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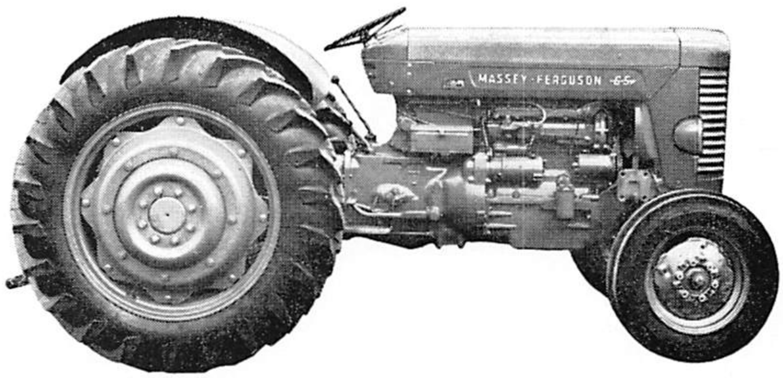

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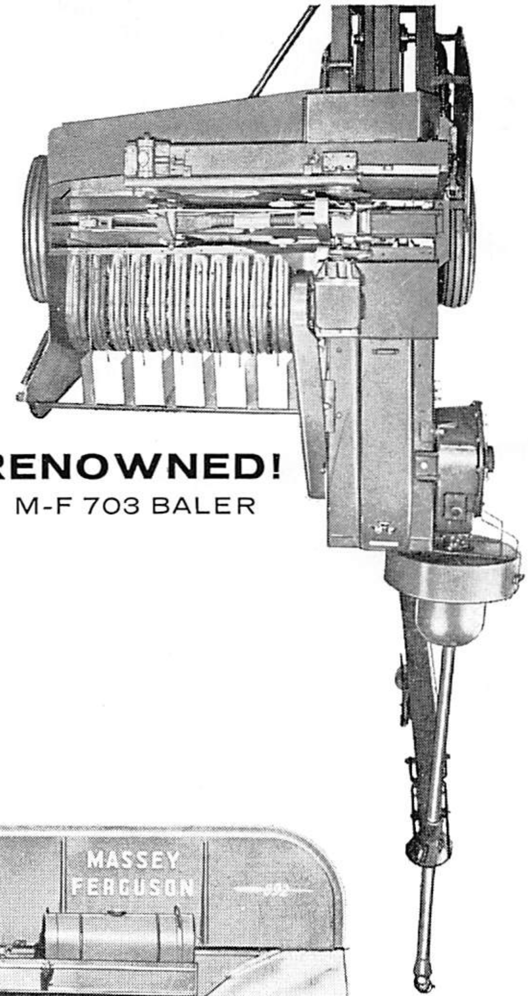

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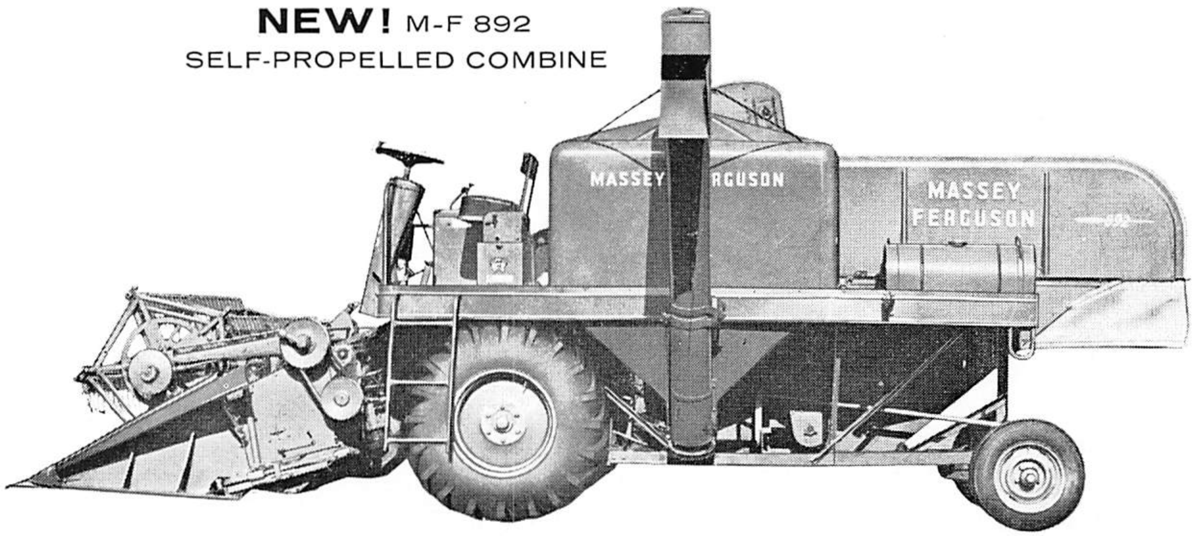

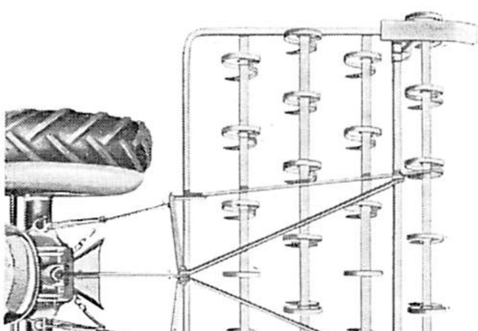

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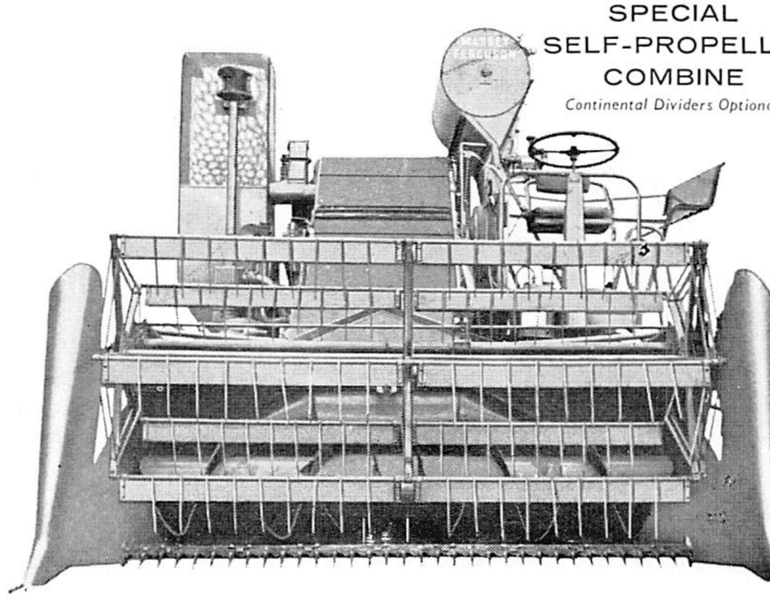

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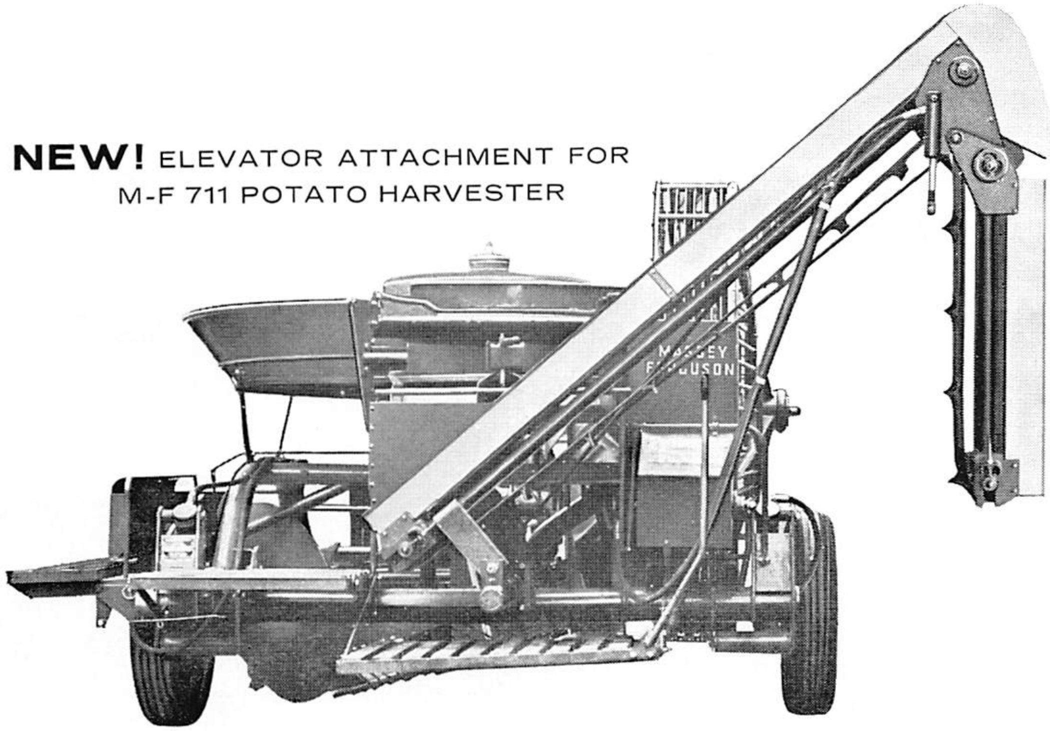

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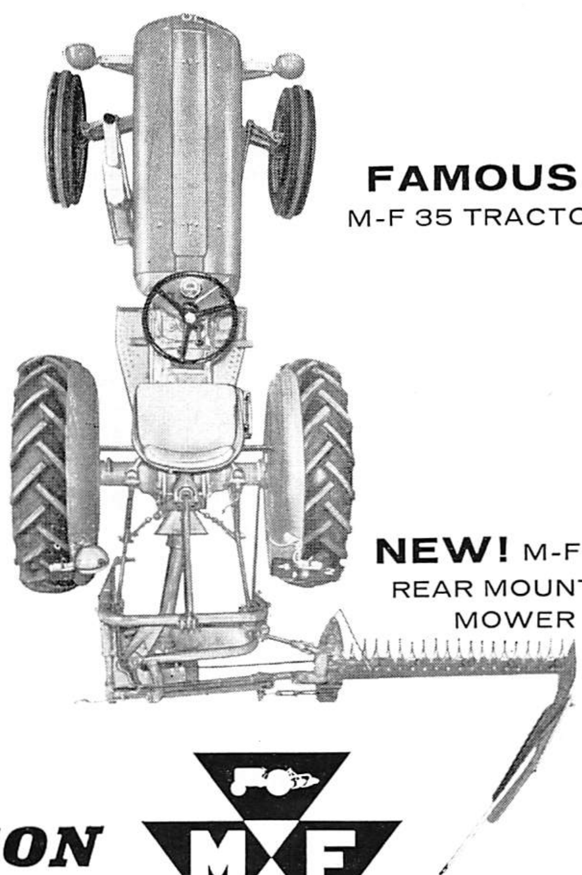

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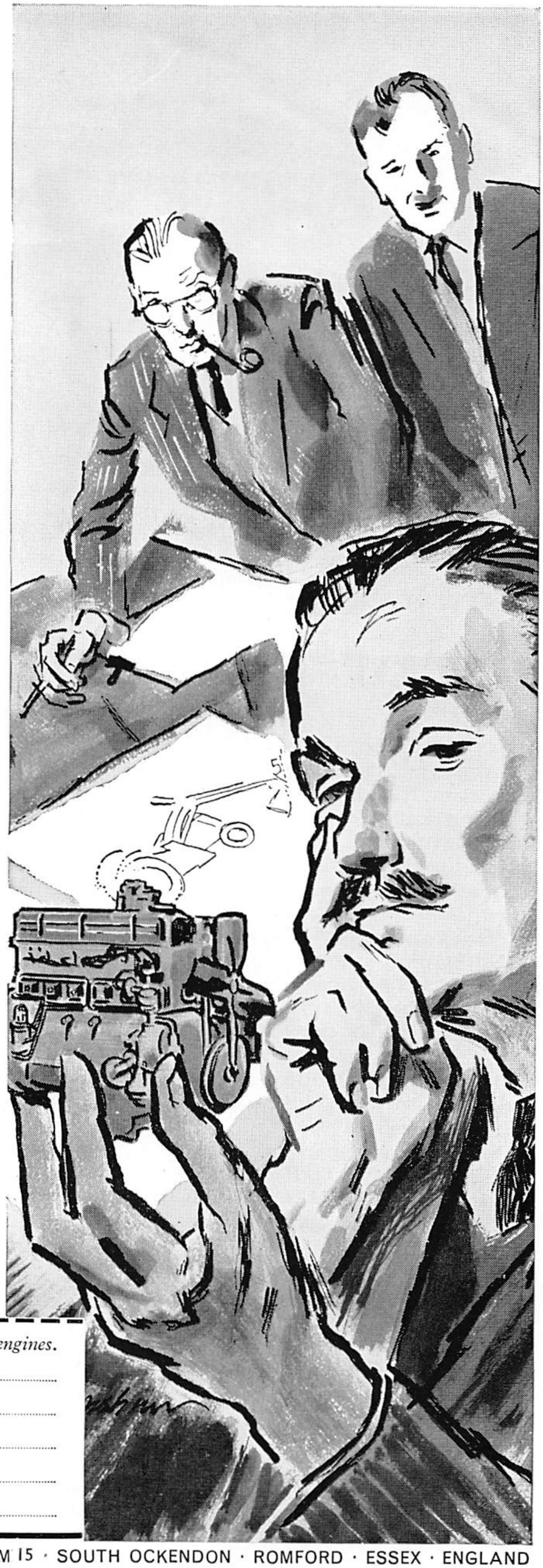

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INSTITUTION NOTES

Annual Conference, 1962

THE Institution Conference in 1962 will be held at the Royal Society of Arts, John Adam Street, W.C. 2, on Tuesday, May 1st. The day's proceedings will commence with the Annual General Meeting at 10.30 a.m., followed by two Papers and an informal discussion. The Annual Dinner will be held on the same day at the Piccadilly Hotel, Piccadilly, W. 1. The full programme will be announced later.

Institution Representative in East Africa

The Council has appointed Mr. W. H. Boshoff, B.Sc. (Mech.Eng.), M.Sc. (Agric.Eng.), A.M.I.Mech.E., A.M. I.Agr.E., as Institution Representative in East Africa, following the resignation from this position of Mr. S. D. Minto, due to other commitments.

In appointing Mr. Boshoff, the Council expressed its appreciation of Mr. Minto's services during his term of office, his advice on matters of concern to members in East Africa being of particular value.

National College of Agricultural Engineering

Members will doubtless have seen Press announcements regarding the appointment of Dr. P. C. J. Payne as Principal of the College. Dr. Payne is a past member of Council, and during his term of office was Chairman of the Papers Committee and served on the Finance and General Purposes Committee. He has also been active in other Institution affairs, including the preparation and presentation of lectures on careers in agricultural engineering.

The Council, on his appointment, conveyed congratulations on behalf of all members, together with best wishes for success in this important position.

It is anticipated that the College Prospectus will be published in December, 1961. Applications for copies should be made to :

The Registrar,
National College of Agricultural Engineering,
Queen Anne's Chambers,
28, Broadway,
WESTMINSTER, S.W. 1.

Affiliated Organisations

At the meeting of the Council held on September 26th, 1961, the following Companies and organisations were elected as Affiliated Organisations :

Agricultural Engineers' Association, Ltd.
Catchpole Engineering Co., Ltd.
New Holland Machine Co., Ltd.
Morris Motors, Ltd.

Annual Subscriptions, 1962

Members are reminded that subscriptions become due on 1st January, 1962, except in the case of those paid by Banker's Order, when payment may be made up to March 31st.

SYMPOSIUM ON AGRICULTURAL TRACTORS

The Institution of Mechanical Engineers (Automobile Division) has arranged a Symposium to take place at 2.30 p.m. on TUESDAY, NOVEMBER 28TH, at the Institution's main meeting hall at 1, Birdcage Walk, Westminster, S.W. 1. Four Papers will be presented :

"The Agricultural Tractor—its Function and Design," by W. J. Foxwell.

"The Measurement of Tractor Performance," by T. C. D. Manby.

"Tractor-Mounted Implements and Adaptations," by W. S. Hockey.

"The Influence of Tractor Service Conditions on Fuel, Lubricant and Protective Oil Qualities," by E. S. Bates and R. P. Strettell.

An invitation has been extended to members of the Institution of Agricultural Engineers to attend this meeting, further particulars of which may be obtained from the Secretary at 6, Queen Square, together with the necessary form of application for tickets.

The Council hopes that as many members as possible will attend to hear these Papers and take part in the ensuing discussion.

MACHINERY IN BRITISH FORESTS

by R. G. Shaw,* B.A., A.M.I.Mech.E.

A Paper presented at an Open Meeting at 6, Queen Square, on Tuesday 10th October, 1961.

THE area covered by British forests suffered grievous reduction through the industrial development which took place throughout the last century, and it took the first world war in which timber imports had to be kept to a bare minimum to reveal the extent of this loss. The policy of restoration and expansion of British forests under the guidance of the Forestry Commission was initiated by the Forestry Act of 1919 and has been followed resolutely by successive Governments, notwithstanding that the second world war took further toll of our already slender resources in home-grown timber.

The rate of planting by the Commission was increased in the years following the last war, and the table below shows the rate at which their forests have increased in the last decade :

1947–50 = 160,400 acres
1951–55 = 324,700 „
1956–60 = 289,500 „

The rate of planting has varied from one year to another, the limiting factor being the rate at which suitable land becomes available. In 1958, however, a change in policy was announced by the then Minister of Agriculture, Fisheries and Food, in that the Commission's planting programmes are now to be fixed for decades. The programme for the currect decade (1959–1968) is 535,000 acres. In carrying out future planting, the Commission is required to pay special attention to afforestation in upland areas, where a diversity of employment and consequent social benefits are desirable.

The foregoing figures, of course, take no account of private forestry. It is, however, a matter of considerable satisfaction that in more recent years there has been a considerable revival and increase in interest in forestry by private woodland owners. They have steadily stepped up their rate of annual planting, mainly in the old woodlands in need of restoration, and in so doing they have taken advantage of grant schemes introduced by the Commission.

It is in fact estimated that something like a million acres of private woodlands are now under active forest management.

Forestry Commission

The build-up and maintenance of national forests have called for a high degree of mechanisation and civil engineering, and the Forestry Commission today carries a staff of specialist engineers as follows :

17 Professional Mechanical and Civil Engineers.
104 Assistant Mechanical and Civil Engineers.

The mechanical engineering staff is responsible for the maintenance of

648 Tracked and wheeled tractors.
894 Vans, cars and personnel carriers.
699 Lorries.
2,177 Other powered machines, such as saws, road rollers, concrete mixers, mowers, compressors, etc.

The Civil Engineers maintain 6,000 miles of forest road and build an average of 400 miles of new road a year, with all the necessary bridging that is involved. Indeed, it has been estimated it may be necessary for the Comission to build a further 14,000 miles of forest road in the next 20 years.

As this Paper is confined to the activities of the Mechanical Engineers, no reference will be made to the problems involved in road building. Forest engineering in both branches can, however, be regarded as providing what must be the most pleasant, if rigorous, working surroundings in the whole field of engineering.

To the young man who utters the familiar cry " give me a life in the open air away from an office desk " the forest provides an outlet nearer to the ideal than almost any other branch of engineering. A day spent on a cableway site calling for three or four ascents of 800 ft. or more over soft peat on a December day will convince the most hardy youngster that he has indeed chosen an open-air life.

The Forestry Commission has Headquarters in London and Directors with " self-contained " staffs in England (London), Wales (Aberystwyth) and Scotland (Edinburgh). These Directors separate their territories into a number of Conservancies, each covering three or four counties, and controlled by a Conservator.

The mechanical engineers fit into this picture at all levels with the planning and control centred on the offices at the various headquarters and the main day-to-day field work concentrated in the conservancies and at the three small base workshops.

Machinery used in the forest is required to fill a number of rôles, amongst the most important being :

Cultivation :	Tractors, ploughs, rotavators.
Road Binding :	Earth movers, graders, dozers, rollers, etc.
Transport :	Lorries, vans, cars, motor cycles.
Timber Extraction :	Winches, trailers, power saws, cableways.
Maintenance :	Machines for destroying unwanted vegetation, mowers, diggers.

The policy is to employ standard agricultural machines wherever possible, and modifications to these are used in preference to the design of something entirely new. Owing to the comparatively small numbers of special machines that are required, their cost is inevitably high and spare parts and service have to be provided from within the organisation.

There are many examples today of very satisfactory forest machines which, though they differ in many ways from their original parentage, are still basically the same.

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* *Machinery Research Officer, Forestry Commission*

An example is the tractor developed to meet the problem of hauling heavy ploughs on very soft peat. A theoretical ground pressure of under 2 lb. per sq. in. is necessary, and this was achieved by taking a standard tractor and widening it to allow 30-inch tracks to be fitted. This change was so encouraging that the tractor was then lengthened by fitting an extra transmission case. The result is a tractor which bears the brunt of the soft-ground ploughing, but still uses 90 per cent. of the standard parts that are available throughout the country.

A further example of adaptation is the conversion of a standard 4 × 4 load-carrying vehicle from normal road wheel sizes to 10 × 28 (tractor rear wheels). Different axles and brakes are, of course, needed to restore reasonable overall gear ratios and braking power, but the rest of the vehicle remains basically standard. This has only been done as a research project to determine the actual effect on cross-country performance. The result is a quite remarkable vehicle.

Machinery plays a part at every stage in the establishment of a forest and the harvesting of the timber. The following notes will give an indication of the ways in which the machinery is used.

Nurseries

This is the stage in which the young forest trees are grown from seed. It is also the period at which quite wide variants in technique are used either to meet variations in local conditions or the individual views, often quite strongly held, of the man in charge of the nursery. One common tendency is to go for larger and larger nurseries to allow the full benefits of mechanication to be achieved. Every nursery is self contained in its tractors and cultivating machinery.

Seed sowing is still sometimes done by hand, but machines are gradually taking over to give both drill and broadcast sowing, the operation differing from horticulture only in the narrow-row spacing that is used in forest nurseries.

After one or two years in the seedbed, depending on species, the plants are lifted for lining out in transplant beds, where each plant is given more room to allow it to develop. The lining out is done by clamping the seedlings in long boards which are placed in position in furrows in the ground. The furrow is then turned back, gripping the roots at the correct height and the boards are released for refilling. Special ploughs have been developed which open up a furrow and back fill the previous one at the same time. Using this technique a team of 15, of whom half may be girls, can line out 140,000 plants in a day. The planting-wheel type of machine which opens a furrow, places the seedling in it and then closes the furrow all in one operation is another method, but is in less general use.

Keeping down the weeds in seed and transplant beds is an expensive operation. A number of mechanical inter-row weeders are employed and chemical control is widely adopted.

Planting in the Forest

In the majority of cases some ground preparation is required either to cultivate and break any pan that may exist or to provide drainage. The ploughs used for this purpose are specialist implements and are very much larger than any normal agricultural plough. Forests are normally only formed on ground unsuitable for agriculture, so the conditions are very severe. Single-furrow ploughs often require a drawbar pull in excess of 6,000 lb. The actual planting of the tree is still done by hand because no machine has been found that will adequately deal with the wide variety of conditions, though planting machines are used on some of the easier sites. Once the plant is established in the forest, nature takes over and machinery plays a minor part, except for some weeding operations, until thinning takes place at a forest age of 25 years onwards.

Timber Extraction

It is in the harvesting of timber from the first thinning onwards that machinery plays an increasing part in production. The power saw has been very greatly improved in both reduction in weight and increase in cutting speed. We already have one-man saws weighing under 27 lb. which can cut at a speed of 17 sq. ins. per second. The value of power saws, of course, increases with tree size, and 6 ins. diameter is now generally taken as the break-even point with hand saws. Once the tree is felled the object is to get it on to road transport with the minimum handling, hence the need for a close network of roads and the road-building programme mentioned earlier in this Paper. In a fully-roaded forest there should be a mile of road per 80 acres and the longest carry from stump to road would be 110 yards. These are, of course, target figures, and they are not achieved on the more difficult sites.

In the first and second thinnings much of the initial haulage to roadside is done by hand and horse, and it is not until thinnings weigh upwards of 300 lb. that machinery comes into its own. If tractors, either tracked or wheeled, can compete with the conditions of slope and ground they are used, and the longer the haul the more it pays to employ machine power, though a well-trained horse is still a most valuable friend of the forester.

Devices are now available which provide for the haulage of heavy logs by standard agricultural tractors over very difficult ground. All these aim at keeping at least the butt if not the whole log off the ground when in transit in order to reduce the amount of ground disturbance. Steep slopes offer problems of their own since no vehicles of any kind can be safely operated on gradients much in excess of 20°. All kinds of chutes and cableways have been used, but in an early thinning operation they are very seldom an economic answer as the volume yielded per acre is too small to cover the heavy overhead costs involved in their erection. Great use is made of cableways on the Continent, but there big timber is normally handled over long distances to a comparatively distant road system.

Winches have always played a big part in timber extraction, and the rapidly-developing double-drum system combined with a high lead, as pioneered in Norway, is likely to be seen to a greater extent on some of our steep slopes.

Loading

Having reached the roadside there remains the problem of loading onto lorries. As length may be anything from pulpwood (4 ft.), which has been converted at the roadside to full-length poles of over 30 ft., a wide variety of loading gear is needed. It is always a finely-balanced choice whether to use one of the many lorry-mounted loaders that are available or to use mobile cranes, fork-lift trucks, etc. All these methods will be seen in use in British forests.

Transport

There is a sufficiently wide variety of load-carrying vehicles on the British market to provide a standard vehicle to meet almost any transport problem once the road is reached. There remains, however, the case where roads are expensive to make, some across bogs or on steep and rocky hillsides. The helicopter provides a tempting line of thought, and experiments have been made to find out just how practicable this machine would be. The result in 1956, when using a small machine with a ¼-ton payload, showed that the cost of a one-mile haul was about six times more than the job would bear. Recent helicopter development resulting in lower operating costs and higher payloads has probably halved this discrepancy, but the helicopter is still a long way away from being an economic timber transporter. The Hovercraft, however, in the commercial form in which it is appearing as an overland load carrier may well provide an answer on soft ground where all that is required appears to be a smoothed path. These machines do not involve high capital cost, and their success will depend on whether the saving in road-building costs is more than offset by the extra handling on to and off the Hovercraft.

In concluding a review of this kind it is necessary to mention the work being done by the Food and Agriculture Organisation of the United Nations, who act as a focal point for international liaison. Meetings are regularly organised among specialists of all countries in order that the results of experimental work can be shared. Through this association there are already a number of international testing schedules in draft form which will enable the results of tests carried out on machines in one country to be compared with similar tests elsewhere.

Invaluable help also comes from the National Institution of Agricultural Engineering at Silsoe and the Forest Products Research Laboratory at Princes Risborough. A great deal of use is made of the " know how " and the resources of both these organisations, thus saving the duplication of much scientific testing equipment.

In presenting his Paper, Col. Shaw extended and amplified some of its comments.

After describing some of the early history of the Forestry Commission, he continued that 1½ million acres were administered by it to-day. In addition to that, there were 1 million acres in private hands. The annual rate of planting was now running at up to 60,000 acres —even amounting to about 100,000 acres in some years after the war. Private owners were planting around 30,000 acres. The setting up of a pulp mill in the Fort William area of Scotland was under consideration, with an anticipated consumption of 600 tons a day. The mechanical problems at the mill were quite considerable.

He referred to people who criticised certain aspects of the Forestry Commission's work, one complaint about the spread of forests being that they were planted in rows. But this was how they had to be planted, and, in any case, after some years' growth no one would think they had been planted in that way. He stressed the importance to the Forestry Commission of standardising on certain machines. It was a bone of contention between them and the trade, but they had to standardise. When they had decided on one particular make it had to be used for a number of years, unless something serious took it out of the field. There might be other machines just as good, but they had to plump for one.

He stated that the Commission had three workshops. But they were tremendously dependent on the repair service of the manufacturer and their choice of machines was often governed by the service offered by the manufacturers throughout the country. The value of present equipment was £2·6 million, and £1·3 million was spent on maintaining it every year. In their replacement programme, £600,000 was spent on buying new machinery each year.

Mentioning the Commission's greatest needs that were not satisfied at the moment, Col. Shaw said that one was a tractor with an infinitely variable gear, for they wanted a tractor which would " creep." This was largely for nurseries, where a speed of about 100 yds. in an hour was required. While they had planting machinery, it was essential that the rows should be accurate. When putting in transplants by hand it was almost impossible to mechanise subsequent operations owing to variations in spacing. At the moment they were using tractors with tremendous gear reductions, but it was not too satisfactory. Therefore, they were waiting for the hydrostatic drive tractor to come into being. If they did not get one soon they might have to build their own. They could buy the necessary bits and pieces.

For picking up timber at the road-side they needed a British machine, as the only one they had found satisfactory had to be imported.

In showing some slides, he included one of an American transplanting unit. They could plant six rows at a time and 140,000 plants a day.

There was a large variation in the inter-row cultivation machines in the nurseries in this country, he said. If there was a tractor that would go slow enough, all the need for these special machines would disappear.

Standard tractors were used to pull the special forestry ploughs, which required a drawbar pull of 5,000 to 6,000 lb. But, while on the usual dry ground normal tractors would do it, on peat it was a different problem, because conditions were usually very slippery. He showed a slide on which were depicted two tractors—one adapted to go over really soft ground. Track area was the feature they went for. The first thing was to make it wide gauge and put the track centres out to accommodate the tracks, which were 30 ins. wide. That had been the first thing that was done and the track chain was not altered, so that 12 ins. was entirely unsupported by the track chain. However, the result worked so well on peat that they lengthened the tractor by 3 ft., and it became a real land battleship. That type of machine in its long form was now doing the whole of their peat ploughing in the North of England and Scotland.

Another slide showed a vehicle modified to try and improve its cross-country capacity. The first prototype had 10-28 Ferguson wheels as an experiment. After the axles and brakes had been modified, these vehicles were ready to go into production in the near future.

They felt now in the Commission that double-drum winches were essential for forestry operations, he went on. One slide was of a prototype of such a winch, and the feature was that hydraulic drive was used. An advantage was the lack of shocks sustained by the unit, because braking was done so steadily. It was said to be the first British double-drum winch mounted on a tractor ; it looked attractive, but had not so far done any field tests.

The slides were followed by a film, the first subject of which was the prototype drain cleaner developed by the Commission. It had not proved entirely satisfactory and consisted of flails driven on a rotor by a tractor power take-off. The trouble was that the drain was not deep enough, and he did not think the machine was acceptable, unless a machine able to go deeper could be built.

New types of loggers and a self-loading timber arch were shown in operation.

APPENDIX I

The History of the County Tractor Swamp Models

The story of the development of the Swamp model tractors originated with the need to haul drainage ploughs over immense acreages of very soft peat which was becoming available for afforestation in the early 1950's. A tractor was therefore looked for which could be modified without great expense to deal with this very soft ground condition, yet remain basically composed of standard parts and carrying a nation-wide service organisation.

The problem was obviously one of ground pressure, and the first step in collaboration with the manufacturers was to increase the track centres in order to allow really wide tracks to be fitted. This was done by inverting the sprocket discs, fitting longer suspension springs and radius links and altering the suspension frame which carried an outrigger bearing on an extension to the sprocket axle. This bearing was later abandoned when stronger axles were introduced.

The main problem was to provide a track 30 ins. wide, and this, at first sight, appeared to call for a formidable re-design. Before departing from standard to this extent, it was decided to try the effect of simply fitting 30 in. plates to the existing track chains. This left the plate unsupported for a distance of 12⅜ ins. on each side of the chain, and even the most optimistic minds felt certain of trouble. However, the machine was intended for soft ground only, so there was a chance of cheating in this way.

The first experimental tractor was an immediate success. It was able to achieve far more than any other tractor at a comparable price. The expected difficulty in steering with tracks 30 ins. wide was offset by the greater distance between track centres, but the much greater drawbar pull available on soft ground accentuated the " tail heavy " condition so familiar in all soft ground ploughing. A drawbar pull of 4,500 lb. was obtained under bog conditions, track slip being the limiting factor.

Whilst the wide-tracked tractor had gone a long way towards a solution of the soft ground problem, it was obvious that a great deal more could be done by increasing the length of track on the ground. The next stage, therefore, was to increase the length of the tractor, and it was decided, again with collaboration with the manufacturers, to do this by inserting an extra transmission casing between the existing case and the final drive casing. This, in fact, increases the length of the tractor, sprocket centre to idler centre, by 2 ft. 11¾ ins. Longer suspension frames were fitted carrying four extra bottom rollers and one top roller. This cahieved the desired results in giving a better balanced tractor and far higher drawbar pull. The tracks have proved able to give a reasonable life on peat, but they give trouble if used in hard, rocky conditions.

The Swamp tractor, in both standard and lengthened form, is now used by the Foestry Commission for most of the peat ploughing that is undertaken.

APPENDIX II

Timber Extraction by Helicopter

Experiments with the Bell 47G helicopter showed that it is quite easy to pick up timber in remote areas in a forest and carry it to road or rail head. To pick up, travel a mile, deliver the load and fly back took 6 minutes for the round trip. As the payload on this particular machine is only ¼ ton, the hourly rate was 2½ tons, which, with practice, could probably be raised to 3 tons. The machine cost is £30 per hour, so the transport would cost £10 per ton or some six times the maximum rate that the job would stand. Machines with greater payload may well bring helicopters within economic range in due course. In the meantime, the indications are that the hovercraft will be the first of these new type machines to justify their use as forest transport.

Planet News Photograph

The Agusta Bell 47G helicopter taking off with a 600 lb. load of forest thinnings at Glenduror.

would bite on that.

Power saws were improving all the time, and had done so considerably since he had quoted an ideal specification.

working in various other fields already. He did not feel that they should be too depressed at the progress shown because he felt that things were going pretty well.

APPENDIX III

The Sorbeau Saw

This is a portable sawmill designed to allow the mill

COL. SHAW said he could not give any figures worth having, except to tell him that the present income from all sources was about £3 million a year. They had, of course, thought about safety cabs and had had some on some of their tractors. The reaction of their drivers had often been unfavourable. The reason was that they felt much safer if they could abandon ship on the more frightening slopes. They had been lucky in having few casualties, considering that they worked on such difficult slopes. He had heard that barking after chipping was being done in Germany. He felt that it was untrue that he had not talked of any break-through, because the hovercraft was one—if it worked, and they were going to try.

COL. P. JOHNSON (Roadless Traction, Ltd.) stated that the time might come when there would be some vast machine invented to produce pulp or even paper at the end of the harvesting process ! But he wanted to emphasise that the Institution should have in its membership, maybe on special conditions and terms, those people like Col. Shaw who were engaged in forestry.

THE PRESIDENT was sure that these remarks were taken note of by the chairman of the membership committee, who was present that day.

MR. T. P. GREGORY (Hants.) was convinced Mr. Hamblin was right about hydrostatic tractors. He would not spend a penny more on one of these tractors than on an ordinary one. One thing interested Mr. Gregory about the planters, which was where the demand was for hydrostatic tractors ; he could not see why they did not use their winch to pull planting machines, like the old steam tackle. That way they could save £300.

COL. SHAW agreed that it was certainly an idea. They would have to steer the planting machines and would have to have something approaching the weight of a tractor to do it ; so the saving might not be very great. The price of using reduction gears was nearly the same as for hydrostatic drive. He believed that winching had been done in America.

COL. W. N. BATES (Kent) wanted to know what the pruning policy was in this country to-day. He had to teach students from overseas and they were interested in it. Could Col. Shaw tell them anything about mechancal pruning, he asked. And also about the method of making fire brakes ? His last point was about an American saw which he had used. It weighed 23½ lb., had a 3½-h.p. engine and a 21 in. chain drive.

COL. SHAW remarked that the pruning policy had not been altered. With most trees they pruned to 6 ft. The latest machine they had tried had a quick thread screw, which attempted to screw its way through the branch. However, with many powered pruning machines they had found that an experienced forest worker could beat them using a hand pruning saw.

COL. BATES replied that when he had left Africa they were pruning to 22½ ft., but the Americans now were pruning soft pine up to 30 ft. in stages.

COL. SHAW remarked that the Forestry Commission had done work to 20 ft.

MR. C. A. GOODGER (Rycotewood College of Rural Crafts) said that it seemed to him that the Commission was concentrating on conifers. He asked if the Commission was doing anything with hardwoods.

COL. SHAW answered that the proportion was 95 per cent. conifers and 5 per cent. hardwoods, and that this was owing to demand.

MR. R. L. GALLOWAY (Scottish Woodland Owners' Association) referred to some work that had been done in a forestry scheme in north-west Sutherland with wartime " Weasel " vehicles. He queried whether the Forestry Commission had done anything to develop this type of tractor.

COL. SHAW said that no work had been done with the " Weasel " because the wide-track machines he had shown would cope with these conditions.

MR. J. M. CHAMBERS (Warwicks.) reminded Col. Shaw about the acreage under forest belonging to private growers. Col. Shaw had stuck to the machinery used by the Forestry Commission, he continued. Mr. Chambers wanted to know what machinery was used by the private growers, who looked upon forestry as part of their farming operations. Did they use light machinery, as people did in Norway and Sweden ?

COL. SHAW said that private growers, because of the smaller scale, could not afford big machinery. In Scotland they were forming forestry machinery cooperatives. Sometimes the Commission hired out machines to private enterprise.

MR. CHAMBERS asked if there was a market in this country for Norwegian sledges and winches.

COL. SHAW said that winches could be produced in this country, and he agreed that tractor-drawn sledges might be useful.

A REPRESENTATIVE (Caterpillar Co., Ltd.) declared that he was interested in the subject of land clearing, particularly in the cost of between £40 and £50 per acre. He inquired if this included windrowing and so on. Also, was the figure assumed to be high, or was it just the type of equipment used that was responsible.

COL. SHAW replied that the figure did include burning and was a frightful price to pay. Some planting was done for amenity and strategic reasons. The £40 figure was too high, and in some cases they were now only clearing avenues through the scrub—some people said that the plants got better protection that way. The figure did not include shifting stumps.

THE PRESIDENT thought that all would agree with him that it had been a most intriguing Paper and had covered many subjects that they probably had known nothing about. He referred to the courage of arranging to feed the new mill at Fort William with 600 tons a day. He remarked that in his opinion Col. Shaw had emphasised that the Forestry Commission had a very strong leaning towards using British equipment. The President asked whether there was not a challenge left behind by the Paper to members of the Institution. Could they accept it ?

THE PLACE OF AGRICULTURAL MECHANISATION IN THE INDIAN ECONOMY

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A Paper presented, by invitation, to an Agricultural Engineering Seminar, Indian Institute of Technology, Kharaghpur, in October, 1960.

THE NATURE OF BETTER FARMING METHODS

AGRICULTURAL mechanisation (the term is restricted in this Paper to the consideration of the use of tractors for cultivation and general farm use) is one of a number of special techniques which have been spontaneously evolved in many parts of the world, over a long period of time, in order to permit agriculture to make its indispensable contribution to the economic development of different nations.

Other techniques of the same kind include irrigation ; improved cultivation through drilling and inter-row weeding ; improved seeds ; the application and improvement of artificial fertilisers ; the analysis of soil requirements ; marketing and transportation improvements ; pricing systems and support prices ; the preservation and packing of agricultural commodities, and many more. The lack of any one of these techniques limits the effectiveness of the remainder, even at quite modest levels of productivity.

By making use of all the resources available to him, the modern farmer in the developed countries of the world has been able to take on his shoulders production burdens that would have been thought impossibly large as little as fifty years ago. In the early days, for instance, the average American farmer provided food for four persons. By 1950 the average American farm produced sufficient food for 25–30 persons. It would not be too much to say that the prosperity and economic " balance " of Europe and North America has only been made possible through the European and North American farmer's ability to remove the responsibility for food production from an increasingly large proportion of his fellow countrymen.

THE SITUATION IN INDIA TO-DAY

The Draft Outline of the Third Five-Year Plan, released in June of this year, summarises very clearly the minimum levels of achievement which must be attained if the country as a whole is to enjoy economic independence and a release from the conditions of grinding poverty which afflict all but a few per cent. of the population. The Draft states clearly, and logically enough, that further progress is necessarily tied to the agricultural sector of the nation, and to its success, or otherwise, in meeting the production goals assigned to Indian farmers. It is quite possible that failure to attain these goals will result in widespread privation and even starvation. It should be understood at the outset that many independent demographers and experts in economic development doubt whether the Indian plans are sufficiently realistic (*a*) in accepting population increases of the correct magnitude, and (*b*) in estimating the national capacity to meet the new targets, against the relatively optimistic view that is held by the Planning Commission of future additions to population, and of the *current fulfilment of earlier targets*.

Notwithstanding these reservations, the Draft is a sufficiently formidable document, and the production burdens facing the Indian farmer, if he is to make his vital contribution to the general welfare of the country at a level no higher than that planned, are vast indeed.

A Summary of Food Production Targets to 1966

Nearly 90 per cent. of Indian farm land is sown to food grains of various kinds. Naturally enough, it is within this category of farm production that progress is almost solely expected in the immediate future. Mr. S. K. Patil, Union Minister of Food and Agriculture, has created a time table (dovetailed with the Third Plan) for virtual self-sufficiency in food supplies by 1966. Graph III indicates the target of 105 million tons required by that date, and shows past production superimposed on a general trend. The team of experts borrowed from the Ford Foundation by the Government of India in 1958/59 to assess India's food crisis, and the steps necessary to meet it, proposed a target of 110 million tons of food grains by 1966, and the Third Plan refers to its current, slightly smaller, objective as a " minimum target." It can thus be agreed that very great advances in production must be accomplished if food supplies are to do no more than rise neck and neck with anticipated population increases. It will be generally accepted, moreover, that to restrict the agricultural sector of the nation to the mere production of food grains would be to handicap disastrously any national developments based on food exports, or on the increasing use of agricultural raw materials for industry. The Third Draft lays particular emphasis on this aspect. Such restriction would, furthermore, limit drastically the variety and nutritional value of the national diet.

Nevertheless, this Paper will consider ways and means, related to the application of farm tractors, for attempting to ensure the attainment of the food grain production targets so far established. (It should be understood that the agricultural and climatic environment in India is well able to sustain far higher production volumes, providing a number of crippling limiting factors, which will be described, are made good.)

THE FARM WORK CAPACITY POSITION IN INDIA

It is a commonplace of general, and largely uninformed, opinion that India is burdened with a severe surplus of

* Tractors and Farm Equipment Private, Ltd., Madras ; I.Agr.E. Representative in India.

labour and a superfluity of workstock for the cultivation of available farm land. The reasoning then employed goes on to draw attention to the small size of the average Indian farm holding, and finishes by assuming that all these " obvious " disadvantages make the use of tractors and farm machinery impossible. Let us examine the true position with respect to these different factors, which together define the potential productivity of Indian farming.

The Indian Farm Work Force

Graph I shows the diminishing proportion of the population, in comparison with the total, that remains in the rural areas from year to year. All demographers agree that this trend has been evident for many years. " Data for recent decades suggest that the urban population has tended to grow somewhat more than twice as fast as the general population."[1] The overall aim of the Five-Year Plans is to produce just such an increase of urbanisation as part of the general programme for forcing increases in both industrial and agricultural productivity.[2] The extrapolations for the years beyond 1951 are generally confirmed by a number of different surveys, and have been used to draw the Rural Population curve, against Total Population, in Graph II. Total population shown in Graph II is higher than that predicted in the Second Five-Year Plan, and is taken from various surveys postulating a cderease in fertility rates of 50 per cent. between the years 1956 and 1981. It is thus possibly optimistically low. If this is the case, then the food targets are also under-estimated. However, variations are unlikely to be of undue significance during the period of the Third Plan.

In the census years for which figures are available the rural work force has consistently amounted to very nearly 35 per cent. of the rural population. Graph III therefore shows, plotted upon the Foodgrain Achievement and Taıget lines, a curve for the anticipated Rural Work force at a level of 35 per cent. of the Rural Population curve established in Graph II. The 1951 figure is taken from the National Census of that year.

It will be immediately observed that this Rural Work Force curve is beginning to flatten out, and is in any case much flatter than either the " trend " or " target " Foodgrain lines. A consideration of the position that might exist in 1971 emphasises the widening gap between desired food supplies and the labour force necessary to produce them.

It must be accepted at the outset that the general application of improved farm practices, as listed at the commencement of this Paper, will account for a proportion of the gap which must be bridged by the dwindling work force. However, this gap is of the order of 48 per cent. of 1959 " trend " by 1966, and by 1971 has widened so much that the work force of that year (only some 6·5 per cent. greater than in 1959) will have to produce more than twice as many million tons of foodgrains as were produced a decade earlier. This is a truly staggering target. Even if it can be accepted that the target line might be allowed to flatten out once target has been achieved, and that thereafter foodgrain production could march equally with population increase, the economic survival of India demands that the Indian farmer should turn his attention to increasing the yields of other crops as well as foodgrains, as already noted. It can thus be safely assumed that the future load on Indian farming will be a greater one with each succeeding decade, *and one that will have to be assumed by a work force steadily diminishing in relation to targets, if not eventually in actual numbers.*

The farm work force available is largely considered to be more or less unemployed. Contrary, however, to popular opinion, the real problem is *under-employment* of existing labour, and it can be assumed that this will continue to exist. " Enquiries conducted by the National Sample Survey have shown very little sign of visible unemployment in rural areas. There is, of course, widespread under-employment ; persons engaged in agriculture and in associated activities have productive work only during the appropriate season."[3] It is well known that this is a description of a universal characteristic of agricultural employment. In this respect, India does not differ greatly from any other country in the world as far as potential idleness during non-peak cultivating and working periods is concerned. But the N.S.S. statement confirms that *during paek work periods* the present work force is only just sufficient *for the present level of production.* An important associated consideration is that reserves of labour exist for non-peak periods. It is precisely with the aim of freeing labour from peak obligations, and thus permitting year-round commitments of other kinds, that farmers in developed countries have come to rely on the use of tractors and farm machinery.

It must also be remembered that India is placing great hopes in the ambitious irrigation schemes by which many additional millions of acres of land will receive adequate water supplies. Irrigation farming is notoriously labour-intensive, and is commonly only commercially possible when the crop increases are of a high order indeed. The Ford Foundation Agricultural Production Team has stated that *average* yield increases of irrigated crops over unirrigated crops in India are at present no more than one-fourth to one-fifth of a ton. Only 12 per cent. of present irrigated acreage is being double-cropped.[4] It is thus possible—at least during the Third and Fourth Plans—that farm labour will be tapped unproductively for mismanaged irrigated farming, accentuating the work force shortage-against-target already noted.

Indian Farm Workstock and Livestock

Having considered the decreasing rate of supplies of manual labour likely to be available for the achievement of national farm production targets, it must be remembered that some form of draft power is necessary for all but the most primitive kind of uneconomic subsistence farming.

According to the Livestock Census of 1951, summarised in Table I, total adult bovine workstock (considered to have remained steady since the Census) is 67·2 millions out of a total of 198·4 millions. There is no need to elaborate on the poor condition, for various reasons, of the majority of bovines of all kinds and classes of utilisation. The pressing need to reduce the bovine population has been recognised even by those who would prevent such a reduction for ethical reasons. It is not, perhaps, realised, however, that the workstock is rather less than sufficient for the work-task imposed by the necessity of cultivating Indian farm land at the appropriate time each year. " Draft power (in India) is barely sufficient for farming on the present scale by present methods. In some regions there is said to be a surplus of draft power, but elsewhere crop yields are known to suffer frequently from insufficient animal power for thorough and timely working of the fields at times of seasonal peak activity."[5]

A great deal could be done, by culling and by restriction of bovine wandering population, to improve the work capacity of workstock and to reduce their numbers, while quite possibly increasing total draft-power potential. This would ease a deadly pressure on the land as a result of which bovines compete with the human population for food. There are many obstacles in this direction, however. Such a solution, even if feasible, would still leave unsolved the problem of undesirable labour-intensivity in the management of draft animals, together with the problem of how to *increase very substantially* the draft-power potential—in consonance with the foodgrain targets and as an inescapable forerunner to diversified high-production farming in India. Clearly, increases in the workstock force *must* be prevented. Equally clearly, mechanisation *must* be employed to fill the draft-power gap that is already widening in the face of production targets.

Table I
BOVINE LIVESTOCK IN INDIA, 1951
(millions of head)

	Total	*Cattle*	*Buffaloes*
All Classes	198·4	155·1	43·3
Adult Work Stock	67·2	60·7	6·5
Males	64·4	58·4	6·0
Females	2·8	2·3	·5
Breeding Stock	68·2	46·9	21·3
Males	·9	·6	·3
Females	67·3	46·3	21·0
Young Stock, etc.	62·9	47·4	15·5

Source: Second Five-Year Plan, pp. 281–2; based on Livestock Census of 1951.

The Size of Indian Farm Holdings

The Planning Commission has recently admitted that the general pattern of land tenure in India has only changed insignificantly in response to the pressures of land reform. Professor Mahalanobis, Adviser to the Planning Commission, has pointed out that the fruits of land reform, if carried in the teeth of growing opposition to the ultimate achievement originally envisaged, would merely provide a few million persons owing 2 acres of land or less with an admittedly uneconomic holding, while deliberately reducing potentially economic holdings to a size below the threshold of economic production. To the extent that land reform will redress the wrongs suffered by the crop-sharing tenants of absentee landlords, it is overdue. As a means of supposedly increasing food production through the application of a " ceiling," it is working directly against the fundamental interests of the country as a whole. The Third Plan Draft is deliberately vague about this. " The first . . . specific object (of) . . . land reform programmes . . . is to remove *such* impediments to agricultural production as arise from the rural structure inherited from the past. This *should* help to create conditions for evolving, as speedily as possible, an agricultural economy with high levels of efficiency and productivity. The second object is to . . . assure equality of status and opportunity to all sections of the rural population."[6]

Table II
PATTERN OF LAND HOLDING IN INDIA
(July, 1954 – March, 1955)

Size of holdings (acres)	*Percentage of total number of households (65 m. households)*	*Percentage of total area operated 310 m. acres)*
Nil	6·3	Nil
0·01 – 2·49	48·5	5·9
2·50 – 4·99	15·9	10·9
5·00 – 7·49	9·3	10·5
7·50 – 9·99	5·6	9·1
10·00 – 14·99	5·5	12·6
15·00 – 24·99	4·9	17·7
25·00 and above	4·0	33·3
	100·0%	100·0%

Source: India, 1960. Publications Division, Government of India.

Perusal of Table II yields the following observations:

(*a*) For various reasons, not the least being a system of inheritance which discounts primogeniture, very severe fragmentation must obstruct efficient production on more than half of India's farms. From this point of view, legislation to encourage the consolidation of farmland, either by suitable deeded arrangements or by increased co-operativisation, is greatly needed.

(*b*) Some 33·3 per cent. of the total area considered in Table II, amounting to 102·2 million acres, is, however, in holdings of a size sufficient to generally permit efficient capitalisation, especially the individual purchase and use of farm tractors of suitably varying horse-power.

(*c*) If it can be assumed, for instance, that half the number of holdings in category (*b*) above is potentially fit for the use of tractors (from the point of view of investment capacity, as well as land suitability) at the rate of one tractor per holding, then 1·3 million tractors could be immediately applied without embarrassment and in the confident belief that their use would go a very long way towards making good the shortages in manual labour and workstock numbers already established ($65 \times 4/100 \times \frac{1}{2} = 1{\cdot}3$).

(*d*) In all probability, the tremendous increases in foodgrain production required to meet Third Plan targets will *not* be achieved as a result of the activities of those 64·4 per cent. of all farmers who own land less than 5 acres in quantity. From the point of view of national survival, it is thus unrealistic to allow the admittedly large numbers of such farmers to obscure the necessity for recognising that priorities must be given to those at the other end of the scale. Least of all should an uninformed approach to the true position result in the condemnation of farm mechanisation, through tractors and improved tractor implements, as impracticable.

METHODS AVAILABLE FOR RATIONAL MECHANISATION OF INDIAN FARMING

The arguments which have been put forward so far will have gone a long way towards establishing the *need* for mechanisation with tractors and implements that already exists in India. Data have shown that much of the more important sector of Indian farming can safely be mechanised (foodgrain production targets having been accepted) without the adverse effects commonly predicted by those who are unaware of current trends and future objectives. At the same time, the undesirability of over-mechanisation can be accepted, and any excess application of farm machines can in any case be dismissed as a result of the probable inability of Indian industry to produce more than a part of the tractor volume required within the time available.

It remains only to outline those means of attaining an economic level of mechanisation that are open to Indian agriculture.

State-Controlled or Assisted Tractorisation

(*a*) *Taccavi Loans.* State Governments have for many years (with a few exceptions) created funds from which private farmers have been able to borrow the cost of farm machinery on a long-term low-interest repayment basis. This official recognition of private needs (especially welcome in view of the obstacles facing the Indian farmer who wishes to make long-term capital investments in his operations) can be accepted as a general sanction for the rational introduction of mechanisation in India.

(*b*) *Tractor Organisation.* Although largely restricted to the contract cultivation of extensive marginal areas, the work of the Central Tractor Organisation and the Bhopal Tractor Organisation (to name only two) has resulted in the useful (though possibly unduly expensive) mechanical cultivation of land uncultivable by traditional methods. Here it is appropriate to consider the very great inadequacy of the bullock plough for farm cultivation, as compared with the improved ploughs and methods of cultivation made possible through the use of tractors of all horse-powers above 20-d.b.h.p. It is also necessary to consider at this point some conflict of opinion that exists regarding the balance of virgin land available for extra food production. " The scope for increasing the area under cultivation is extremely limited . . . the main source of increase in agricultural production must be increase in yields from more intensive, more efficient, and more profitable agricultural production."[7] " It would seem that something of the order of a million acres a year might be reclaimed for addition to the cultivated area on a fully economic basis, with the aid of some power equipment supplied roughly at cost by the State."[8] It might be difficult to decide, nevertheless, whether the increase in coarse foodgrain production conferrred by such reclamation would not be more economically attained through raising yields of existing cropped land. " It is now known for certain that only a very small proportion of this residual area (the 123 million acres of ' other uncultivated lands, excluding current fallows ') can be brought under the plough at costs which the expected revenue from their cultivation would justify . . . The maximum rate of reclamation of new land which might possibly be maintained for a few years would be about 1·5 million acres."[9]

These opinions emphasise especially the absolute indispensability of tractors for the execution of such reclamation work as is possible, if costs are to make investment in such operations economic. The targets envisaged for each year would demand very high inputs of mechanical horse-power. However, much reclamation in small parcels could be undertaken by private farmers in adjoining lands, provided they were assured of cheap tractors and implements, which could be used, of course, for general farm operations as well.

(*c*) *State Mechanised Farms.* A substantial move is afoot, following the application of a gift of Russian farm machinery put to generally successful use at Suratgarh Mechanised Farm in Rajasthan, to promote the establishment of large mechanised farms in each State of the Indian Union. Much of the justification claimed for this step is derived from the possible advantages attending reclamation of marginal lands, as examined above. At the same time, the support for such proposals is based, without question, on the acceptance of the benefits to be derived from mechanisation. It is, perhaps unfortunate that hopes are centred around the exclusive form of mechanisation which develops under State control. The experiences of the Russian Collective Farms and certain of the experiences of the large Indian Tractor Organisations provide much substantiation for the view that mechanisation by private individuals is a preferable form, wherever it is possible. In any event, such developments, taking place on an acreage insignificant by comparison with the total, and under conditions vastly different from those likely to be experienced by the average progressive Indian farmer, can have little effect on the overall situation.

Non-Official Tractorisation

When confronted by the immensity of Indian farming dimensions, involving the day-to-day activities of tens of millions of farmers as they farm hundreds of millions of acres, the informed observer must surely conclude that any worthwhile progress in productivity *must originate with the farmer*, and that official activities, limited in size by their very source and nature, can have very little effect of an independent kind. The final portion of this Paper will discuss the *motivation of the farmer*, which is a very obvious pre-requisite to any increased activity on his part. At this point, however, let us consider the means available through which individual farmers can, by their independent or collective efforts, finance and procure their own inputs of mechanical power.

(*a*) *Private Purchase for Sole Use.* A formidable, and largely untapped, number of Indian farmers is to-day in a position to purchase and to utilise efficiently mechanical cultivating power. This potential has been obscured during the past few years by the uncertainties attending the indecisive prosecution of Land Reform Programmes. Demand has been screwed down for at least three years by the creation of an artificial shortage due to Import Licence restrictions. Under these conditions, progressive farmers have been effectively discouraged from the consideration of tractor purchase, and all extension work devoted to the explanation and promotion of mechanisation has come to a standstill. There seems little doubt that private purchase can account for the whole of tractor production contemplated in the Third Plan.

Such production, however, falls woefully short, as planned, of the amount required to bridge shortfall-against-target quotas arbitrarily laid upon Indian farmers in the Third Plan.

(*b*) *Private Purchase for Contract Use*. Many farmers owing tractors, whose lands are too small to permit full utilisation of their machines, but who still derive conclusive advantages from their equipment, make a practice of hiring it out to neighbouring farmers. Contractors specialising in such activities are growing in numbers, and several private studies indicate conclusively that the advantages of mechanical cultivation are sufficiently apparent to cultivators to create a scale of charges providing equitable profits to the contractor *and* to his clients. The enterprising sharing of machinery resources in this fashion offers great hope for the selective mechanisation of Indian farming, and for the best utilisation of those tractors which can be made available within the course of the next two Plans. The very nature of the operations, and the stake that the owners of the machinery hold in its speedy and efficient application, guraantees a standard of utilisation probably unattainable through official tractor pools. If the policy of the Government were to encourage such enterprises in the same way that a number of village industries and occupations are fostered and protected to-day, a great deal might be done to muster concealed private capital and thus to harness it to agricultural production.

(*c*) *Co-operative Societies*. A large literature exists dealing with the presumptive advantages attached to the widespread co-operativisation of Indian agriculture. Much can be said for and against the possibility of such an official policy attaining a successful practical outcome. It must be agreed, however, that if co-operative societies of the " service " type succeed in India, then they will provide perhaps the optimum environment for the extension of rational farm mechanisation to the three-quarters of all Indian farmers whose present holdings would probably not justify independent tractorisation. Here again the numbers and quantities involved raise problems of estimation which far exceed any possibility of significant mechanisation, even of basic cultivation and transportation, being attained for two or three decades. The very nature of co-operative activity results in a certain wastefulness of utilisation (and particularly in a heavy load of administrative expenses) which places the mechanisation of co-operatives (if these can be established) somewhat further down the scale of priorities than might at first be imagined.

(*d*) *Farm Machinery Syndicates*. Considerable progress has been reported in several parts of the world as a result of groups of farmers joining together with the exclusive and sole purpose of jointly purchasing and operating farm machinery which would be beyond their individual resources. Although this is a relatively new devopment, even in high-production farming regions, it holds out a special hope for Indian farming because of the unique personal motivation uniting those who promote such schemes. Here there is no regimentation and no loss of any individual freedom. The enjoyment of privileges inevitably implies the creation of certain obligations at the same time, but with the Machinery Syndicate these obligations are kept at a minimum, *and do not extend outside the specific purpose of the venture*.

(*e*) *Credit and Finance*. A word should be added regarding the general capacity of private farmers to finance farm tractor purchases. The institution of Taccavi loans has already been referred to. Much valuable work is being done by co-operative and Land Mortgage Banks in various parts of the country to make substantial capital sums available to farmers on a long-term basis for the purchase of farm machinery. There is a great variation between the level of success in these banking operations in various parts of the country. Repayment is at a very high level and the transaction is, from a banking point of view, a profitable one. Nevertheless, many banks find it difficult to expedite the handling of the loans (especially the initial authorisation), with the result that the general availability of such a service is not widely known. It is relevant to note that the Saurashtra Land Mortgage Bank commonly processes loans of this kind within a fortnight. It is not, therefore, surprising to learn that very many transactions of this kind have contributed to the Bank's trading figures, and have also made substantial contributions to the farm productivity of the surrounding area.

Little publicity has been given so far to the tremendous extent to which private capital is capable of providing long-term finance for agriculture through hire purchase companies. This field of investment assistance is still almost entirely untapped and could well become decisive in placing much-needed farm machinery in the hands of Indian farmers.

Finally, it must be recognised that the effective application of such funds as are potentially available for the financing of investments in machinery is directly related to the price of the machinery. The Indian farmer will pay almost twice as much for a farm tractor made in India as does his far wealthier brother farmer in the West. Thissituation will continue, and may even be aggravated, until Indian tractor production reaches a level at which unit costs approach those ruling in world markets. It is clearly a grave responibility of Government to do everything humanly possible to stimulate tractor absorption until Indian tractor factories attain economic volumes. Any other course of action wilfully throws a most unjust and avoidable burden on the individual—the Indian farmer—least able to bear it.

INCENTIVES FOR INDIAN FARMERS

So far this Paper has sought to establish the fundamental necessity for accepting, and attaining, foodgrain production targets set against the ever-present threat of rapid population increases. We have brought out the speciousness of the principal arguments used to discourage mechanisation with tractors, and have dwelt on the very large burdens that will face the Indian farmer, even if he is fortunate enough to be able to acquire mechanical sources of cultivating power in order to make good the labour and draft animal shortfall-against-target. The dependence of all on the farmer, and the farmer's dependence, in turn, on the ready availability of cheap tractors, have been emphasised.

We must now examine the extent to which the progressive farmer in India can be motivated towards the immense efforts and constant forward commitments without which he will be unable to embark on ratoinal mechanisation and without which he will thus be unable to sustain a high level of production.

The Rural Standard of Living and Level of Consumption

One of the most (if not the most) important effects of increased farm productivity per capita results from the correspondingly increased purchasing power of the farmer. A farmer with money to spend can take an active part in the development of a national economy. He becomes a potent consumer of capital goods and equipment, and can purchase supplies of agricultural raw materials and machinery, the production of which provides employment for persons on the non-agricultural sector of the community. The extent and profitability of his operations are much improved as a result. By means of more extensive purchases of consumer goods, and especially consumer durables, he can further stimulate industrial production. With more money he can give his children a better education, and can make a greater contribution to the National Exchequer through the direct and indirect payment of taxes. His diet improves, as does that of those to whom he sells his surpluses for cash. In fact, he attains, and begins to enjoy, and indeed to cherish, *a higher standard of living*—something he will not easily forego once it has been experienced, and something which comprises in its benefits a perpetual self-igniting incentive to strive even harder and higher.

But before this ideal state of affairs can be attained some initial impetus must be built up. We agree that a " balanced " economy demands a proper exchange of goods and services between the agricultural and industrial sectors, with the provision of due incentives for both sides. The critical difficulty in India, however, lies in *first* extending these preliminary incentives to the farmer, for without them he cannot reasonably be expected to make any advances of any kidn at all. It is clearly impossible to create an extension service large enough to carry *irresistible* counsels of perfection to the 59 million Indian farm households. Even if it were remotely possible, there would still exist the insurmountable problem of ensuring that long-term motivation remained sufficiently strong to guarantee the execution of plans formed in a moment of otherwise unrelated enthusiasm. In short, motivation can only be secured, *and maintained*, by the constant provision of suitable incentives for the Indian farmer.

Much thought has been given to the crucial need for support prices for Indian basic farm commodities, preferably made public well before the sowing season. Current thinking on incentives has so far halted at this point. And, indeed, the inexplicable delays which have attended such a commonsense step may well discourage further planning. Nevertheless, it has to be conceded that the Indian farmer may not at present (remarkably enough) wish to derive cash surpluses from his production, even if such surpluses could be more or less assured through a system of support prices. It is quite likely that a significant proportion of Indian farmers are actually opposed to increasing their production of foodgrains for one or more of the following reasons :

(*a*) The very common practice of crop-sharing results in landlords participating in kind in harvested production (usually on a fifty-fifty basis, notwithstanding legislation to the contrary), but avoiding participation in production expenses, particularly where these involve the addition of special increments necessary to secure increased production. Under these circumstances, many farmers are actively discouraged from trying to grow more. It is absolutely essential for legislation to compel cash rental payments wherever possible, thus relating rent to land area alone and encouraging the farmer to work for encashable surpluses.

(*b*) Highly artificial and imperfect markets for staple grains work against the farmer who grows more. The local control of grain markets by small merchants in the Taluks approaches complete monopoly. Any indication of excess supplies from any one cultivator produces penal price reductions far beyond those which might be attributed to normal market response.

(*c*) Hundreds of years of exploitation have produced a frame of mind in the ryot conducive to the inconspicuouscultivation of a minimum quantity of produce. There is a deep psychological aversion to any very noticeable increase in crop quantity or quality. Such improvements have always meant extra assessments in the past, with ensuing penalties if the new level of attainment has not been maintained in subsequent years.

(*d*) Should the ryot surmount the obstacles so far listed, and receive a fair return for his investment and labour, he will find it difficult, in many parts of the country, to hit upon a satisfactory way of spending his newly-won funds. It will certainly be hard for him to find many objects, the purchase of which might improve his standards of living, and thus set in motion the " incentive chain reaction " referred to earlier. His observation of community development activities, as far as they comprise a raised standard of living, may have led him to conclude that this will accrue to him free of charge. Such activities may therefore act as a disincentive.

There is little disagreement, in general, with the high-consumption form of incentive described here, or with the statement of the disabilities afflicting a large proportion of Indian farmers. The Third Plan affirms that : " The principal economic objective of long-term development is to secure a progressive rise in the level of consumption per head. This rise in consumption can only be achieved through a large and continuous increase in production (per capita understood) . . . development has to be so planned and organised that the economy expands rapidly and becomes self-reliant and self-generating within the shortest possible period."[10]

What has been overlooked so far, however, is that additional agricultural production *is very largely dependent on the prior provision of sufficient inducements to the Indian farmer to abandon his traditional outlook*, and to accept the precarious and unaccustomed role of an economic individual. If such inducements, in the form of industrially-derived commodities, including farm tractors, attractive to the farmer (and thus arousing his desire to possess them in exchange for his cash surpluses), can be offered in increasing quantities during the next five years, then the Indian farmer will willingly fit in with the plans dictated from a level far above him, even in ignorance of those plans. In the pursuance of his personal goals he will generate a movement of a size and momentum entirely unattainable through the authoritarian relaying of instructions, which is apparently expected to secure target achievement in 1966 by a process of planned delegation.

In achieving increased production of the order deemed desirable, the farmer will demand every conceivable aid to improved farming that is being enjoyed by farmers in other lands. Once suitable incentives for him have been assured, the immense task of providing these aids will fully occupy planners and officials for many years to come.

The operation of incentives of this kind will automatically turn the progressive Indian farmer's attentions to the ways open to him for increasing production per capita. It is here that mechanisation becomes an indispensable tool. Without mechanisation few of the developments necessary to insure India against constructive famine can take place. Mechanisation forms a critical link in the chain of factors leading to the establishment of a self-generating economy in India.

SUMMARY

To summarise, therefore :

1. The attainment, on schedule, of the high Food Grain Production Targets laid down in the Third Five-Year Plan is a matter of urgent and national necessity. It is even possible that these targets may have to be raised in the light of information that may emerge after completion of the 1961 population census, thus greatly intensifying problems that are already formidable.

2. The intensive application of every form of improved farming technique is necessary if Indian agriculture is to achieve the production objectives defined in 1. The lack of a rational amount of farm tractorisation will form a significant limiting factor, reducing the capacity of Indian agriculture to meet these targets. The traditional objections to such mechanisation are largely imaginary.

3. If Indian farming is to play its part, it must be immediately recognised that the provision of suitable incentives for Indian farmers is a *prior condition* to their adoption of the techniques necessary to secure increased agricultural production.

[1] Coale and Hoover, "Population Growth and Economic Development in Low Income Countries." Princeton, 1958, p. 137.

[2] "Another important objective to be attained by the end of the Fifth Plan was the reduction of the proportion of the population dependent on agriculture . . . to about 60 per cent." Draft Outline Third Five-Year Plan. Planning Commission, Government of India. p. 4.

[3] Third Five-Year Plan : A Draft Outline. Government of India Planning Commission. p. 84.

[4] Report on India's Food Crisis and steps to meet it. Government of India. pp. 5, 146, 147.

[5] Coale and Hoover, *op. cit.*, p. 92.

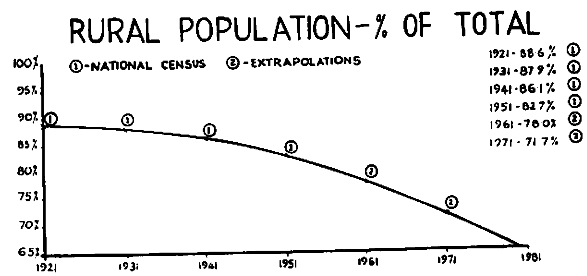
[6] Third Five-Year Plan, p. 93 (emphasis underlined by writer).

[7] Second Five-Year Plan. Planning Commission, Government of India. p. 260.

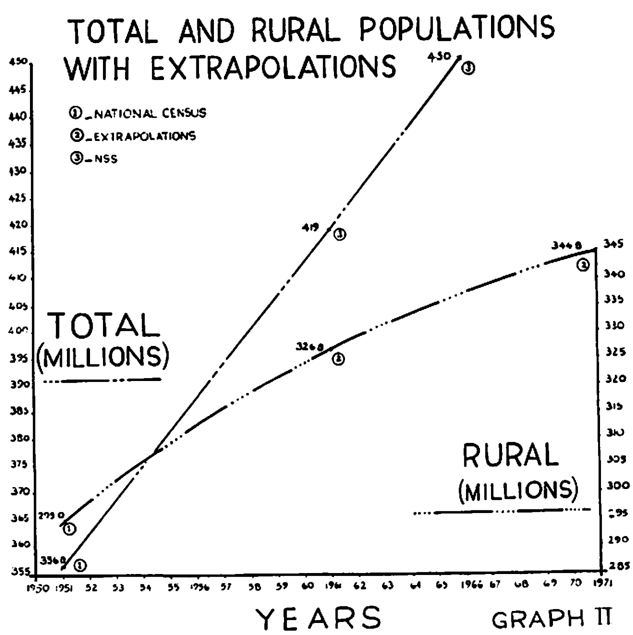
[8] Coale and Hoover, *op. cit.*, p. 98.

[9] J. G. Anand, "Reclamation and Settlement of New Lands in India," Agricultural Situation in India, September, 1954, p. 348.

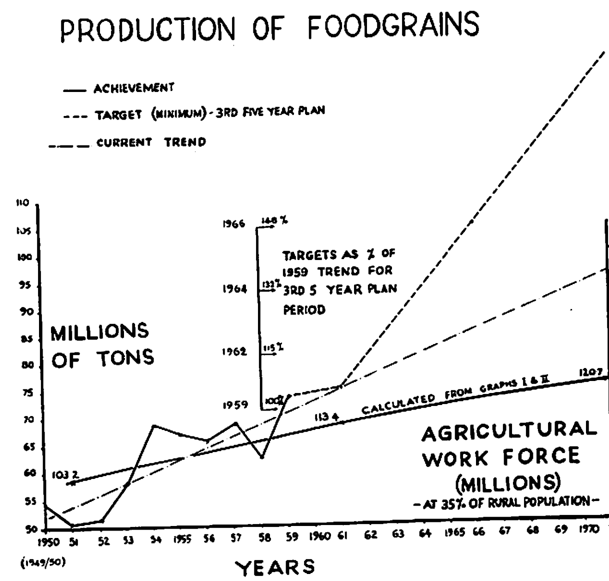
[10] Third Five-Year Plan, pp. 5–6.



GRAPH I



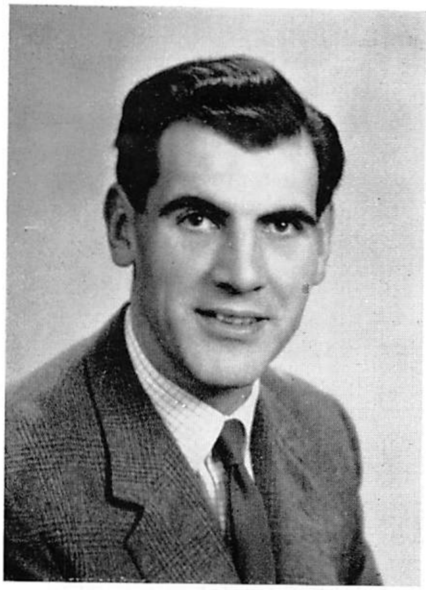
GRAPH II



(INDIA 1960-3RD FIVE YEAR PLAN-NATIONAL CENSUS)

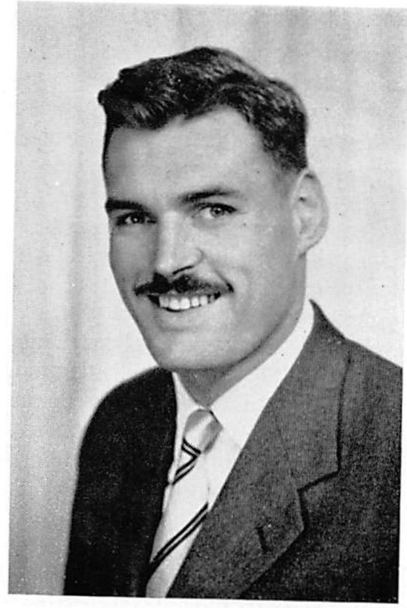
GRAPH III

N.D.AGR.E. SCHOLARSHIP AND BURSARY AWARDS



Mr. I. D. GEDYE

Mr. J. J. B. GIBSON



Mr. J. N. LANDERS

The Dunlop Scholarship Winner for the 1961/62 N.D. Agr.E. Course is Mr. John Nicholas Landers. Mr. Landers attended the Penarth County Grammar School, Glamorgan, from 1949 to 1957, from where he attained G.C.E. Ordinary Level passes in English Language and Literature, Latin, Chemistry, Physics, Biology, Maths. and French, and Advanced Level passes in Chemistry, Physics and Biology.

On leaving school he wrote to the Danish Embassy and secured a year's practical work on the farm of a Mr. Christian Jorgensen in Morkov, Denmark. On his return to this country in 1958, he commenced an agricultural course at the University of Reading, and obtained his B.Sc.Agric.

Shell-Mex and B.P. Bursaries have been awarded to Mr. Ian David Gedye and to Mr. Jeremy James Buist Gibson.

Mr. Gedye attended the Kingswood School, Bath, from 1946–51, where he gained his School Certificate and Maths., Physics and Chemistry in the Advanced Level of the General Certificate of Education. In 1958 he gained the National Diploma in Agriculture after a course of study at Harper Adams Agricultural College.

After leaving College, he was appointed a Field Officer in the Department of Agriculture, Uganda, where he was in charge of a coffee spraying unit. He returned to the U.K. earlier this year in order to take the final year of the course leading to the National Diploma in Agricultural Engineering.

Mr. Gibson attended Sherborne School from 1952–1956, where he obtained seven passes in the General Certificate of Education. In July, 1961, he gained his National Diploma in Agriculture after a course of study at the Essex Institute of Agriculture.

Above: Hereford Cross Friesan and Welsh Black Bullocks eating their ration of maize silage and supplement.
Left: Filling the concentrate hopper at Harper Adams mechanical feeding unit. The silage hopper is to the left and the "press button" panel on the right. Note the enclosed auger for food mixing.

MECHANICAL HANDLING OF FORAGE FROM FIELD TO FEEDING

by R. G. MORTIMER,* B.Sc.

A Paper presented at a meeting of the East Midlands Branch on October 19th, 1961.

FARMERS in this country have frequently been criticised in the past for their unbusinesslike methods. This has applied particularly to their approach to " materials handling," and industrialists who pride themselves on the achievements in this field have been quick to point the finger of scorn at the farm worker with a sack on his shoulder or his fork and barrow for handling bulky fodders.

However, the situation has changed very rapidly in recent years, and thanks largely to the efforts of agricultural engineers and machinery manufacturers British farming can now quote examples of streamline handling as good as any found in industry. So far, most attention has been directed towards cereal handling, and some elaborate and expensive drying, storage and processing plants have been erected. The costs and likely returns involved in these set-ups are generally fairly easily calculated. This is not always the case with bulk handling of fodder crops where quality and feeding value —equally as important as quality in cereal—are not, in my view, given sufficient consideration. Developments in bulk handling of forage have, therefore, been slower than with cereals and concentrates.

The advent of the flail and chopper type harvester has meant that handling of forage in the field has been reduced considerably. Although hay is still the most popular method of fodder conservation, silage has many advocates.

However much we may differ on the relative merits and demerits of silage, there is one point on which we would all agree—namely, that silage, be it grass, arable or maize, is a bulky, weighty food. Fed in the traditional method of cutting by hand with a silage knife, loading by hand on to a trailer, then unloading and feeding by hand into troughs or mangers, it is a laborious and costly operation needing 2 - 4 man-hours per ton for feeding. If the Grassland Utilisation Committee hopes for an annual output in the region of 10 million tons to be achieved, it is obvious that some means of reducing the labour involved in feeding must be found.

Two solutions which have already been adopted by some farmers suggest themselves. The first is to let the animal do most of the work—*i.e.*, some system based on cafeteria or self-feeding methods—and the other is to mechanise the work as much as possible.

A complicating factor in the latter instance is that most of the silage in this country is made in lots of between 100 and 300 tons ; *i.e.*, amounts which do not lend themselves to expensive outlays for mechanised equipment.

I do not intend to dwell on self-feeding methods, as they are well known and have been tried out with varying degrees of success for a number of years on many farms. It does seem, however, that as with many other things in farming this is a system which looks simplicity itself, but the results achieved in practice often fall short of the theoretical possibilities. Capital costs with the system can vary from as low as £200 where a silo is already available to £2,000 or more where a new silo and covered yard have to be erected. One N.A.A.S. survey indicates costs of £3 - £4 per ton stored. Average consumption of silage with the system varies from 40 to 120 lb. per day, depending on the variety of other bulky foods fed, and the time allowed at the silage face.

In some cases the saving in labour involved in cutting and carting is more than balanced by the extra labour involved in keeping the feeding face and surrounds clear of sludge and wasted silage. However, the main disadvantage of the system is the lack of control and over-feeding, and the possible wastage which can occur in badly-managed set-ups.

As with other aspects of farm mechanisatoin, it frequently happens that the Americans, because of their higher labour costs, as well as its shortage, have had to tackle a problem before it affects our farmers. This is especially true of forage handling, and many of the ideas and mechanical set-ups in this country are based on U.S.A. work in the field.

An example of this adaptation of American methods to British conditions is the experimental mechanical feeding unit which has been set up at Harper Adams Agricultural College.

The Unit was established at the College in the Autumn, 1960, to investigate the possibilities of the use of tower silos, mechanical unloaders and auger feeding arrangements. The system is based on American methods of storage feeding, whereby a series, or battery, of tower silos are filled mechanically by means of forage blowers or elevators with maize, grass or arable silage for feeding cattle all the year round on a loose housing system. Supplementary storage for cereals and concentrates to be incorporated with the silage ration are normally provided adjacent to the silos.

The main advantage of tower silos, apart from their use for mechanical feeding, is that nutrient losses are less

* Harper-Adams Agricultural College.

than with trench or horizontal silos. The following table, based on American work, gives some idea of these relative losses :

Type of Silo	*Quantity of Silage Product*
Pit or Trench, no cover ..	100 tons
Pit or Trench, plastic cover	114 tons
Concrete Tower Silo ..	126 tons
Steel Tower Silo, gas-tight	131 tons

It is essential in this country, if fodder crops are to compete with cereals as the main basis of livestock rations, that nutrient losses during conservation be reduced from 30 to 40 per cent., typical with surface silos, to 10 per cent. or less.

The mechanical feed set-up is shown diagrammatically in Fig. 1, which gives the relationship of the 20 ft. by 40 ft. high concrete stave silo to the 52 ft. by 50 ft. covered cattle yard. This is designed to fatten 38 animals at a time.

Filling the silo with maize harvested by means of a chopper forage harvester is undertaken with a P.T.O. driven forage blower. Mechanical unloading wagons are used to convey the chopped material from the field to the silo.

Unloading of the silage is undertaken by a top unloader, driven by a 7-h.p. motor, which is suspended just above the surface of the silage by three-point suspension steel cables. A single auger rotates around the silo and conveys the silage to a central blower, which discharges the material by means of a spout through a series of openings running down one side of the silo. These openings lead into a chute down the outside of the silo, and this directs the silage into a hopper above a 7½ in. auger. The latter is driven by a 3-h.p. motor, and the drive from this is used to operate the concentrate feed hopper mechanism. (For larger units a bulk store for the concentrates, with a small auger to feed into the hopper, could be used, but with the College unit the small hopper is sufficient for the concentrate used at one feed.)

The finely-chopped silage and concentrate is mixed in the enclosed part of the auger before it is conveyed to the open auger in the cattle yard. This mixing of silage and concentrate is an essential feature of the system at Harper Adams.

The amount of feed per head of stock is controlled by adjusting the height of the auger above the boarded floor of the manger. On a commercial scale only the auger and floor is needed, but at the College manger divisions and automatic ties have been installed to allow other feeding trials to be conducted in the same yard.

An 11 ft. wide area on either side of the manger is kept clear of muck by a tractor squeegee. A straw-bedded area, separated from the unstrawed by a 12 in. high brick wall, is on the outside, and the animals lie back on this and then come forward for feeding. The system has operated very successfully and has reduced straw requirements to less than a half of that normally needed.

Feeding the daily ration of 80 lb. of maize and 4 lb. of supplement (which has given liveweight gains of 2½ lb. per day at a cost for feed of 1/- per lb. liveweight gain with 8–10 cwt. Hereford cross-bullocks) takes 10 minutes each night and morning. This allows sufficient time for the stockman to inspect the cattle and check the water bowls, etc., whilst the machinery is operating.

Although the unit described above is experimental, it illustrates the main features of mechanical feeding as it is likely to develop in this country. A similar set-up comprising four tower silos and a partly open yard has been erected in Oxfordshire, and after preliminary trials last season should be operating this winter.

An alternative system is one familiar to visitors to the Royal Show at Cambridge—namely, the use of a steel plastic-lined silo (Harvestore type) with a bottom unloader. The latter method is not so efficient, in my view, as the top unloader, as it is more difficult to get at when mechanical breakdowns occur. The claims for this type is that it can be filled continuously. A series of concrete stave silos can achieve the same results.

However, the main disadvantage of the steel glass-lined type is its high capital cost. This also applies to a lesser degree to all the mechanical feeding arrangements at present available in this country. The main reason for this is that the equipment used at present in America. As such it has to cover higher U.S.A. costs of production freight charges and import duties.

At present, unloaders cost in the region of £400–£500 and augers around £3 per foot run. These costs should be reduced considerably when—you note I do not say if—manufacturing takes place in this country. Similarly, the cost of concrete stave tower silos will come down, and a reasonable figure would be of £1,000 for a 300–400 ton silo ; *i.e.*, £3–£4 per ton stored. This is about the same —or less in some cases—than storage in Dutch barn silos.

I have said little on hay feeding. Blae handling equipment is now becoming commonplace and quick methods of hay feeding will, no doubt, be developed.

I cannot see a great future for chopped hay (chopped straw will become more popular, I think), but the use of forage boxes or mechanical unloading wagons may encourage it. Incidentally, I did not mention the use of forage boxes for feeding silage. This is already practised on some farms and is likely to increase.

The main problem at present is the economic one of lowering costs. Another factor to be considered is the health of the stock, and I should like to see far more joint work being undertaken by agricultural engineers, farm building specialists and animal husbandry workers to determine the effectiveness of these systems to our conditions. I consider further mechanisation of fodder feeding will be essential in the incrreasingly competitive days ahead, but it is a field in which we want to tread warily and not merely slavishly copy American and Continental systems.

In conclusion, I consider that if the price is right then I am sure that—based on our experience at Harper Adams—mechanical feeding systems are right for stock and stockman.

WORK STUDY APPLIED TO GRAIN HARVESTING AND STRAW HANDLING

by I. J. Fleming, A.M.I.Agr.E., and J. D. Cunningham, A.M.I.Agr.E.

DURING the 1959 harvest a study was made of harvesting operations on 31 farms in south-east Scotland. The aim of the investigation was to examine, and by application of Work Measurement techniques, to evaluate existing practices ; to study new and alternative methods and to compare them in the same manner with established practices ; and, finally, to recommend ways in which time spent on harvesting can be kept to a minimum when using existing machinery.

The investigation fell naturally into two parts—combine harvesting field work and pick-up baling.

COMBINE HARVESTING FIELD WORK

This necessitated a study of the machines as well as the method of operation.

Machine

It soon became evident that a number of combines fell short of the ideal, which, among other features, should have :

A high threshing capacity, with some indication visible to the driver of ability to handle crop under conditions which frequently vary widely from time to time during the day.

A wide cutter bar associated with an adjustable near-side divider to help to minimise operator fatigue.

A carefully-positioned driving seat and controls to enable a smooth and effective hand and foot rhythm to be developed for changing direction at corners.

The size of the enterprise and the facilities at the steading influence the choice between a bagger and tanker combine. It would seem, however, that there is little to justify the employment of a bagger model, and the practice of filling bags and dropping them in groups of two or three all over the field has nothing to commend it. Where grain must be handled in bags, the bagging platform should be of sufficient size to hold the produce of a round and be at such a height that the bags can be shot straight on to the trailer which is going to carry them to the steading. Better still, the grain should be bagged directly from the grain tank spout on to a trailer drawn alongside.

Operation

The total time spent harvesting may be divided into " working time," of which not all is effective, and " out-of-work time." Ineffective working time and out-of-work time, then, are sources of potential loss which deserve detailed study.

Effective Working Time

Depending on the width of cut, a definite distance has to be travelled in order to cut and harvest a given acreage. The condition of the crop will determine forward speed.

Ineffective Working Time

In many instances, combines are not driven as fast as crop conditions permit, usually because the operator is in ignorance of the state of loading of the threshing mechanism.

Moreover, by not utilising the full width of knife, extra rounds—and hence extra turns—are made. Even more serious, stubbles which are recut during a subsequent round enter the mechanism as 2–3 in. straws to produce a cavings build-up which depresses the throughput.

Out-of-Work Time

So long as a combine has to harvest all the grain within a fixed area, there must be time spent out of work when changing from one line of travel to another.

A systematic examination of out-of-work time caused in this way reveals that attention must be paid to methods of opening the field and subsequent cornering practice. The type of cutting pattern, also, is worthy of detailed study.

Opening

Very few operators of trailed combines nowadays open their fields by hand, and for machines over 6 ft. cutting width, machine opening should be employed. Where the crop is very ripe and liable to shed, the " Inside Out " opening and cutting pattern (see below) has much to commend it, because it involves the minimum knock-down area.

Cornering

Various cornering methods were examined, and under most circumstances it was found that by using a reverse turn out-of-work time at corners was kept to a minimum.

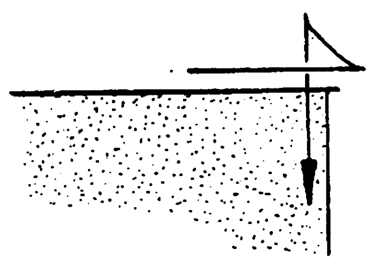


FIG. 1.

Reverse Turn

The quickest turn for corners greater than 60 degrees.

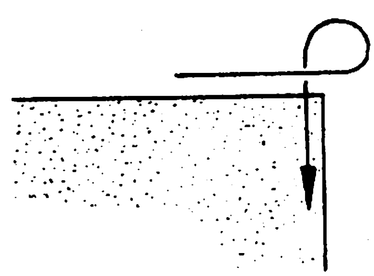


FIG. 2.

Loop Turn

Best employed where the corner is less than 60 degrees.

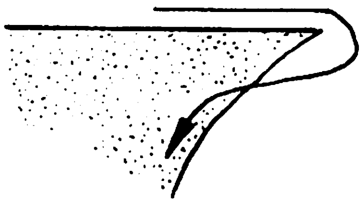


FIG. 3.

Swing Turn

Most suitable for binders and trailed combines.

Involuntary Cornering

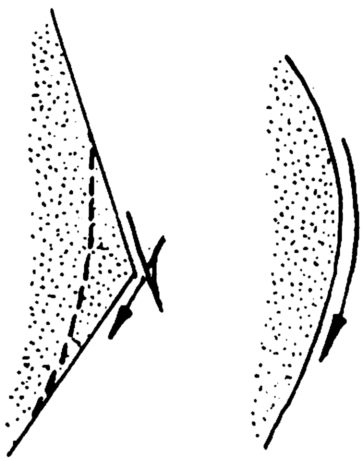


FIG. 4.

During the course of cutting a field having a curved side, a corner may form due to lack of care. If more than five rounds remain to be cut, time should be taken to eliminate the corner and regain the curve.

A point is reached when it is no longer worth cutting along the short side, that is when the time taken to run idle in the headland is less than that required to make two turns. In very many cases observed, cutting the short side continued long after sliding should have begun at 35–50 yards.

Another advantage of sliding the short end is that it is the quickest way to reduce the number of corners by one and hence the out-of-work time.

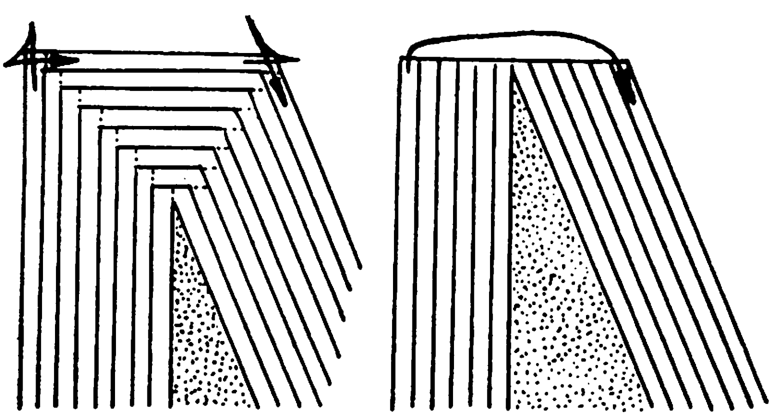


FIG. 5.

Cutting Patterns

Any cutting pattern which reduces the number of corners or makes cornering easier and quicker reduces out-of-work time. Various patterns were examined and their effectiveness compared with the conventional Round and Round method.

Round and Round

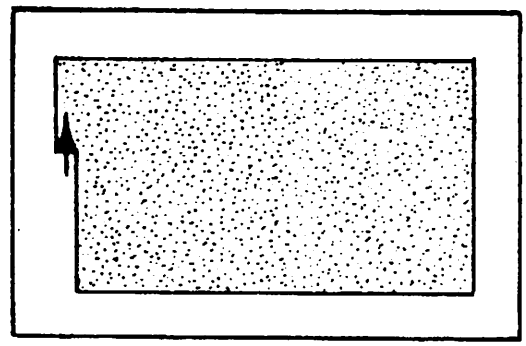


FIG. 6.

The most common cutting pattern in use whereby the field is cut round and round in a clockwise direction from the outside to the centre, using Reverse or Loop turns at corners.

It is suitable for self-propelled and trailed combines and can be used in any shape of field where the crop is standing. No pre-harvest planning is needed. If reduction in out-of-work time is important, replacement by another pattern should be considered.

Bisectors

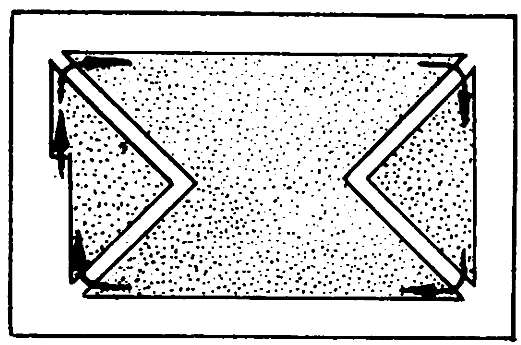


FIG. 7.

A method of cutting which relies on sufficiently wide strips being cut out of the corners to allow the combine to change direction by simply driving round the corner. This pattern has erroneously been called " Diagonals," but it must be emphasised that the strips cut into the field from the corners are " *Bisectors*," being only diagonals in a square field.

This method is most suitable for a single S.P. combine working in a regularly shaped field of four or more sides. Extreme accuracy in layout and subsequent cutting is essential to obtain the two-thirds saving in out-of-work time which is possible.* If through "losing" the Bisectors, resort has to be made to conventional Reverse or Loop turns, an increase rather than a saving in total time will result.

Inside Out

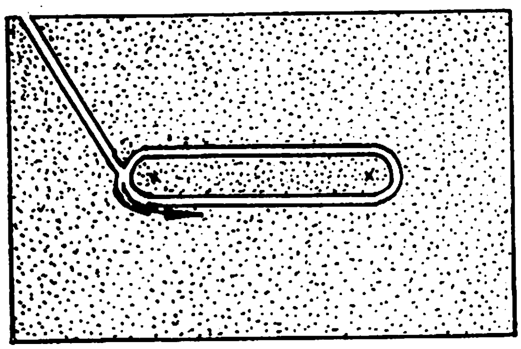


FIG. 8.

A cut is taken from the gate to the middle of the field, where, depending on field shape, the smallest possible circle or oval is cut in an anti-clockwise direction. Cutting then continues in ever-increasing circles until the fences are reached at the sides and ends of the field. Finally, the triangles in the corners are cut out.

This pattern is recommended for square and rectangular fields and for any of regular shape with more than four corners, but is unsuitable for triangular fields. Its usefulness as a cutting pattern is reduced in tapering fields, or those with projections or peaks, or where one or more corners are less than 90 degrees. Since 80 per cent. of the field can be cut without having to stop, it is to be recommended in gale conditions where there is a risk of shake.

Lands or Strips

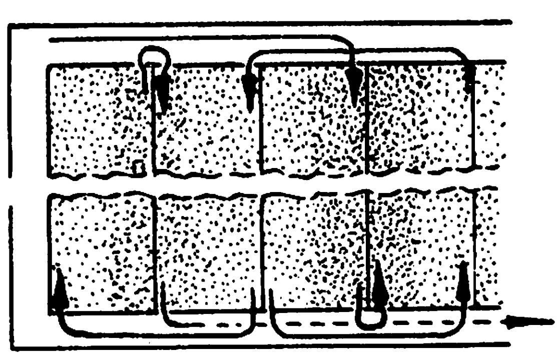


FIG. 9.

A system of cutting in sections, each 24 yards wide, alternately gathered and scaled with the direction of cutting parallel to the longest side. The headland should be about 30 ft. wide. It is suitable where a number of different self-propelled combines are working in large or long, narrow fields. Out-of-work time may not be appreciably less than for Round and Round if inaccuracies occur, but savings up to 15 per cent. are possible.

To and Fro

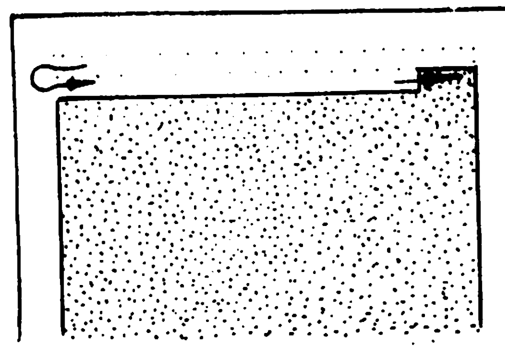


FIG. 10.

A method of cutting backwards and forwards along one side (generally the longest) of a crop, employing 180 degree Shuttle turns at either end of the cutting face. It is most suitable for a single self-propelled combine where the out and back journey yields a tankful of grain. Compared with Round and Round, a 15 per cent. saving in out-of-work time is possible.

Where a wide cut combine is working in an elongated field, opportunities for saving of time are limited. With a narrow cut machine, however, working in a square field time can easily be wasted and the scope for economy is great.

Transport

A greatly increased rate of harvesting is the reward for careful planning of bulk grain transport from field to steading. Most combine grain tanks fill in about 15 minutes, and empty in about 1½ minutes, giving the trailer 15 minutes for the round trip from field to steading.

Many factors influence the speed of this journey and several which are within the control of the farmer deserve careful study :

(*a*) A rough farm road forces a reduction in speed, particularly on the return journey, when empty.

(*b*) Trafficators increase safety and help to eliminate time lost when making a right-hand turn from a busy thoroughfare.

(*c*) A flat and straightforward approach to the grain intake pit is essential.

(*d*) When two or more trailers are serving two or more combines, forced combine stoppage and unnecessary trailer travelling time can be avoided if an effective signalling system is adopted. Whatever system is employed, it must be visible from the gate so that the returning empty trailer can go first to the combine with the fullest tank.

(*e*) The round and round cutting pattern necessitates the greatest amount of grain trailer field running, whilst the inside out and to and fro provide the least, though this is only true of the to and fro system where the out and back journey from the gate yields a tankful of grain.

(*f*) Turn-around time at the steading can be reduced by the use of an automatic opening and closing rear door to the trailer so arranged that the tractor driver does not have to leave his seat during the unloading operation.

No one factor in operation or cutting pattern offers a spectacular saving, but by paying attention to detail, substantial cumulative economies can be made in harvesting time, amounting in some instances to as much as 40 per cent.

* Work Study Report on Combine Harvesting. No. 1—Field Work, by I. J. Fleming and J. D. Cunningham, contains detailed descriptions of the cutting patterns described and is available on request from Scottish Agricultural Industries, Ltd., 39, Palmerston Place, Edinburgh, 12.

Open Meeting at Smithfield Show, 6th December, 1961

A Paper on

Agricultural Engineering Problems in Australia

will be presented by

Professor A. H. WILLIS, Wh.Sc., B.Sc. (Eng.), Ph.D., M.I.Mech.E.,

at 4 *p.m. in the Cromwell Hall*

The Paper will give a broad picture of Australian farming conditions, emphasising the geographical, climatic, economic and social factors that govern agricultural engineering problems ; also the characteristics of the farm machinery industry. Examples from fodder conservation practices, tillage methods and materials handling will be described as evidence that European machinery is often quite unsuitable for Australian conditions. The development of agricultural engineering as a profession will be discussed. An important factor is Australia's lack of educational programmes for agricultural engineers, but a turning point has been reached in the new degree course offered by the University of Melbourne. This course must be supported by others devoted to training at the diploma level, and the nature of these diploma courses will be discussed. Advisory work, while extensive in agronomy and animal husbandry, is almost non-existent in agricultural engineering. Research is carried out in a few centres, notably in the universities of Western Australia Melbourne and New South Wales, and also by the Commonwealth Scientific and Industrial Research Organisation.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& LUBRICANTS
keep all your machinery going
Esso
Esso
You want the best
-Esso make it!

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Approved by Council at their Meeting on 26th September, 1961.

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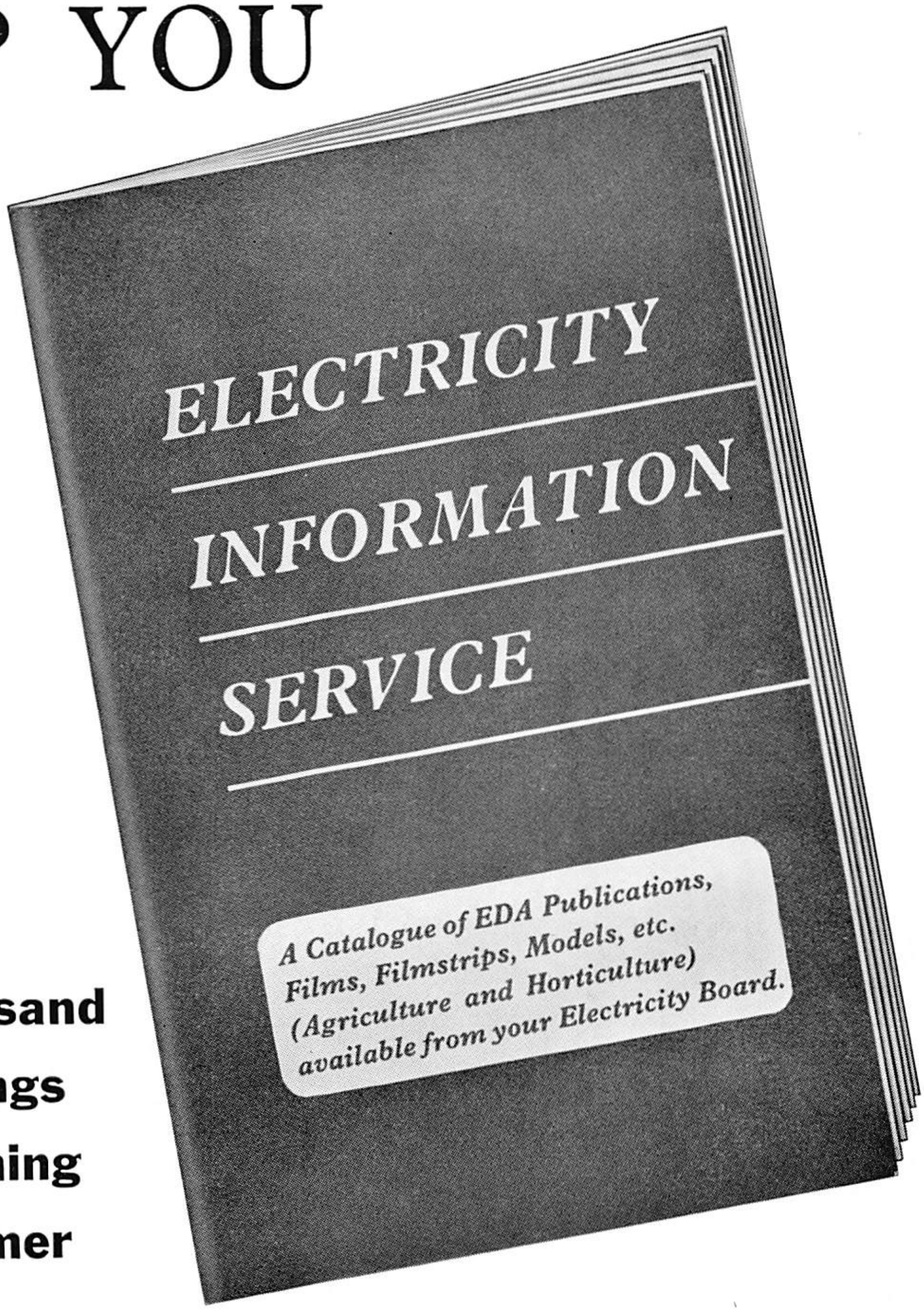

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