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A Tractor Mounted Manure Loader

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By H. H. DeLong*

The tractor mounted manure loader described in this bulletin was constructed by the Agricultural Engineering department of the South Dakota Agricultural Experiment Station in answer to numerous requests for plans and suggestions on how to build these machines. The purpose of the experiment was to use materials available during wartime, to test their suitability, and to assemble them into a unit which could be made with the minimum of tools and labor. Mechanical manure loaders are great labor savers, and if built and used now during the war-time labor shortage, they will be aiding in the over all wartime effort of South Dakota farmers.

Please Note: The following plans are not complete in every detail. We cannot prepare exact plans and detailed dimensions to adapt this loader to every make, model, and size of tractor on the market. We do not have blueprints or drawings other than those shown in this bulletin. Please do not write for them.

Developments in Manure Loading Machinery

The mechanical manure loader is not a new machine. Attempts were made as early as 1915 to drive yard manure loaders by gasoline engines. By 1920 the small tractor had become common and the manure loader unit was tried out as a tractor mounted machine. After 1925 the small tractor type most popular was the general purpose, or the tricycle type. The loaders first made for the standard four-wheel tractors were redesigned for the general-purpose tractor. The power-take-off (p.t.o.) and rubber tires for tractors, both now standard equipment, have opened new possibilities for the mechanical manure loader.

The tractor mounted manure loader is still in the stage of development. There are at least six different types. It has not become standardized into the one best

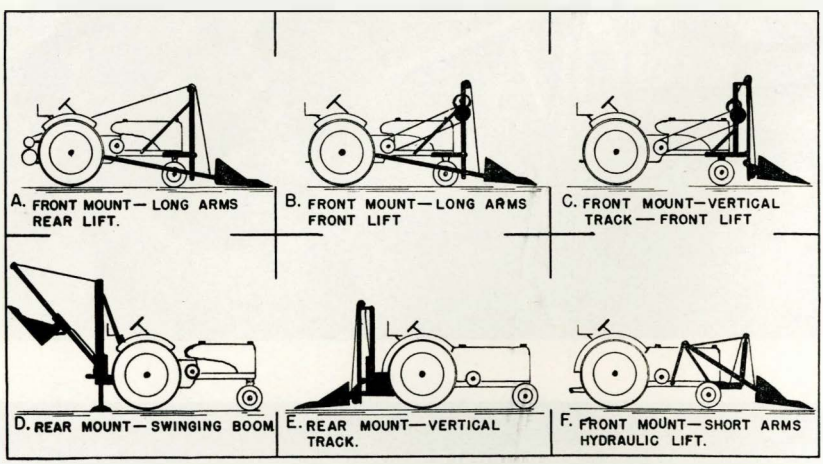

Fig. 1. The main types of tractor mounted manure loaders are pictured here.

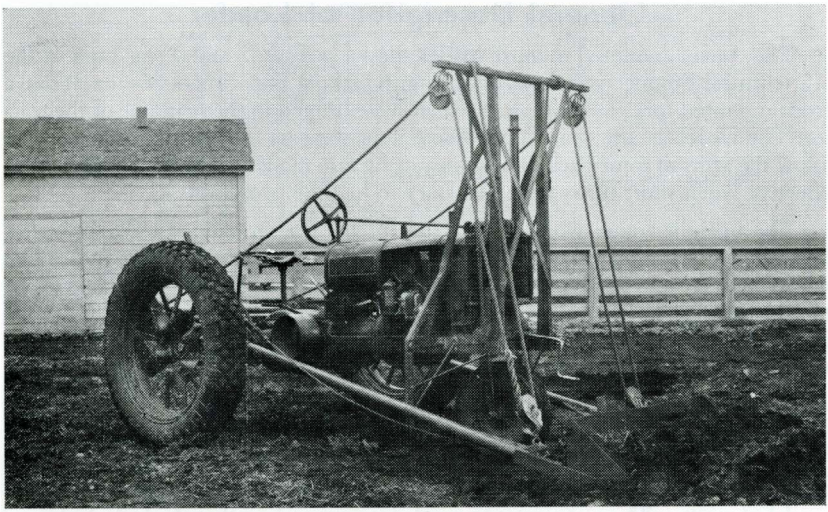

Fig. 2. The tractor mounted loader with the scoop down.

design, such as we see in the grain binder or the thresher. Fig. 1 on page 2 shows sketches of these six types:

1. The front-mounted loader (Fig. 1A) with fork mounted on long arms and hoist unit in rear close to the power-take-off coupling, is suited to the general-purpose tractor, and is popular in home made machines.

2. Fig. 1B shows a type the same as 1A except the hoisting mechanism is on the forward upright frame, and is belt driven from the tractor belt pulley. Both manufactured loaders and home-made loaders of this type are being made.

3. The front mounted loader (Fig. 1C) with manure fork on upright track, is obtainable in manufactured units, but is not as easily constructed in the home-made version as types A and B.

4. The rear mount, swinging boom loader is unique in that the tractor is stationary most of the time and the boom swings from loading to unloading postion. (Fig. 1D.)

5. The rear mounted fork on upright track (Fig. 1E.) places the load on the large rear wheels rather than on the lighter front wheels.

6. Fig. 1F shows a standard type tractor with front mounted fork on short arms. The lifting mechanism consists of a hydraulic pump and long upright lifting cylinder. Manufactured units are now sold for some models of tractors. The hydraulic principle has some definite advantages for all types of hoisting work. In the future the tractor may be equipped with high pressure oil pump of adequate size, and a large oil supply, which will adapt it to all types of hoisting work. Furthermore this oil pump can be mounted independently of the tractor clutch so that the raising of the load can be done when the tractor clutch is disengaged.

The machine built and tested at the South Dakota Agricultural Experiment Station was of the type shown in Fig. 1A. It was believed that the necessary parts and materials to make this type were most easily obtained and most easily assembled.

General Description of Loader

The tractor mounted manure loader shown in Figs. 2 and 3 was built at the Agricultural Engineering shops of the South Dakota Experiment Station. It had a front mounted fork, on long arms which were hinged to the rear axle of the tractor. The wheels of the general purpose tractor were set at their widest spacing to allow the arms to come back. The wide setting also made the steering brakes more effective when short turns were necessary in loading operations.

The upright frame work at the front of the tractor carried only the upper hoisting pulleys. Lower vertical guides kept the arms from sidewise movement while the fork was down and being pushed into the fork load. There is no objection to spacing the uprights far enough apart so that they act as the guides for the arms. All parts of the frame were of steel, arc-welded together. Dual hoisting ropes were used, to raise the fork.

Detailed Description of Fork and Uprights

1. The arms were made of 2½ inch pipe and were cut 8 feet 6 inches for this model of tractor. The arms must be made long enough so that the fork, lock, and arm braces clear all parts of the tractor for all positions of the fork. The outer end of the arm was made of a 3 foot length of 3 inch by ½ inch strap iron welded to the pipe, because the flat shape made a more satisfactory connection to the fork unit.

2. A detailed drawing of the arm hinge is shown in Fig. 4. One should not bolt the stationary hinge part to a cast flange on the tractor axle housing. A severe twist on the arm might break the casting. The swivel coupling pictured here was used to prevent such breakage.

3. The teeth were made of 1½ x 1½ x ¼ inch angle iron. These teeth were spaced 7 inches apart and were placed with the 90° angle upward. The ends were

Fig. 3. The loader in position to dump into the spreader.

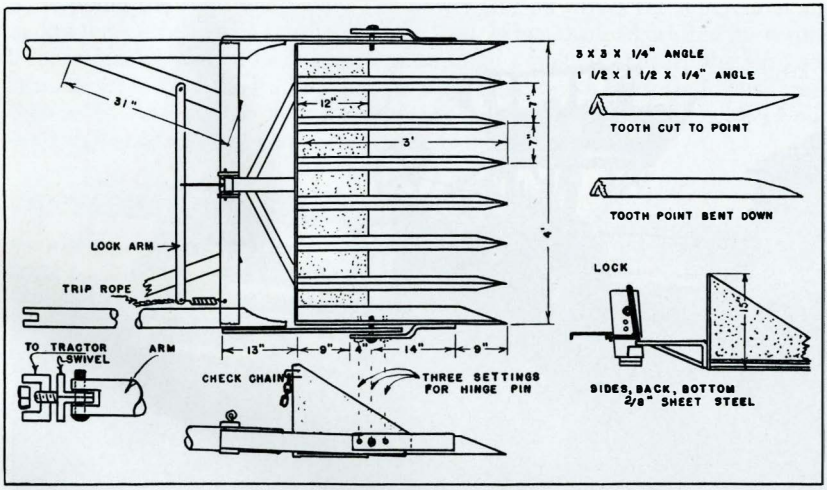

Fig. 4. Details of construction of the manure fork are shown.

tapered to a sharp point and bent downward. For average yard conditions this fork was satisfactory. Rear axle shafts from old cars make a more rigid tooth, and being round in shape will penetrate better, if well sharpened, than the angle iron.

4. The dimensions of the manure fork or scoop are given in Fig. 4. A removable bottom was made to extend forward 16 inches from the permanent bottom. This was used to handle dirt, gravel, or loose dry barnyard manure.

5. The detailed drawing of the scoop hinge (Fig. 4) shows a worthwhile feature. The scoop dumps itself when unlocked because the center of the load is in front of the hinge pin. After the load falls, however, the rear part of the fork is heavier than the front and it pulls the fork back to its locked position. With several settings of the hinge pin available, the operator can select the proper balance.

6. The upright frame was made from old car frame members. This material is light but strong. Each size of tractor requires its own style of framework and attachment. An overall height of 8 feet has been found adequate for loading spreaders and wagons. The structure should not interfere with steering or cranking, and should be easily removed.

7. Arm Guides seemed advisable, if not essential, to prevent the fork from sidewise movement with respect to the tractor front end. These bumper guides need not extend the full height of the upright frame, unless they are also used as as part of the frame structure.

8. The Pulleys used are standard 6 inch hard wood hay rope pulleys.

9. Hoisting ropes may be installed many ways by use of rope and pulley systems. The dual rope system was used on this loader. Each of the ropes was secured to the lifting drum (a 3½ inch pipe) on the rear of the tractor. Each rope (one for the left arm and one for the right) extended upward and forward on its respective side, to the pulley on the top bar. From here the rope traveled to a pulley on the lifting arm and back to the top bar. This arrangement proved to be best; the speed of lifting was satisfactory and the brake and clutch responded without jerking. No breakage was sustained when ¾" rope was used, except when defective pulley guides cut the rope.

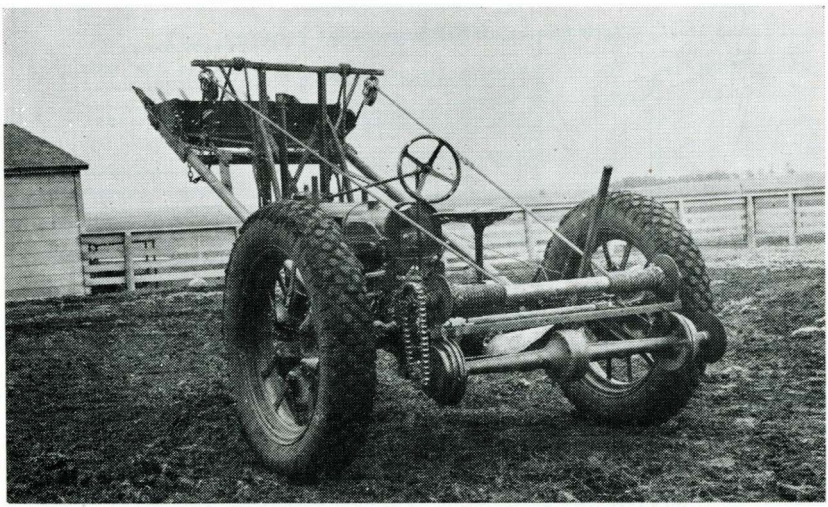

Fig. 5. Car axle hoist showing auxiliary winding drum.

Car Rear Axle for Hoisting Unit

The automobile rear axle makes a versatile hoisting unit when it is properly mounted and connected to the power-take-off shaft. Such applications have been used for years; and various versions of the same basic idea have been published from time to time in bulletins and magazines.

The car rear axle derives its usefulness for a hoist because it combines the bevel gear reduction and differential gear with two brake band members. One brake is used to lift the load, while the other is used to hold the load in place, or to gradually lower the fork.

Details of Installing the Hoist

1. Selection: Any car rear axle with good gears and good brakes can be used. The Hotchkiss type axle is preferable to the Torque Tube drive axle, because the universal joint is already in place on the differential drive shaft.

2. Mounting: The mounting brackets must be strong and rigid. The end of the car drive shaft must be directly in line with the tractor power-take-off shaft. Even with strong mountings there is enough give to make a double universal joint necessary between the two shafts just mentioned. One must allow for *two* universals. The mounting brackets should be such as to allow quick mounting or removal.

3. Ropes: Double hoisting ropes were used on the machine in Fig. 5. This makes the fork more rigid than some arrangements of a single rope lift. Often one side of the fork will become heavily loaded while the other side is not. Dual ropes keep the fork level even though it is loaded unevenly. The dual rope system does require the additional work of making the winding drum and the chain drive, as shown in Figs. 5 and 6.

4. The Control Lever: This must be placed in easy reach of the operator, as it is used frequently and must be moved quickly. When moved forward the control lever acts through a linkage (as at R′, Fig. 6) and engages the right hand brake

R, stopping the right hand axle. The power-take-off drives the differential and makes the left hand axle turn to raise the load. When the load is lifted the control lever is quickly shifted backward; and through a linkage as in L′ the left hand brake is set to hold the load up and the right hand brake is released. The fork is lowered by bringing the control lever to the neutral position. Here, neither brake is engaged and the fork comes down due to its weight.

Basic Design Data

1. Before the loader was mounted the tractor shown in this bulletin weighed 2,700 lbs; with a weight of 910 lbs. on the front wheel.

2. The total weight of the manure loader when empty was 680 lbs. Its weight was so distributed as to add 620 lbs. on the front wheel; thus making a new weight on the front wheel of 1,530 lbs.

3. The weight of an average fork-full of barnyard manure was 430 lbs. Due to the fork position being out in front, an additional weight of 685 lbs. was placed on the front wheel. This further increased the front wheel load to 2,215 lbs.

4. This loading is in excess of the loads for which the tractor was designed, as a typical front mounted cultivator (2-row) weighs from 700-900 lbs. (The operator must remember that the manure loader places greater stresses on the tractor front end than ordinarily expected. It is advisable, therefore, to avoid fast and reckless operation of the loader.)

5. Motor speeds of ½ to 2/3 maximum speed are recommended; and the resulting power-take-off speeds are 275 to 366 r.p.m.

6. Car rear axle ratios are close to 3 to 1.

7. When one side of a differential is stopped the other side doubles its normal speed.

8. A linear rope speed of 140 to 235 feet per minute was satisfactory.

9. The time for lifting the loaded fork was from 3 to 5 seconds.

10. Standard spreader loads averaged 7 loader scoops per load.

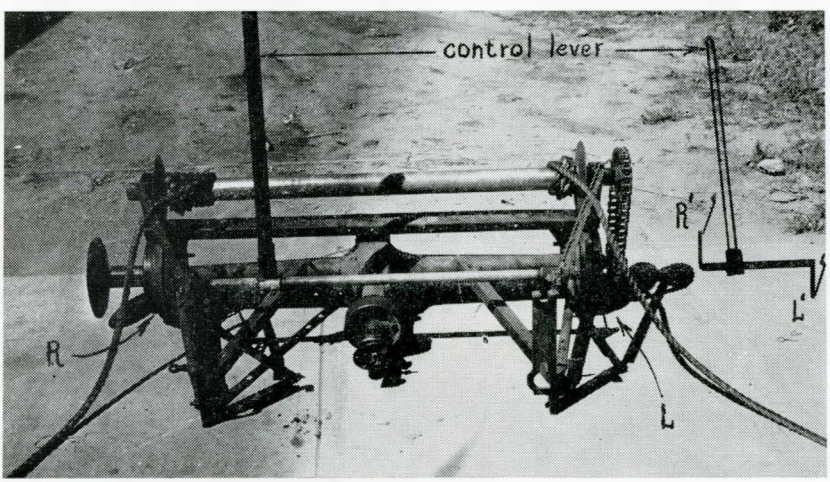

Fig. 6. Hoisting unit, showing braces to quick-detachable brackets. (R is right hand side as one faces front of tractor.)

Rental Rates on Custom Work

1. At conservative speeds and under open yard conditions one can load a spreader in 9 minutes on the average, or from 40 to 50 spreader loads per day. (Three spreaders and haulers are needed on short hauls. Five or six are needed on longer hauls.)

2. Rental rates should be by the hour or day rather than by the load. On long hauls the loader may stand idle part of the time. However, when loading near gates, feed racks, or in lanes, the haulers may have to wait on the loader.

3. Cost figures quoted here are for: (a) a tractor costing $1,000, used 100 days per year, and lasting 15 years; (b) a manure loader valued at $200 used 6 days per year, and lasting 10 years; (c) Interest figured at 6 per cent and annual repairs at 2 per cent of first cost; (d) fuel and oil, at $2.25 per day; and (e) labor at $6 per day.

4. The total of tractor machine cost, loader machine cost, fuel and labor was $14.50 per day.

5. The cost for a tractor, spreader, operator and fuel are very near $14.50 per day. One neighbor with a tractor and manure spreader, could exchange his services on even terms with another neighbor who owned a tractor and loader.