to live with a precarious water supply, and in dry times might have to cart even his domestic supply from some distant water-hole, while a little intelligence and "graft" might construct for him a reservoir in the nearest gully, and a windmill and pump would thence irrigate a patch of lucerne that would keep his stock alive in drought times.

Of coure, this meant hard work and expense, but the amount of labour that had been expended on agricultural lands in old countries, to bring them to their present condition, was sometimes hardly realised. Engineers could do much to lighten this labour, or rather to produce more immediate results, but in primary industries "nihil sine labore" always held good, however otherwise it might be in the world of finance and commerce.

The ordinary small reciprocating steam pump was a great waster of power it worked with little expansion of steam, and the friction and eddying in the intricate pump chamber and passages and the starting or accelerating the column of water at every stroke caused a great dynamic loss, increased often by two small delivery pipes and right-angled elbows at bends.

There was plenty of room for improvements in small pumps of all classes , especially steam pumps ; we were too often satisfield if they worked at a slow speed. They might be made to work quietly and efficiently at much higher speeds by applying to their design ronsideration of how fluids in motion behaved and should be treated. The monstrosities in massive cast iron that were to be seen at agricultural shows were awful examples of how not to do it.

The implements used in the preparation of the land to receive the water—the earth-scoops, ploughs, surface, subsoil, and draining, cultivators, etc.—were of high interest to engineers, and he thought a few of our meetings devoted to Engineering in Agriculture would be highly profitable. If we did not yet come up to the "ancients" in irrigation, the multiple-furrow plough was a notable development of the

"cas chrom" or crooked foot of the Scottish aborigines, and the progress made whereby the thrashing of grain was now carried out by high-class steam machinery should somewhat console us.

MR. W. H. GERMAN said that the author had pointed out that irrigation would make but little progress in these States, unless institutions such as ours imparted information on the subject. It was not, however, an easy matter to furnish the particulars required by the "Man on the Land," be he squatter, farmer, or orchardist; this was mainly because of the extremely varying conditions to be complied with, but if light were thrown on the matter, either by the paper under review or the discussions thereon, the purpose of the former would have been served.

The first questions the proposing irrigator would ask were:—What will be the cost and will it pay? Who could answer the questions? Certainly not the average farmer or squatter, who might see millions of tons of water running through his property to the sea or to waste. He might have a hazy idea that the stream might be dammed or the water lifted by pumps, but he could form little idea of the distance the water could be thrown back, and of the area to be served, and the cost of pumping he knew less. He could certainly ascertain the price of pumps and engines, but what result he could obtain from the land was still an enigma to him; neither could the machinery merchant or manufacturing engineer answer the questions. They could quote the price and capacities of plant, but they lacked the knowledge of the contour of land, the nature of soil, climate, and other conditions that needed weighing, before a reliable decision could be given. It was here that the irrigating engineer should act as the medium, but to be a success he should, accordnig to a most eminent authority, have a practical knowledge of agriculture.

In the speaker's opinion, irrigation, or water conservation, if attempted in these States on too large a scale at first, would be foredoomed to failure. It was very well in densely populated countries, where produce could and must be raised by cheap labour, to feed the frugal living natives; but that the staple products of Australia could be largely assisted by such means was extremely doubtful. For instance, the cost of raising "cereal crops" by these artificial means would prohibit their competing with similar produce grown under natural conditions.

Crops that are suitable for irrigating on the "furrow" system can, however, hope to compete in the world's markets, such as maize, sugarcane, sorghum, and fruits. Irrigation must, however, in the first instance be tackled with the view of enabling the operator to tide over the drought periods. For the purpose of explaining the method of ascertaining the cost and return of an assumed pumping scheme, he desired to make the following rough statement.

STATEMENT OF ASSUMED ANNUAL COST AND RETURN OF IRRIGATION PLANT FOR 75 ACRES SEWN WITH LUCERNE.

The plant to consist of a portable engine and 6″ centrifugal pump costing, say, £500, ready for work and capable of supplying the land with 3 inches of water every second week, or 6 inches per month=72″ per year.

Assumed height of lift from water level to top of bank, 20 ft.

CREDIT.

6″ Pump will throw 800 gallons per minute.

„ „ 48,000 „ „ hour.

working 8 hours per day=48,000×8

or, 384,000 gallons per day.

6″ of water per acre=134,400 gallons.

then $\frac{384\,000}{134,400}$=2·8 acres watered per day.

Say, 3 „ „ „

So, 1 if day's pumping suffices 3 acres for a month,
then 12 „ „ „ 3 „ for a year.
or, 300 „ „ „ 75 „ „ „
With good land, well irrigated, 1 acre should produce 7 tons of hay.
So, 75 acres should produce 525 tons of hay.

DEBIT.

lbs. ft.

800 gallons per minute lifted 20ft. high $\frac{8000 \times 20}{33{,}000} = 4.8$ water horse power.

or, say 10 I.H.P. required.

@ 10lbs. wood per I.H.P. per hour.

= 100lbs. wood per hour.

100 x 8=800lbs. wood per day of 8 hours,

or, say, ½ ton wood per day @ 8/- = 4/-
Fireman's wages = 6/- } 10/- per day.

Then, 10/- per day=per year £150
10% interest and depreciation (on £500) 50
£1 per week to water attendant 52
£252

For an expenditure of £252 per annum 525 tons lucern should be grown.

or, $\frac{252 \times 20}{525} = 9/6$ per ton.

According to E. V. Wolff (a well-known authority) a sheep in good condition will do well on 3lbs. meadow hay per day.

Say. 2½lbs. lucerne hay per day.

2½ x 365=917 lbs. per year.

and $\frac{525 \times 2240}{917} = 1282$ sheep fed for 1 year.

(say, 1280 sheep.)

In the above estimate, nothing was debited by the speaker to the cost of preparing or sowing the crop originally, or for

harvesting it, as these items would vary greatly owing to circumstances. On the other hand, however, it was highly improbable that so much as 72in. per year would be required, therefore the quantity of water allowed for should suffice for a much larger area than 75 acres.

This statement had not been prepared so much with the intention of showing that irrigation, under the conditions assumed, would pay, but more with the view of illustrating to a landholder a simple method of calculating the cost and return.

According to the foregoing statement, 75 acres would feed 1280 sheep (or about 17 sheep per acre). The author had, however, mentioned a case where 75 sheep per acre had been carried.

To illustrate the varying conditions to be met with, it was evident that if the lift were only 10ft., double the amount of water would be thrown for the same power (the same cost of plant nearly, an 8in. or 9in. pump being required), with the same engine watering double the area at same cost, because the cost of water attendant for opening and closing the "checks" would be almost a negligible quantity.

To those interested in irrigation, the speaker commended a recent work by F. H. Newell on the subject as practised in the United States.

MR. CLARKSON, in reply to the criticism on his paper, said Mr. Finlayson, in the course of his remarks, told you a story about a squatter who had ordered a pumping plant. He would also tell a story in connection with the same thing. On the opposite side of the river, on the station where he was then employed, there was a gentleman who thought he would go in for irrigation, and he applied to him for some information thereon. He gave him particulars with regard to a plant, the cost of which would be about £400—just a small arrangement. The squatter then left for Sydney with the full intention of buying that plant, but while on

the journey, an inch of rain fell, and his son wired him that they had had a splendid fall of rain. When he (the speaker) next met him he was informed the pumping plant was not wanted, as there had been a fall of about an inch of rain, and the money had been invested in a bull instead.

Mr. Finlayson had dealt with windmills, but his (the speaker's) experience was that the small farmers did not appreciate them at all. There were relics of windmills to be seen in every town, and farmers did not renew them as they ought to do. Sometimes they did not get enough water out of a windmill to supply a plunge bath. Mr. Finlayson had spoken with reference to the power used in irrigation. He (the speaker) had not touched on the subject of power. What he intended the outcome of his paper to be was that its discussion should lead up to the question of power. What he wanted to point out was that there was a simple way of irrigation. Reference had been made to the Mole plough as a draining implement, and he (the speaker) might point out that this type of plough had been used on the Duke of Sutherland's Scottish estates, the shell of the plough having a diameter of 35 inches, and the drains thus made had stood good for many years. The lands were thoroughly drained, and it was also found that the work was done simply and cheaply.

The speaker, in concluding, referred to a recent book by Mr. Willcox, an American authority on irrigation, and expressed the opinion that by a system of sub-irrigation a smaller quantity of water was required, and the farmer would reap the greatest benefit from it. It did not cost so very much—from 1d. to 1½d. per chain being sufficient.

THE PRESIDENT said it seemed to him that the question of irrigation must naturally follow the question of population. They could not expect very much to be done in any direction,

more especially in the back country, until it was more thickly populated. There was no doubt a great future before irrigation in Australia, but unless more people were got on the land, that future must be deferred. The countries that were best irrigated, were those most thickly populated.