

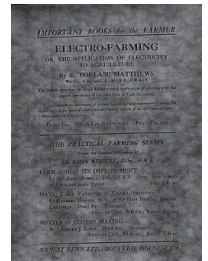
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Power for Cultivation and Haulage on the Farm

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Account of the Discussion

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THE DISCUSSION

SIR MERRICK BURRELL, in opening the proceedings, said that the purpose of these meetings was to bring together farmers, representatives of industries connected with agriculture, and agricultural scientists for the discussion of specific problems in agriculture. The present Conference was the sixth of the series, which had already dealt with lucerne, fodder crops, sugar-beet, green manuring, and the art of cultivation.

The subject chosen—"Power for Cultivation and Haulage on the Farm"—was beyond question of wide importance at the present time: how far could mechanical power aid the farmer, what form of power was best, and to what extent would it aid, or replace, traditional horse-power operations? His personal opinion was that the horse would continue to hold its own, although mechanical power would prove a very useful aid. He thought that the bulk of the discussion would centre around the tractor, but he asked the audience not to forget the long and honourable record of steam-power, and the claims of electric-power, in which large developments might come in the near future.

Mr W. C. DAMPIER-WHETHAM, in opening the discussion, said that his own experience was mainly on grass-land farms. Horses were cheap to buy, depreciation was small, a team could be split and distributed to different pieces of work—and they were better for small fields. The small development in power in agriculture as compared with other industries is due to the following reasons: (1) industries were localized in factories, whereas agriculture had a diffuse and spasmodic requirement; (2) the farmer's main source of power was the sun, whose energy was utilized by the growing crops, and all other forms of power were subsidiary to this. The development of electric-power was held up in England by the high cost of overhead lines, due to stringent safety requirements. They cost £500 per mile against £200 on the Continent. The amount of power needed per acre was small, but over the whole rural area the load would be economic.

Mr H. DECK (Ransome, Sims & Jefferies) considered that the use of electricity for barn machinery was its most likely outlet. For cultivation and haulage work permanent and movable cables and heavy batteries would be highly inconvenient. He thought there would be little immediate change, except in the direction of more economical design, either in the tractor or the implements designed for use with it. Nevertheless there were great possibilities

in deeper ploughing and cultivating. He stressed the importance of speed in all farming operations in our uncertain climate.

Mr BOSANQUET of Alnwick (delegate of the Northumberland N.F.U. to the Conference) said that as a practical farmer he supported all that Mr Porter had said. He farmed 1800 acres of light hilly land, mostly reclaimed from moorland within the last one hundred and fifty years. At first tractors were unsatisfactory because buried boulders broke the tackle, but they were excellent for thrashing. He used motors exclusively for haulage, except for carrying rations to the farm-buildings and transporting women workers between the fields and their homes each day, for which light horsed carts were used. This practice has been found so advantageous to the farm work, and is so much appreciated by the workers, that the horse will shortly be replaced by a light motor-lorry, which would also be used for ordinary transport.

Mr J. R. BOND (County Organizer for Derby) thought that the imported-meat trade was largely responsible for the present depression in agriculture, and believed that laying down land to grass could not help. The present difficulties largely arose because of our traditional practice of keeping animals partly to supply manure.

Steam cultivation was too costly. There had been little improvement in engine design since 1850. The engine need not be heavy, and in any case the distribution of weight over the present form did not correspond with the point at which the pull was experienced. Very little had been said about the destruction and killing of weeds during cultivation operations. It seemed as if half of a farmer's life was spent in getting a tilth, whereas it was his experience that more than half of a farmer's life was spent in destroying weeds. He thought that if an efficient machine for this purpose could be devised the time of cultivation work could be greatly reduced.

Mr BLACK (President, Suffolk N.F.U.) stated that his experience was gained on heavy land in Suffolk, where he could not work his horses for 260 days a year as Mr Porter did. He found the tractor essential to get through the necessary work in time. On large farms it was better to have both heavy and light tractors and lorries rather than general-purpose types. He supported conveyor distribution for produce in the granary.

Mr VAN DIJK (Messrs MacLaren's engineer for export trade) said he had come over from the Continent especially for this Conference. On sugar and tobacco soils in Sumatra, where the

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soil resistance was very high, he had, after ten years' work, reduced the plough draught by 50 per cent. Had he had the advantage of the Rothamsted studies on soil resistance he could have solved the problem much earlier. The vital question to-day was to reduce tractor costs. This implied a reduction in the number of moving parts in the engine, and the use of crude oil—the Diesel engine was the solution. It was now in use successfully for cable tackle, and smaller tractor types were also in use.

Mr HUGH YOUNG dealt with his experience as a farmer on hilly land at High Wycombe. He stressed the necessity in tractor design for keeping the weight as near the ground as possible and well distributed over a large base. The front wheels of one of his tractors tended to be pulled off the ground when travelling uphill, while another, when working across the hill, tended to topple over sideways.

The purchase between the tractor wheel and the land was the weakest point in present-day design; a four-wheel drive or track-laying type would be better: his three-wheel drive tractor hauled a binder last summer on land so greasy that the two-wheel drive tractor could not manœuvre itself with no load at all behind it.

He strongly urged the desirability of an efficient two-furrow one-way plough for the tractor: no horse plough was needed to open and close the furrows between the lands; no time was spent in driving along the headland between lands, which, for an acre with 200-yard furrows, meant some 380 yards extra travel; the passages over the same piece of headland were three against eighteen with the fixed plough. He invariably used one-way ploughs with horses, and was surprised at the little use made of them in England (except in the anti-balance form in the south-west counties), in view of their great popularity on the Continent. Finally, in his hilly land the tractor was worth its cost for binder work alone.

Major C. E. BENTALL (Heybridge Works, Maldon) raised the question of the performance of implements rigidly attached to the tractor. If the essential feature of such an implement was that the wheel of the tractor took the place of the land wheel, it would result in uneven work on uneven land. This seemed an argument against a simple rigid attachment between tractor and implement. With the existing types, the hitch was flexible, thus allowing the plough to follow the contour of the land and maintain an even depth of furrow.

He drew attention to the value of the tractor for broadsharing. This implement was formerly very popular, and did undeniably

valuable work, particularly in stubble cleaning, but its use had been largely discontinued, mainly for the reason that it was considered to overtax horses.

Mr F. H. JOHNSON (Bull Motors, Ipswich) considered that electric power would be economically used for cultivation only if a single engine were used, the implement being pulled backwards and forwards between this and an adjustable anchor truck, by means of a double haulage rope. This method would halve the number of permanent supply cables needed on the farm and would eliminate the necessity for any flexible conductor winding and unwinding with the movement of the implement—an arrangement that is cumbrous at the best.

Although the above scheme is the most practicable so far as distribution is concerned—which is the governing factor—there is the great disadvantage that the electric tractor and anchor truck must of necessity be hauled to their work by internal-combustion or steam tractors, and the only way that this can be eliminated is to fit the electric tractor itself with an engine, or heavy and expensive batteries, which will enable it to travel by road when disconnected from the distributing wires. The latter introduces complications which would be highly unsatisfactory in the hands of ordinary agricultural labour, and would certainly be very difficult and expensive to install and operate where the supply is alternating current, as it would be in almost every case of rural electrification. For the larger ploughing equipments the question of petrol-electric operation is well worth consideration, as by this method the control of the tackle could be simplified enormously. The whole equipment could be handled by means of a simple drum-type controller, similar to that used on tramcars. The capital cost of the tackle compared with steam gear would be reduced, and the depreciation would also be less. There would be a considerable saving in labour, since no supplies of boiler-feed water and coal would be needed. The petrol-electric system could be made perfectly reliable; the reliability of the electrical portions is at least equal to that of the petrol engine, and, with properly designed machinery, the depreciation on the electrical portion is almost negligible. One advantage of the petrol-electric system is that it would give a very wide range of hauling speeds. It could very easily be so arranged that the maximum tractive effort for which the equipment is designed was developed at any speed from standstill to the normal full speed, corresponding to the maximum output of the engine driving the dynamo. The same plant could also be made capable of developing half the maximum tractive effort for which it was designed, at a speed as high as twice the normal hauling speed if necessary. This would enable a great variety of work to be handled, and on the

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lighter work would enable a great economy in time to be effected, provided the maximum speed available could be utilized effectively.

Therefore, by utilizing the electrical drive, an equipment could be provided which has a very wide range of hauling powers and speeds, and able to utilize the various implements which it is designed to haul, to their full capacity. Provided the electrical engineer is shown what is required, there is no reason why he should not produce plant which will deal in a highly efficient manner with a large variety of haulage and other problems.

Lieut.-Col. F. GARRETT, C.B.E. (Leiston Works): To get more men on the land and to pay the higher wages necessary we must introduce, as far as climatic conditions allow, mechanical means into agriculture, and thus increase the output per man. My firm has recently developed a device for reducing the labour of haulage on soft or wet land. The idea applies to all vehicles (even tractors) and enables, for instance, one horse to haul a load off heavy land that formerly taxed two.

I disagree entirely with Mr Bond on the development of steam-power; it has advanced quite as much, by higher pressures, superheaters, valve-gears and turbine systems, as any other form of power. In haulage, ten-, six- and four-ton load steam vehicles are popular, and beat the internal-combustion engine in cost of running, durability and capacity for overloading and overspeeding; steam-power has still many useful outlets in agriculture.

The two grave obstacles confronting electric-power in agriculture are the absence of cheap and light batteries, and the high capital cost of current distribution systems.

Mr B. G. SHORTEN (J. & F. Howard, Ltd., Bedford): Steam cultivation on large estates has been successfully proved for many years. The smaller landowners and tenant farmers in many cases employ the service of a contractor owning steam tackle. In this way extensive areas have been kept under cultivation which otherwise would have been found most difficult to deal with.

As agricultural engineers, we deplore the present tendency of so much land being laid down in grass. The time is not far distant when landowners and farmers will find it to their advantage to devote more attention to this question of tillage. The figures plainly show that the importation of foreign meat will increase rather than decrease, and with this undoubted position in view, how can farmers hope to make grass-land pay by producing beef in competition with such an array of foreign competitors?

I do not agree with the suggestion that manufacturers have adhered to the principles of the horse-drawn implements in designing tractor implements. I can assure you this is not so. Most efficient

self-lifting arrangements are now fitted, operated by the driver. It has been suggested that more efficiency could be secured by combining the tractor and, say, two-furrow plough, in one unit, braced together with certain flexible movement. On closer experience problems will be found presenting difficulties—*e.g.* a double-furrow plough closely connected to tractor, negotiating uneven surfaces, is deprived of the necessary vertical and horizontal movements required for dealing with rough and heavy soils, and so far more satisfactory results are produced by independent couplings.

While we believe the demand for tractors is steadily growing, and their usefulness more recognized, it must not be taken as indicating that horse-power is on the verge of collapse. The implement production of my firm is about 85 per cent. horse-drawn as against 15 per cent. tractor-drawn. I believe horse-power will continue to be largely used, more especially by the medium and smaller farmers, and, by reason of the variety of duties performed by them, they will remain first favourites with the majority of farmers. I believe the horse, the tractor and the steam tackle, with their suitable implements, hold an important place in the development of our farming industry, and where well and wisely employed, even under existing conditions, all three can be used with progressive and profitable results.

MR HAROLD DREWITT gave some figures for the cost of tractor work on his farm near Chichester. His tractor was bought shortly after the War and was very extravagant in paraffin and oil. His second purchase was made about five and a half years ago, and this tractor, in its working life of three years, ploughed 1615 acres (taking 5 acres of cultivating as equivalent to 1 acre of ploughing); the average cost of operations per acre was :

	s.	d.
Labour, fuel and oil	9	6
Repairs	4	2
Depreciation	4	9
Total	<u>18</u>	<u>5</u>

His third purchase was made two and a half years ago, and has, up to the present time, ploughed the equivalent of 1640 acres at a cost per acre of :

	s.	d.
Labour	2	5
Fuel and Oil	4	4
Repairs	1	9
Depreciation	2	6
Total	<u>11</u>	<u>0</u>

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These figures do not include belt and miscellaneous work, which was not sufficient materially to affect them.

The driver, who has driven all three tractors, is an excellent ploughman but not a mechanic—all except the simplest repairs have to be done by a skilled mechanic; during the life of the present tractor there has been only one stoppage due to mechanical breakdown. The most expensive part of breakdowns is not the cost of repair but the delay to the work of cultivation.

When there is great pressure of work in the summer, two drivers work the tractor 18 hours a day, thereby doubling the daily output of work.

Mr G. R. HUNTER (Midland Agricultural College) thought that interchangeable wheels or tyres for the tractor were of great importance. A figure of 90 days per year seemed to be the average working time of the tractor on the land, and even this was not reached in wet seasons. Some simply attached system of rubber-tyred rims for road work, and a suitable trailer, would be very useful as a means of increasing the yearly working time, and especially advantageous to those farmers whose holdings were some distance from a railway station or market. It would reduce, or perhaps obviate, the necessity for a motor-lorry; a non-governed tractor, fitted with brakes to comply with regulations, would, however, be needed.

He thought that the horse had well held its own in the discussion, and suggested that not enough stress had been laid on the great advantages of higher speed and power that the tractor afforded. On the College farm this year they had, thanks to tractors, been able to cross every stubble twice; few Midland farmers were in that fortunate position.

While he agreed that certain tractor implements, being adapted from horse-drawn types, did not adequately utilize the power of the tractor, the modern disc-harrow should be excluded. Properly set, it taxed the tractor to its utmost and did better work than the horse implement.

Mr T. MILBURN (Principal, Midland Agricultural College): The relative value of horse and tractor work was a matter of expediency rather than of cost. Just as the best horse-ploughing could not equal spade-work, so tractor-ploughing could not equal the best horse-ploughing; nevertheless, poor tractor-ploughing done at the right time may give better results than good horse-ploughing done too late in the season. To discuss their relative merits only on a cost-per-acre basis was beside the point.

He was sceptical about hitching harrows behind the cultivator so as to give the tractor a fuller load; for the best results were

often obtained when there was a period between the respective operations to allow the ground to dry, weeds to be killed, and weed seeds to germinate. The same objective applied to rotary tillage.

Mr H. CURRANT (Farm Foreman, Rothamsted) spoke of his experience with the Austin tractor on the Rothamsted farm.

It was valuable for the autumn ploughing of clean stubbles, and in harrowing down before the drill, when the ploughed land was dry enough. The tractor was most useful in the cultivations for spring crops and roots. The land could be re-ploughed and tilled quickly, and the extra depth of cultivation needed for roots could be easily obtained without upsetting the horse work. Further, the tractor could deal with any field needing bare fallowing, and plough and cultivate it as many times as it might require. One could not plough fallow land too much in the summer when the land is dry.

For neatness of ploughing on clover, ley or stubble the single-furrow horse-plough beats the tractor, because it is the same plough following round its own work, and it is "held" by the ploughman; the tractor-plough, being pulled along and guided only by the tractor, cannot be expected to turn out work of the same quality.

Rolling the corn with the tractor is not an ideal job; a big acreage can be covered in a day, but the wheel-marks show below the roller and much of the corn on the headland gets over-rolled. But it will deal really well with a rough piece of uncropped land in the spring or summer; working in the low gear it will take a heavy set of harrows fastened behind the roller if desired. The tractor was unsuitable for drilling, ridging or bouting some of the lighter harrowing, rolling and, if he might use the term, "horse-hoeing": neither could one divide up the horse-power of the engine and use it for so many carts in times like haytime and harvest.

In conclusion he invited the tractor-plough makers to fit a more efficient skim coulter, as one of the chief difficulties in tractor-ploughing was to bury the rubbish. He also urged tractor manufacturers to fit some plugs that will not persist in oiling up, and to provide a more comfortable seat for the driver.

Mr G. A. BARBER (Messrs. J. & H. McLaren, Ltd., Leeds): The various papers read to-day emphasize the need for greater economy on the farm. As a means to this end I would advise the more extensive use of machinery. The most up-to-date implements and power units, embodying simplicity and low running costs, must be employed. The use of machinery requiring highly skilled labour is neither advisable nor necessary for farm work to-day. A large proportion of the agricultural machinery produced in this country at the present time is sent to foreign countries where only native

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labour is available for operation. Mechanical cultivation may be divided into two systems—namely, the Cable system and the Direct system. In the Cable system the steam engine is being replaced by the motor-windlass, in which Diesel Oil Engines are used as the prime mover. This has reduced the working costs tremendously, and, in addition, provided a power unit weighing 7 tons as against 14 to 17 tons in the case of the Steam Cable Engines. Such a tackle can be worked in the field practically all the year round, and its light weight greatly facilitates its movement from field to field. The Diesel engine has the flexibility of the steam engine, and such complications as magnetos and carburettors—the two parts requiring special care and attention—are eliminated. The fuel costs for ploughing 500 acres, double cultivating 500 acres, also harrowing and rolling 1000 acres, amount only to £75 on medium to heavy soil, the depth of work ranging from 6 in. to 12 in. A variety of implements can be worked with this system, and a series of change-gears permit the implement to be operated at the desired speed, in accordance with the views expressed by Dr Keen.

In the direct traction system, too, the steam engine has been superseded by the internal-combustion engine, the very latest developments being the introduction of the Diesel Engine Direct Tractor. The fuel costs per acre with this tractor are under 1s. when working in average soil—a great advance in economy when compared with the petrol tractor. Simplicity here, again, is the keynote, and as the whole of the mechanism is enclosed—a point stressed by Mr Burford—a long life is assured.

The work I have seen carried out with rotary tillers both in this country and abroad does not lead me to believe that this class of implement will be extensively adopted in this country.

Mr J. E. NEWMAN (Institute of Agricultural Engineering, Oxford): The objections raised by the ordinary farmer to the tractors are usually—(1) difficulty of maintenance, and (2) padding the ground. With regard to maintenance, the most modern tractors have reached a high degree of reliability and with ordinary care should give little trouble. Much of the trouble experienced in the past has been due to faulty design, and even now there is room for improvement. Farm tractors, under working conditions on many farms, cannot be garaged every night without serious loss of working time, and tractor designers should recognize the fact.

A good deal has been said about the non-mechanical nature of the ordinary farm hand, but there is no reason why agriculturists should include a lower proportion of mechanically minded folk than the rest of the community.

The farm of to-day, apart from tractors, has a lot of machinery. Consider the binder—one of the most complicated bits of machinery

there is. On the mechanical farm of the future, men with a mechanical bent will be as necessary as those with a love and eye for animals on a present-day stock-raising farm.

These objections to the use of tractors apart, the gravest objection most farmers have to it is that it will pad the ground. Our climate and the nature of our soil make this objection a real one, though the ill-effects are often exaggerated. Padding, or compression of the soil, is caused more by the tractive force of the machine than by its dead weight, and it is bound up with the shape of the lugs or strakes and the size of the wheels. Caterpillar tracks have the great defect of heavy cost and of excessive wear. It seems doubtful if these are not inherent in the design, and it is possible that some form of skeleton wheel will be the eventual solution of the difficulty. The Institute of Agricultural Engineering has had the Dawe Wave Wheel under observation for some time, on tractors of varying weights. When these wheels are fitted to a light tractor—such as a Fordson—the wheel-tracks can be harrowed out, and they have the great advantage that when the tractor is being used for general haulage on the farm it can move off soft ground on to a hard farm road, or go through a muddy gateway without slipping.

If further experience bears out our present opinion, they, or some development of the principle, will greatly increase the all-round utility of the tractor. It is this which needs to be increased; the number of hours which many tractors work is far too small, and it is chiefly by increasing the number of jobs which the tractor does that this can be altered. Of course, not only are our implements designed for the horse, but to a large extent farming practice is based on the use of the horses as its main source of power.

Now that a more economical source of the power is available, some of our practices might be altered with advantage. Such alterations will, however, come gradually, as the result of experience. I might mention as an example of greater experience and confidence, that tractors are now used in the hay-field to pull hay loaders. This is now common, but six years ago was hardly heard of. The tractor does this job better than horses, it pulls more steadily, particularly with a big load, and the wheels straddle the window, whereas horses walk on it.

I agree with Mr Bond about steam cultivation. The great weight of the present sets is at the bottom of most of the objections to their use: and that weight is not necessary to prevent slipping. Witness the ability of the M'Laren Diesel Motor Cable sets to work, and their success. At the same time the cable system has probably had its day in this country, and no improvements can be expected to sensibly increase its sphere of usefulness.

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As Mr BLACK said, it is unlikely that one type of general-purpose tractor can do all the work of all farms. Possibly the evolution of the tractor will be in two ways, one being in the direction of a stronger machine capable of easily ploughing three or four furrows in strong land, and used for cultivation work proper and the heavier belt-work—as thrashing—the other being in the direction of a light machine, capable of doing the work of a four-horse team and used for harvesting and drilling and the lighter work generally. Such machines are being evolved, and are necessary if horses are ever to be replaced to any considerable extent by tractors.

Mr J. W. COLLIS (Tractor Traders, Ltd.): Cost data, while of very great value, is most difficult to compile to apply to all conditions. In making comparisons as between horse and tractor work I do not think sufficient stress is laid on the many jobs the general-purpose tractor can do. I submit that with the “caterpillar” or track-laying type of tractor there is hardly any work on the farm it is not capable of doing.

On the question of electrical power, it is significant that in countries where it is so easily obtainable from natural sources—*e.g.* the “Niagara Peninsula”—it has not been applied to farm work on a far-reaching scale.

Hardly enough stress was laid on the necessity of more draw-bar horse-power in the tractor and the advantage of securing deeper tillage so essential for the cultivation of sugar-beet and other root crops. Direct traction is much cheaper than steam tackle by stationary engines, but the necessary power must be available at the draw-bar without track slippage to do the work. I agree with Mr Deck that to take advantage of the speed and superior draw-bar horse-power of the better type of tractor, and to produce a satisfactory implement to use with it, requires the closest possible co-operation on the part of the tractor manufacturer, the agricultural-implement manufacturer and the agricultural expert.

Captain E. H. GREGORY (Rothamsted) pointed out that no comparison was made between roads necessary for lorry work and horse work.

Both the farm wagon and cart are capable of standing the strain of bad roads, and at the same time carrying heavy loads. The lock of the wheels of the modern farm wagon allows it to turn in its own length. The horse is able to get on to other ground leaving the weight of the wagon on the road. An attempt to turn a lorry on a very wet day in a small track will, without doubt, lead to the bogging of the lorry directly it gets on to soft ground. Again, the condition of these tracks is generally so bad that the continued use of a heavily laden lorry on them would not only

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make them worse, but would most decidedly shorten the life of the lorry. Lorries in use on such tracks are either of the 7 cwt. or the 1 ton type, and even these have difficulty in negotiating the roads in bad weather.

The question of repairing the roads so that they may be fit for use with motor traffic is one which would involve a great deal of money. In many cases the farmer is bound by his lease to keep his roads in repair. A few cart loads of stones are put down at most irregular intervals in order to fill up the holes, for as long as a farm cart drawn by a horse can proceed along the road, it is in a state of good repair. The main roads throughout the country are gradually being altered in order to stand the extra heavy wear they receive on account of the increase in lorry traffic. It therefore follows that, if this increase is to spread to the farm, the same change, even if on a smaller scale, will have to take place on rural roads, and the question is, who is going to pay for it?

Mr J. M. BANNERMAN (Agricultural Economics Research Institute, Oxford) stated he had undertaken, under the auspices of his Institute, an examination of the economy of power on the farm, and the resultant effect on the efficiency and standard of living of the farm labourer. The economic evidence put forward, while representing adequately individual examples of actual fact, only serves to draw attention to the necessity of a much wider survey. Issues of deeper significance are also involved. For example, stress is laid in these times on the trend of the efficient agricultural labourer towards the town, and it is one of the crucial questions whether or not this efflux of the best rural worker could be stemmed in proportionate degree to the introduction of machinery. The ideal of obtaining an approximation of rural to urban conditions, both of work and standard of living, is a strong justification for Mr Matthews' advocacy of electrical power on the farm. The recent Electricity Bill should make the availability of this form of power more universally possible.

All the factors that contribute to the efficiency and contentment of the rural worker are of far-reaching importance, and discussions concerning improvements, mechanical and otherwise, on the farm would, I think, be ultimately of greater use were the social and economic point of view kept well to the fore.

Sir JOHN RUSSELL, in summarizing the discussion, said that four main points arose: (1) The need of elasticity in the source of power: in this direction horses were superior; (2) The necessity for getting the utmost out of the source of power: at present horses still retain an advantage here because of the traditional love of the farmer for them, which showed itself in the attention given

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to keep the horses fit ; but this was a decreasing advantage because with the coming of the bicycle, and later the motor-cycle, into rural life, a mechanical turn of mind was growing up in the countryside ; (3) The close adaptation of the implement to the source of power : here, again, the advantage of the horse was declining and improvements in power-drawn implements were constantly being made ; this work necessitated the co-operation of the implement manufacturer, the engine manufacturer and the soil investigator ; (4) The necessity for keeping up the speed of work so as to be well ahead in all operations : here the tractor was definitely superior, especially as it could do the extra emergency work, which was beyond the capacity of horses.