 x 2, but it is necessary to get hold of a few simple concepts—force, work and power.

The idea of force is simple enough—we all know that we exert a force when we say push against a car, and provided the car does not move, that it pushes back with an equal and opposite force.

If we succeed in pushing the car by exerting a force of, say, 55 lb. and if

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we have moved it, say 10 ft. then we have done some work and this work is equal to 55 x 10 or 550 foot pounds.

Power is the rate of doing work, so if we succeed in pushing the car again with a 55 lb. push and over a distance of 10 ft. in say one second, we have worked at a rate of 55 x 10 ft. lb. per second, or 55 x 10 x 60 ft. lb. per minute. This is measured reasonably enough in foot pounds per minute.

The familiar unit of power is the horse-power and is equal to a working rate of 33,000 foot pounds per minute. So in our case we have exerted:

\[
\frac{55 \times 10 \times 60}{33,000} = 1 \text{ horse-power.}
\]

We can work out the power necessary for any operation if we know the drawbar pull necessary to handle an implement and the speed of operation by the simple formula:

\[
\text{Horse power} = \frac{\text{drawbar pull} \times \text{speed, in feet per minute}}{33,000}
\]

and for simplicity, 1 mile per hour = 88 feet per minute.

**TRACTOR TESTS**

Now that we have some idea of what horse-power means, we can proceed to link up our knowledge with practical tractor work.

As I said previously, horse-power is something we cannot see—and the tractor-owner has to take someone else's word for its existence and its measure. In these days, that "someone else" is usually the manufacturer of the tractor or his representative, who gives details of the drawbar horse-power and belt horse-power in the published specifications. In these days too, that information is usually fairly accurate and in many cases it is supported by "Nebraska Test" or "Australian Tractor Testing Committee" figures.

**The Nebraska Test.**

In the "bad old days" some tractor manufacturers took advantage of the fact that horse-power could not be seen, and endowed their machines with quite fictitious horse-power ratings in order to boost sales. If one manufacturer's chief rival in the sales market was say a 35 h.p. model, he would claim that his product was in the 40 h.p. class—and who was there to dispute it?

This kind of deception became so common that in 1919, the State of Nebraska, U.S.A., introduced a law which, in brief, stipulated that a tractor could only be sold in that State if its advertised horse-power was supported by tests carried out at the University of Nebraska; if it had operated under test without serious mechanical breakdown, and if the manufacturers showed that they had adequate supplies of spare parts available within the State.

The manufacturers had to submit stock models for testing, and only those which passed the test were given permits for sale.

This law only applied in the State of Nebraska but its repercussions soon spread throughout the U.S.A. and almost throughout the world. The Nebraska test figures were insisted upon by farmers, and buyer-resistance to untested models was such that fictitious horse-power ratings soon became a thing of the past.
Other Standard Tests.

The demand for authoritative figures, backed by some independent testing authority, led to the establishment of tests in other countries. In Britain they are conducted by the National Institute of Agricultural Engineering (N.I.A.E.) and in Australia by the Australian Tractor Testing Committee which has a testing station located in the Victorian Department of Agriculture's State Research Farm, Werribee.

The Station is financed jointly by the Commonwealth and all State Governments, and the testing work is done by the University of Melbourne. The tests differ only in some details from those conducted at the University of Nebraska. The activities of the station are controlled by the Tractor Testing Committee, representing the Commonwealth, the States and the University.

DETAILS OF AUSTRALIAN TESTS

The following details of the testing procedure were given recently by Mr. G. H. Vasey, B.C.E., A.M.I.E., Aust., the Officer-in-Charge of Tractor Testing.

The station is equipped to carry out tests on tractors, engines, spark arresters, and on tyres, fuels, and other agricultural automotive equipment.

The station's clients are chiefly manufacturers of engines and tractors and like equipment, who see the point of having their product tested by an independent testing authority. There is no compulsion about it, as there is by law in Nebraska (U.S.A.).

If the tractor is a stock-model, i.e., in production for sale, then the test is published for all to see. Farmer's editions of tractor tests have been published in most of the State Journals of Agriculture within the last year or two. For a prototype, not yet in production, the company may seek a private test, for its own information; such a report is not published.

The standard procedure in testing a tractor, according to the test code, is in three main parts—(i), tests on the engine when driving through the belt, i.e., the belt tests; (ii), tests on the tractor as a whole when towing through the drawbar, i.e., the drawbar tests; and (iii), inspection for wear or damage, and generally the examination of the tractor as a whole.

In the belt tests the engine is loaded by the belt-driven dynamometer, which can apply and measure any suitable power demand on the engine. The belt tests establish the maximum belt power of the tractor, at rated engine-speed; they also show the engine performance over the governed range, and on overload with full throttle. Fuel consumption is also measured.

In the drawbar tests the tractor is made to tow a load which can be controlled and varied, and measured, from light to heavy pulls. Road speed and wheel slip are also measured, the product of pull and speed being drawbar horse-power.

Pull, speed and slip, with the engine running at rated speed, are measured in all gears; since, at rated speed, the engine is at full throttle these runs correspond to full engine power, and so give maximum drawbar horse-power in each gear. The maximum power in “rated” gear establishes the maximum drawbar horse-power of the tractor.

The fuel consumption is measured in a series of runs in rated gear at various part loads, running in all for ten hours.

An important point to note is that the drawbar tests are run on a hard road, concrete or asphalt. The reason for this is that such a surface is a “standard” one, compared with soils which are highly variable; and such a surface is the same in all parts of the world. The result of this is that the drawbar performance in the field will usually be lower than in the tests.

The testing officers make many other observations on the tractor, for example the speeds of belt and power-take-off, the position of the centre of gravity, the placing and working of the controls, the instruments, accessibility, comfort and safety.

(End of quote.)

DRAWBAR PULL

The actual pulling power of the tractor—the number of pounds pull exerted at the drawbar—is possibly the most vital factor governing the farmer's choice of a machine.
This is easily tested with a dynamometer—an instrument similar to a glorified spring-balance which is attached between the drawbar and the implement being towed. As the tractor moves off, the actual pull in pounds is registered on the clock-face of the dynamometer.

Two tractors of the same make and horse-power can give vastly different pulling performances even though engine performances may be identical. Many factors can influence the final results but the three most vital are tyre pressure, weights of rear wheels and height of the drawbar.

**Tyre Pressure.**

For field work, air-filled tyres should be kept at the recommended pressures, which are usually the tried and tested “happy medium,” best suited to give efficiency and economy. The lower the pressure—within reason—the greater the area of tread or gripping surface which comes into contact with the ground, but too low a pressure results in wrinkling of the tyre walls and increases the flexing of the tyre to an extent which soon weakens the fabrics.

Too high a pressure tends to leave only the centre of the tread in contact with the ground surface and this leads to excessive wheel slippage with increased tyre wear and higher fuel consumption. Over-inflated tyres do not “iron out” inequalities in the ground surface so the driver has a rough ride.

Be careful to keep the tyre pressures equal on the two rear wheels. Uneven pressures will cause excessive wheel slip on one side and this also results in power losses through friction in the differential, as well as an increase in fuel consumption.

Higher tyre pressures will be needed for roadwork and haulage at transport speeds than would be used for low speed field work such as ploughing and cultivating. High-speed work on soft tyres greatly increases operating costs.

**Wheel Weights.**

The addition of heavy rear wheel centres or the use of water-filled tyres is another method of reducing wheel slip—and excessive wheel slip can reduce the drawbar pull and increase tyre wear to a marked degree.

Some experts state that for every 120 lb. added to the rear wheels of a tractor, the drawbar pull will be increased by 90 lb. In Western Australia some farmers on a 36 h.p. Maximum drawbar tractor are working satisfactorily, with rear wheel centres weighing 1,000 lb. each and also have their tyres three-quarters filled with water, giving them an overall rear wheel weightage of 2,880 lb., an increase of over 1,480 lb. upon the standard rear wheel weights of this type of tractor. These farmers have told me this extra weight has given a highly satisfactory tractor performance.

In England, most popular makes of tractors have light wheel centres, whereas in America, South Africa and Australia, there is a pronounced swing towards the heavy wheel centres. The type of farming and type of implement used may have some influence on this. In England where hydraulics are so popular, their three-point linkage control with the implement mounted immediately behind the tractor may be the reason. Here, the downward drag of the implement tends to bring about a reduction in wheel slippage although, even then, I am of the opinion that heavier centres would be an advantage. In America, South Africa and Australia with their “broad acre” farming the larger trailed implements make heavy centres a necessity.

**Water-Filled Tyres.**

In some popular makes of tractors marketed in Australia today, a special attachment for filling tyres with water is included as standard equipment, which illustrates the keen demand for water-filled tyres.

Two 14 x 28 tyres filled with 75 per cent. water will hold 88 gallons, thus adding 880 lb. to the overall weight on the rear wheels. Correspondingly, with 100 per cent. of water in tyres the weight will be increased by 1,108 lb.

With water in the tyres, the tyre pressure may be decreased to as low as 10 lb. per square inch. You will appreciate that the lower the pressure, the more adhesion or “grip” the tyre has on the ground.

Once you notice any wrinkling along the side walls of a tyre at maximum load, however, you will know you have gone
below the desirable minimum pressure at which you can work—and pressure should be increased until the wrinkling disappears.

With water-filled tyres, the pressure will remain constant for a longer period than if the tyres are air-filled but it is vitally important to have both tyres at the same pressure. As mentioned earlier, wheel slip will be accentuated if tyre pressures are uneven—with water-filled tyres and the heavier weight on the ground, unevenness in pressure will result in a still greater degree of wheel slip.

**Drawbar Height.**

Our final thought on controlling wheel slip is the height of the drawbar in relation to the load. Faulty drawbar positioning can cause excessive wheel slippage with corresponding loss of pulling power.

Remove the locking pins and let the drawbar "float" while you pull the implement a few feet on level ground. Then note the drawbar height correctly and lock it in that position, or perhaps an inch above to allow for weight transferred from front to rear wheels. With hill work, of course, you may have to lower the drawbar, but your own gauge for this will be whether your front wheels tend to rise or not.

With the above factors checked thoroughly, it is possible to reduce your wheel slippage in working gear to as low as 4 per cent—a simple adjustment, which in a year's operations will save a lot of time, labour and money, and enable you to produce at lower cost.

**Testing for Wheel Slippage.**

As a matter of interest to yourself, carry out the following test to see just what your tractor wheel slippage is and then see what reduction you can make by carrying out some of the points discussed.

Mark your rear wheel with a piece of chalk, and then drive the tractor unloaded until the wheels have made exactly 30 revolutions. The distance which the tractor has travelled is marked, and then the same course is travelled with the tractor under load.

The number of revolutions to complete the course under load are carefully counted, and the number of revolutions which the tractor made unloaded subtracted from the number of revolutions made under load.

For instance, the tractor under load may take 34 revolutions of the wheels to cover the same distance it covered in 30 revolutions when unloaded.

If we subtract 30 from 34 we have a wheel slippage of 4 revolutions in 34. To pass this as a percentage we multiply the 4 by 100 and divide it by the number of revolutions made under load (34) and our answer is 11.7 per cent.

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**SAN JOSE SCALE CONTROL**

The necessity of controlling San Jose scale infestation in commercial orchards is becoming a matter of increasing importance. This has been brought about by certain major fruit importing countries prohibiting the importation of any fruit infested with this scale insect.

During the last two seasons strenuous efforts have been made by the Department of Agriculture and all concerned within the industry to highlight the importance of controlling this pest. However, the action taken by growers, though quite successful in reducing scale numbers, will have to be considerably expanded if anything like complete control is to be achieved.

In some commercial fruitgrowing districts the presence of infested trees in backyard orchards can be regarded as a menace for the reason that young scale crawlers can be transferred by wind and on the feet of birds to clean trees in commercial orchards.

The importance of this matter has been accepted and a campaign is now being organised to apply to Bridgetown. In this town there are approximately 3,100 fruit trees. Many of these trees are badly infested with scale, as are other plants including roses and pussy willows. It is proposed with the co-operation of the householders concerned to effectively power spray all susceptible trees once during the winter and/or early spring, and up to three times during the summer. The cost of the spraying treatments will be free to occupiers having 12 or less trees, but full costs will be charged to occupiers who have more than 12 trees.

In addition to the spraying treatments action will be taken by inspectors to order the destruction of badly-infested trees and plants.

The campaign will be in operation for a period of up to three years and it is hoped that eradication will be achieved.

The cost of the spraying treatments will be borne jointly by the Department of Agriculture and the Western Australian Fruit Growers' Association through their Trust Fund.
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