PUBLICATION 999 ISSUED JANUARY 1957

CANADA DEPARTMENT OF AGRICULTURE

TRACTION PROBLEMS with MOUNTED TILLAGE IMPLEMENTS

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Mounted tillage implements for one, two, and two-three plow tractors have become very popular, and under certain field conditions are more suitable than trailed implements. The reasons for this popularity are the low initial costs due to lighter weight and fewer parts, the simplicity and ease of control when in use, and maneuverability in small plots or fields. These characteristics make mounted implements ideal for operations on small farms or for specialized farming.

There are a few disadvantages. For example, the various types of hitches limit the use of particular implements to tractors having the same type of hitches, and more time is required for changing some of the units as compared with trailed implements. Also, under rapidly changing soil conditions, it is difficult to adjust some of the mounted tillage implements to a uniform depth, and in hilly regions and areas of rough land the side draft may present a problem. Most of these points are readily self-evident, but the effects of mounted tillage implements on the operation of the tractor are not always considered.

Types of Hitches

Several types of hitches are used for attaching mounted implements to tractors. The effect of tillage implements on the tractor varies with the type of hitch. These hitches, or methods of attaching implements, may be classified into four groups.

Single hitch point system - For this type of hitch the drawbar of the plow is attached to a single position underneath the tractor (Figure 1). The implement is stabilized by guide chains and operates freely, as does a walking plow. Depth is controlled by means of gauge wheels, supplemented by a chain from the rear of the tractor to the plow frame or by adjusting the height of the hitch point, or a combination of these. No downward force is exerted by the tractor on the implement and so maximum depth is determined by weight and setting of the implement, the condition of cutting edges, and the nature of the soil.

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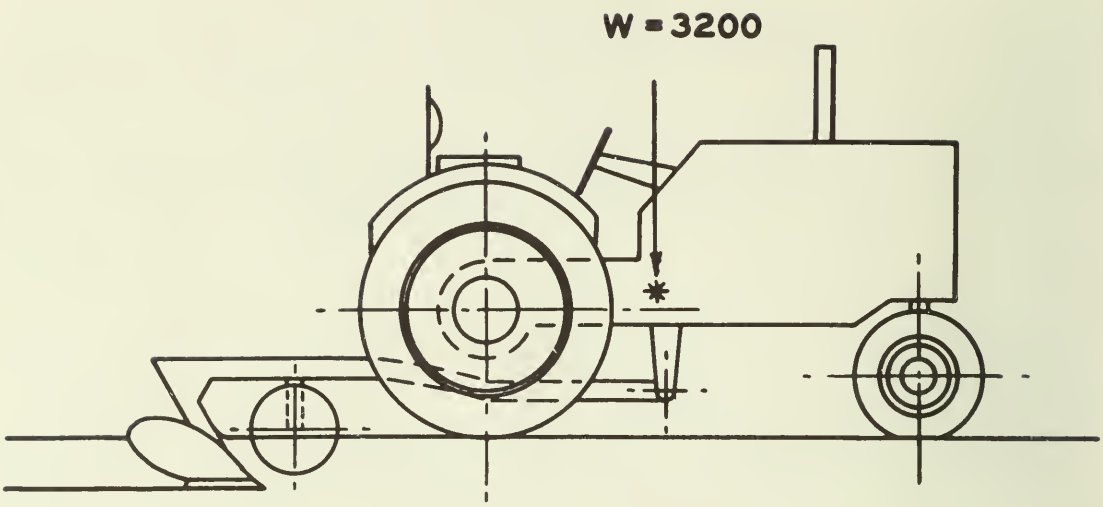

FIGURE: 1 SINGLE HITCH POINT

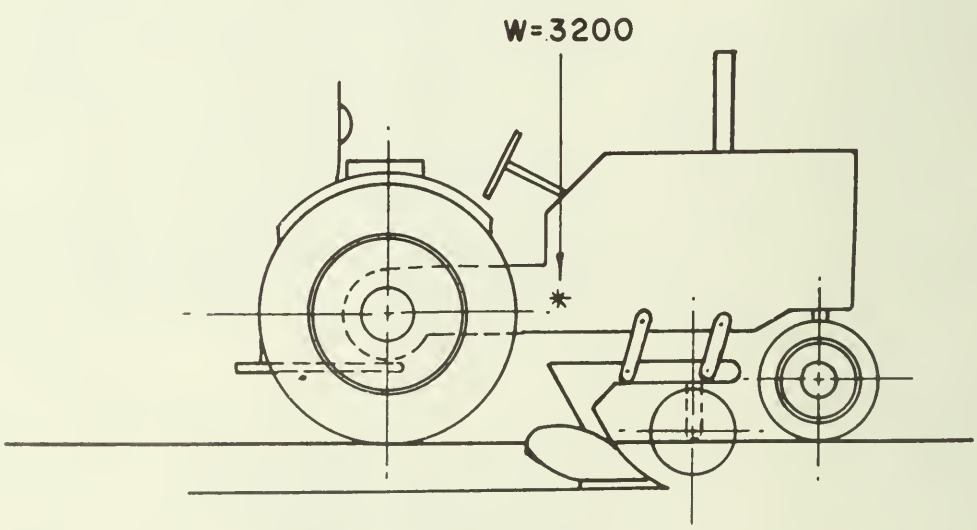

FIGURE: 2 FIXED - LINK HITCH

Fixed-link type - For this hitch the implement may be attached to the rear of the tractor, or is slung underneath the tractor as shown in Figure 2. The position of the implement is positively controlled by mechanical or hydraulic means. As the implement and tractor are rigid during operation, the tractor is used to maintain the desired depth and location of the implement.

Free-link type - This hitch is attached to the rear of the tractor and may have three or more links, or points of attachment. The implement is either held in full, hoisted position or dropped to the ground for operation. There is no means of holding the implement in an intermediate position. With this hitch the implement is free to operate at the depth which will momentarily balance the forces of the implement. Change in average working depth can be obtained by changing the weight of the implement, or by adjusting the top linkage as shown in Figure 3 to increase or decrease the suction of the implement.

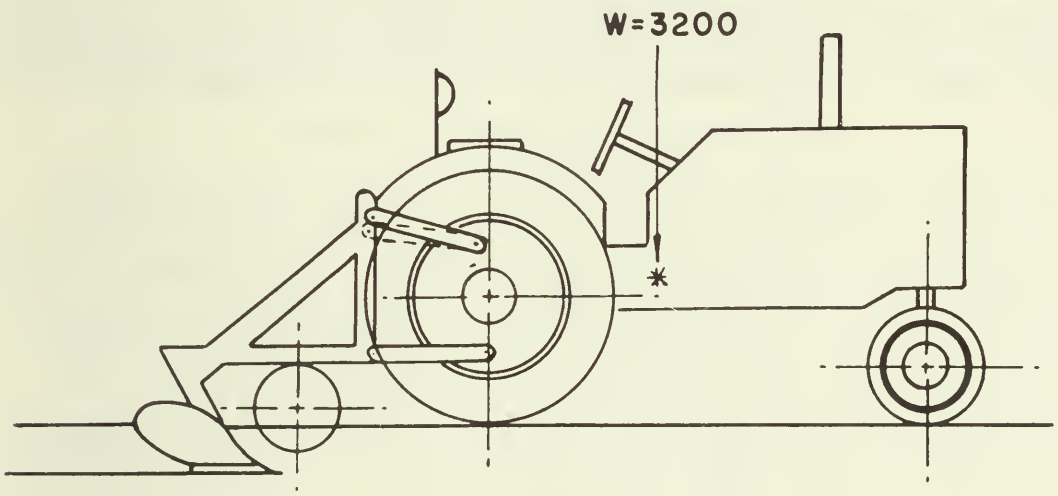

FIGURE 3 FREE-LINK HITCH

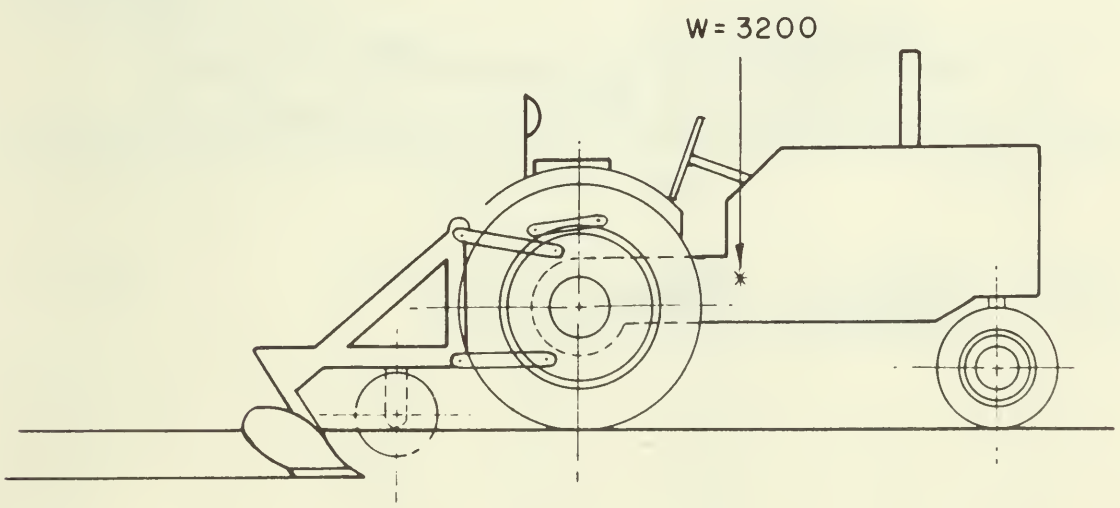

FIGURE 4 VARIABLE FIXED-LINK HITCH

Variable fixed-link type - This type of hitch may have three or more links as illustrated in Figure 4. It is similar to the free-link system but depth of operation is controlled by the tractor hydraulic system. One of the hitch links, usually the top link, is connected to an automatic control valve in the hydraulic system and is used as a control link.

The variable fixed-link uses the draft of the implement as a means of controlling the depth to maintain a constant draft. If the draft increases, the force on the control link increases and thus changes the position of the hydraulic control valve, which in turn causes the hydraulic system to lift the implement. As the implement is raised its draft decreases and thus reduces the force in the control link allowing the control valve to return to its neutral position. The implement is held at this new position until the draft changes again. If the draft decreases, the force in the control link is reduced and the control valve releases the hydraulic system and allows the unit to seek a new depth by gravity and suction. As the implement goes deeper the draft increases until the control valve is returned to its original position. Maximum working depth on this hitch also depends upon the setting and weight of the implement, the condition of cutting edges, and the soil.

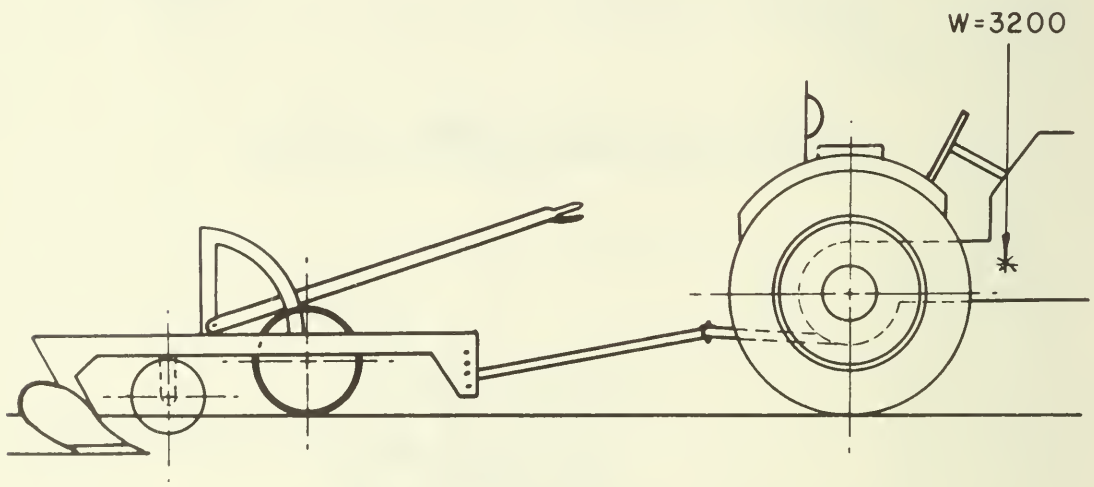

FIGURE 5 DRAWBAR HITCH

Forces Affecting the Traction of the Tractor

Two major forces affect the traction of a tractor under similar field conditions. These are: (1) the weight of the tractor and its distribution on the wheels and (2) the draft of the implement. The center of gravity of a tractor will determine the proportion of the weight of tractor on the rear and front wheels. However, draft changes the distribution of the weight on the wheels, and this is best illustrated when a tractor begins to rear up in the front when pulling a heavy load at the drawbar. In most instances draft will have a downward pull which will add to the total loading on the tractor. How much of this force is applied to front or rear wheels depends upon the location of the hitch. It should be added here that only with the fixed-link system can the weight of the tractor be used to gain penetration for hard soil conditions. Under such conditions, the fixed-link system may actually reduce the total weight on the tractor's wheels. Traction of a rubber-mounted tractor depends upon the weight on the rear wheels if all other factors are constant. It has been found that a rubber-tired tractor can pull between 40 and 50 percent of the load on its rear wheels when in operation.

Effect on a Tractor of Various Hitches

A typical two-plow tractor has been chosen to illustrate the effect of tillage implements on the operation of a tractor when used on various types of mounted hitches as compared with a drawbar hitch. When stationary, there is a weight of 2,100 pounds on the rear and 1,100 pounds on the front wheels to make up a total of 3,200 pounds including liquid-filled rear tires. Two implements were used (1) a plow, with a horizontal pull of 900 pounds and a downward force of 150 pounds and (2) a disk, set at a maximum depth, with a horizontal pull of 1,200 pounds. Data showing the effect of these implements on the tractor are given in Tables 1 and 2. The downward draft of the plow takes into account its weight and suction, the latter may be either a downward or an upward force. Since the disk was set to work at its maximum depth, all the weight of the implement was required to maintain the desired suction and hence exerted no downward pull on the tractor. The implements are the same distance from the rear of the tractor for hitches 1, 3 and 4.

Table 1 The Effect of the Type of Hitch on the Weight Exerted on a Tractor's Wheels by a Plow

Type of Hitch	Loading on Tractor Pounds			Tractive Force = 50% of Rear Wheel Load
	Total	Front Wheels	Rear Wheels	
Single hitch point	3,350	991	2,359	1,179
Fixed-link	3,350	1,201	2,149	1,075
Free-link	3,350	991	2,359	1,179
Variable fixed-link	3,350	991	2,359	1,179
Drawbar	3,350	801	2,549	1,274

Table 2 The Effect of the Type of Hitch on the Weight Exerted on a Tractor's Wheels by a Disk

Type of Hitch	Loading on Tractor, Pounds			Tractive Force = 50% of Rear Wheel Load
	Total	Front Wheels	Rear Wheels	
Single hitch point	3,355	963	2,392	1,196
Fixed-link	3,200	1,085	2,115	1,057
Free-link	3,200	1,085	2,115	1,057
Variable fixed-link	3,200	1,085	2,115	1,057
Drawbar	3,500	720	2,780	1,390

The data in Table 1 show that there is sufficient weight on the rear wheels of the tractor during operation with each type of hitch to supply the required traction to pull the 900-pound load of the plow. However, Table 2 shows that to pull the load of 1,200 pounds of the disk, the tractor has sufficient added weight on the rear wheels for proper traction only with the drawbar hitch arrangement.

It becomes evident from examination of the data in Tables 1 and 2 that the multi-link hitches produce the same effect on the tractor if the implements are in the same position, as shown by hitches 3 and 4. As the implement is moved towards the rear, more weight is transferred to the rear of the tractor during operation, as exemplified by differences between hitches 2 and 3 or 4 in Table 1. However, Table 2 does show that when implements of multi-link type are operating at maximum depth, position no longer affects the final results.

Although examples have not been given to demonstrate what happens when implements such as subsoilers are used, the results are of interest. A subsoiler may have a downward force as high as 600 pounds. When used as mounted equipment this force is brought to bear upon the tractor and thus increases its load. At the same time most of the weight of the tractor is transferred to its rear wheels, resulting in good traction. On the other hand, for a trailed implement most of this weight is carried by its supporting wheels, as the range for a vertical hitch adjustment is not sufficient to place this downward force on the tractor. Thus, the loading on the tractor is substantially lower than for a mounted hookup, and higher slippage may result.

A single hitch point, such as a drawbar and fixed hitch point, always pulls up on tillage implements. Thus, drawbar implements must have extra weight if they are to operate at the same depth as similar implements when mounted. Generally a trailed implement has more than sufficient weight to offset this upward pull and this reserve weight can be used for deeper penetration and for maintaining penetration under difficult conditions. This extra weight with correct vertical hitching can be transferred to the drawbar of the tractor and thus increase the loading on the tractor wheels for added traction Moreover, the extra weight is beneficial in securing initial penetration, as suction does not take effect until the implement is pulled into the soil

Discussion

The overall performance of a tractor with mounted implements can be improved when necessary by:

(1) Adding weight to the implement.
(2) Adding weight to the tractor, preferably to the rear wheels
(3) Adjusting the set of the implement to increase suction.
(4) Maintaining sharp cutting edges.
(5) Replacing rolling coulters with knife coulters as the latter do not require weight for penetration.

The addition of too much weight to a rear-mounted implement will make the tractor too light in front when the implement is out of the ground. Additions of weight to rear wheels must not surpass the manufacturer's load rating for the tires.

Conclusions

Lighter mounted implements with the multiple link type of hitch are capable of the same depth of operation as heavier trailed implements once initial penetration is obtained. Under light loads and good penetration, mounted implements do not create a traction problem. Under heavier loads or difficult penetration, slippage will become a problem if loading on the rear wheels is not sufficient for the required traction. When suction is extremely high, such as for subsoilers, mounted implements produce the best traction. Poor traction can be improved by several methods, the first choice being the addition of weight to the rear wheels.

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1957