Personally I doubt if such a machine can be designed. I do not believe it is possible entirely to supplant the horse for light hauling, for cultivating, or for road work.

There have been some apparently good tractors made especially for cultivating, but that is all they are good for. And there are some very excellent farm trucks that are superior to horses for hauling loads to market, but they are not tractors, and I do not believe a tractor can be made that will be efficient for the heavy work and also for the road. All attempts thus far made have been unsatisfactory. Summing it all up, I am inclined to believe that a field of usefulness for the tractor is more or less restricted. While it is doubtless possible to design special machines for special purposes, it does not appear possible that any single machine can be devised that will do all tasks equally well.

The Problem of Tractor Weight

The problem of tractor weight is one that has not as yet been fully decided. Some of the old style machines weighed as much as five hundred pounds per horsepower and very few were under three hundred and fifty pounds. Now there are a number of tractors that weigh less than one hundred and fifty pounds to the horsepower, but the majority weigh around two hundred and fifty pounds per horsepower. One experienced tractor manufacturer who has done considerable experimenting told me not long ago that results of his investigations indicated that the minimum weight per horsepower should be two hundred and seventy-five pounds or thereabouts, in order that the machine may have the requisite strength. This minimum, however, has been reduced very materially by some designers, and if they have been careful in choosing the right grades of materials and have placed the weight exactly where it should be placed, it would seem as though the machines should be strong enough.

There is one other consideration, however, that must be made and that is the weight necessary for traction. Some years ago it was believed that tractive power was dependent upon the weight on the drive wheels. Now it is known that this is not strictly true. Tractive power is dependent upon the grip the wheels exert upon the ground and this grip depends largely upon the kind of grouters employed. There must, of course, be sufficient weight to sink the grouters into the soil and to compact the soil around them. In different kinds of soil it is evident that different kinds of grouters should be used. For example, on light cultivated soil angle irons bolted to the rims of the wheels seem to give best results, while on a hard clay or gumbo soil sod, sharp conical spurs are best. Neither of these, however, are suitable for traveling over hard-surfaced roads because the shock occasioned by the wheels passing from one grouter or spur to the next would cause too much vibration. Here closely-set, flat-faced grouters are preferable. This problem of an easily changed wheel to meet all conditions of service is one of the difficulties every designer is forced to meet and one that has not yet been very satisfactorily solved.

In discussing the proper weight on the drivers one is at once confronted with the distribution of weight of the entire machine.

This is a problem that very few designers have analyzed carefully. Let us consider an ordinary four-wheel tractor with two rear drivers and two supporting wheels in front. It is evident that most of the weight should rest on the drivers and only enough on the front wheels to hold them down on the ground and provide sufficient grip on the soil for easy steering. If too heavily loaded in front steering will be difficult and if not loaded heavily enough there will be side slippage of the front wheels and lack of control.

It has been found that the best results are generally obtained when the center of gravity of the machine is located about one-quarter of the distance between the front and rear axles, measured from the rear axle. The method of analysis takes into account all of the forces acting upon the machine when in action, including the action of the load.

Since plowing is the first requisite of a farm tractor the next problem to consider is to determine the resultant of the line of draft for various gangs of plows. According to the best information obtainable the resultant of draft of a fourteen inch plow lies parallel with the land side and two inches therefrom. Referring now to figure 1 it will be seen that for two plows the resultant lies nineteen inches toward the land from the edge of the last furrow plowed; for three plows the resultant lies in a distance of twenty-six inches (see figure 2) and of four plows thirty-three inches.

Side Draft on Various Machines

Consider now, a tractor sixty inches wide hauling two plows with both rear wheels drivers. The right hand drive wheel should run four inches from the edge of the last furrow to prevent breaking into the furrow. This then will bring the centre line of traction thirty-two inches from the edge of the furrow; the line of draft of the plows is only nineteen inches therefrom and the two lines lack thirteen inches of being in coincidence. The effect of this offset is to turn the front wheels in toward the plowed land. The effect of this side draft, as it is called, is to twist the frame of the tractor and turn the front wheels off their course. The only way it can be overcome is to make the tractor narrower and a little computation will show that the ideal width for a two-plow machine is only thirty inches. With four plows a sixty-inch tractor will have practically no side draft, since the plows cut almost the same width as the tractor.

In this connection it is interesting to analyze what happens when a three-wheeled machine having a single furrow wheel for driver is used, see figure 3. The centre line of traction will necessarily be the centre line of the drive wheel, which we may assume is twelve inches wide. The resultant of the two plows in nineteen inches from the edge of the furrow, so, consequently, the distance between line of traction and the resultant of draft of the plows is twenty-five inches. This has a tendency to throw the front tractor wheel is toward the land. If three plows are used, conditions become worse, as the offset amounts to thirty-two inches. The reaction against the front wheel in such a case is very great, it throws a heavy twisting strain on the frame work of the machine and causes lost work in the friction of the guide wheel against the edge of the furrow.

I have touched upon only a few of the more important elements that the tractor designer must consider and have presented enough illustrations to show that many of the fundamentals are either not understood or else are wilfully violated. I am inclined to think they have not been thoroughly understood. However, experience is an effective teacher and there are evidences that some of the lessons have been learned. I fear, however, that some very well meaning people will eventually have to pay a handsome price for their failure to recognize foundation principles.

Estimates of the number of farm tractors in actual use in the United States show Illinois leading with 3,202. Kansas is second with 2,287, followed closely by Texas, Iowa and North Dakota with over 2,000 in each case. New York ranks twelfth with 1,210.

Prof. Geo. E. Day, of the Ontario Agricultural College has been secured by the Dominion Department of Agriculture to handle a campaign for more and better bacon hogs in Canada. In his work at the O.A.C. he has made a special study of the swine industry and has written the best book of its kind on the bacon hog, and in fact was responsible some years ago for bringing the importance of the bacon hog and Wiltshire sides before the Canadian farmer and getting him interested in the production of this class of swine. Canada has an opportunity to put her bacon at the head of the list in the Old Country markets, and Prof. Day will do all in his power to help secure that market.