MECHANISATION AS APPLIED TO THE SUGAR FARM

A BRIEF DISCUSSION OF THE POSSIBILITIES AND IMPLICATIONS

By A. D. GOBLE.

Introduction.

The first consideration necessary in dealing with this subject is an understanding of the meaning and implication of the word mechanisation. A literal interpretation is that "Mechanisation is the introduction of mechanical equipment to do the work formerly done by other methods." This is true, but I submit that there is also implied either a reduction in the cost of the final product, or that the quantity or quality thereof offsets a slightly increased unit cost.

There has been a tendency in the past years towards mechanisation in the sugar industry; but today, with high wages, shortage of labour and ration difficulties, the planter is faced with the urgent and immediate necessity of reducing his dependence on native labour to an absolute minimum.

General.

Mechanisation is progressive and, generally speaking, can be divided into two stages. The first is the simple substitution of mechanical power for animal power, and the second stage is the adaptation of techniques and the development of new implements to take full advantage of the potentialities of the mechanical power.

In the main the first stage is complete in the sugar industry, and it now remains for the second stage to be considered and introduced. In the following paragraphs I intend to deal with the clearly defined operations connected with the preparation and reaping of a crop of sugarcane, and to discuss briefly the implements and techniques which are at present in vogue or may in the near future be introduced.

Consideration.

This paragraph may appear, at first sight, to be outside the province of this paper, but I assure you that the success of the entire scheme will depend on the knowledge and forethought applied to the selection of the field before ever a sod is turned. To illustrate, the track type tractor is the basic machine selected for the entire scheme, owing to its versatility and also its ability to operate satisfactorily on the mild to severe hillsides which are synonymous with sugarcane fields in Natal and lower Zululand; there is, however, no reversible plough available which will adequately load the smallest of these machines. Consequently, if a field has to be laid out on a hillside it is necessary, in laying it out, to take the whole hill in belts where this is remotely possible. This will effect a saving of approximately 33 per cent. lost time running light when a fixed plough is used on one face of the hill. Similarly, the routes to and from the field should be studied to ascertain if the crop can be taken off economically.

It is appreciated that the quality and productivity as well as the acreage available are usually the determining factors in selecting a field, but an examination of the above points might well suggest a layout that would be economical as well as practical.

Assuming that this has been done, let us examine the types of implements and attachments that can be used in the various operations.

Breaking-up.

(1) *Virgin land.* There are two methods of accomplishing this object, namely, ploughing or heavy harrowing. Both have been field tested and have proved satisfactory. The heavy harrow outfit, however, from its ability to do good work on hillsides with only fractional lost time, has a decided advantage which is clearly shown on the cost sheet.

(2) *Trashed cane field.* The above two methods are also possible under these conditions, except that the harrow outfit has to do an additional operation to flatten and cut up the trash before ploughing it in. This should be done six to eight weeks before the actual ploughing-in commences.

Harrowing.

A heavy harrowing is necessary after ploughing and a light operation after the heavy plough-harrowing, in order to obtain a fine tilth. For the heavy harrowing a four-gang tandem cover crop disc harrow is necessary, and for the light operation a one-way disc or the cover crop harrow with half angle is suitable. I would recommend the cover crop style in view of its versatility.

Ridging.

A "tool-carrier" capable of having mounted on it one or two ridger attachments, also various cultivating and panbreaking attachments, is the most suitable equipment for this operation. From field trials the double ridger is only really satisfactory on flat land or very gentle slopes.

An improved ridger developed by the Natal Estates deserves special mention. It consists of the basic carrier unit, but the standard on which the ridger

wings are mounted has been greatly strengthened and is longer than the ordinary unit. A renewable point is attached to the toe of the standard with the ridger wings about 6 to 8 inches above its lowest point. The object of this implement, which is accomplished, is to shatter the soil directly below and to both sides of the bottom of the furrow, thus combining both ridging and subsoiling.

Planting and Fertilizing.

Up to this point all the operations are in vogue; but now new and, in the main, untried methods are to be discussed.

The obvious advantage, both from a point of view of germination and economy of opening the furrow, introducing the sett, applying fertilizer and covering-in being combined in a single operation, suggests the development of the ridger equipment to incorporate these additional attachments. The illustration below shows the type of equipment used on a sugar estate in Hawaii.

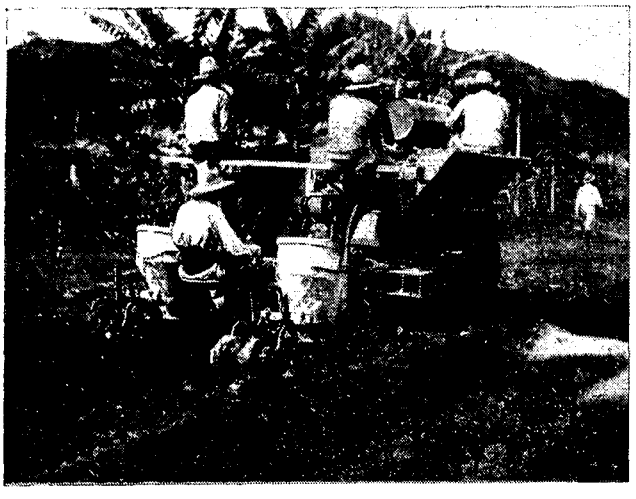

FIG. A.—DIRECT CONNECTED PLANTER MOUNTED ON 30 H.P. CATERPILLAR.

It will be noticed that the cane is already cut into suitable lengths before being placed in the hoppers. This cutting is done manually from selected cane, and would be neither efficient nor economical if incorporated in the planter. The introduction of the fungicidal treatment of the sett also suggests that cutting and dipping be done manually.

Weeding.

A light wheel tractor has been given field trials in this operation. It incorporates suitable standards and points or sweeps coupled to the tractor, but, although it has the advantage of high clearance, its use is limited by hillsides, broken ground and drainage ditches.

A toolbar direct-coupled to the crawler tractor, raised or lowered by tractor power, and carrying the necessary standards and sweeps, will soon be available.

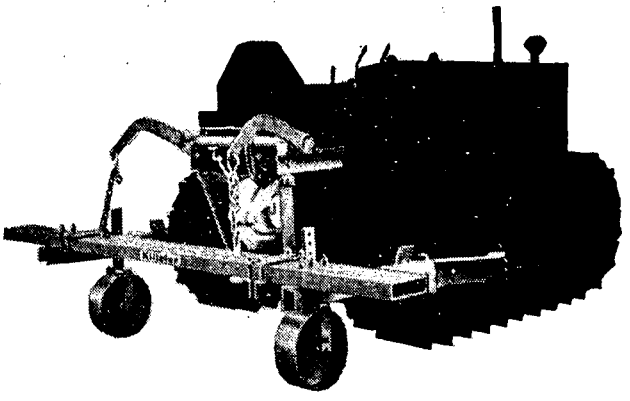

FIG. B.

From the above illustration it will be seen that the tool is set to trail directly behind the tractor and cannot "fall away" on hillsides and so damage the young cane. Another advantage of this implement is that it can operate satisfactorily in restricted headlands.

Irrigation.

The initial cut for the average furrow can be made with a ditcher drawn by the tractor.

If direct or surface irrigation is required the tractor, with belt-pulley attachment, can power the pumps; should, however, overhead irrigation be desired, then a pump can be mounted on the tractor with the spray nozzle on a platform 8 to 12 feet above the tractor and the suction hose made to trail in the furrow. This unit is mobile and water can be sprayed out up to 200 feet either side of the furrow. Up to 1,850 gallons per minute can be delivered with the above units.

Cane Cutting or Harvesting.

There are at present in use in Australia and Louisiana two distinct types of machines for this purpose. From recent reports[1] on the operation of these machines various advantages and disadvantages are apparent, and it is well to indicate these to appreciate fully what the industry is faced with in this respect.

Advantages.

1. Dependence on native labour is reduced to an absolute minimum.

2. The large capacity of the present harvesters would allow the average planter to take off his crop in a very short period, thus taking advantage of the high sucrose content obtaining during August, September and October.

3. Cutting costs should be considerably reduced.

Disadvantages.

1. No provision is made for trashing; this is burnt off.

2. Only reasonably straight cane can be harvested.

3. The capacity of the existing harvesters, approximately 200 tons per eight hours, is too large for the average planter and would mean a drastic reorganisation in the transport system for the large planter.

4. Most harvesters require flexible wheel transport to remove the cut cane.

5. Greater milling capacity would be required with longer "shut-down" periods.

The above apparently condemns the mechanical harvesting of sugarcane in this country, but it should be realised that the existing machines have been developed each for a specific set of conditions, neither of which even approximates those in this country. It is my contention that, with study and experiment, a satisfactory unit could be developed for South African conditions.

Loading.

In the field. The illustration shows mechanical loading with crawler cranes in the Hawaiian Islands. Here again our conditions will not allow the use of these machines. The method can, however, be applied, and the crawler tractor with a crane mounted on it appears to be the solution. Field trials will be taking place at the beginning of the season, and preliminary cost figures indicate a probable saving of approximately 25 to 33 per cent. in units of labour.

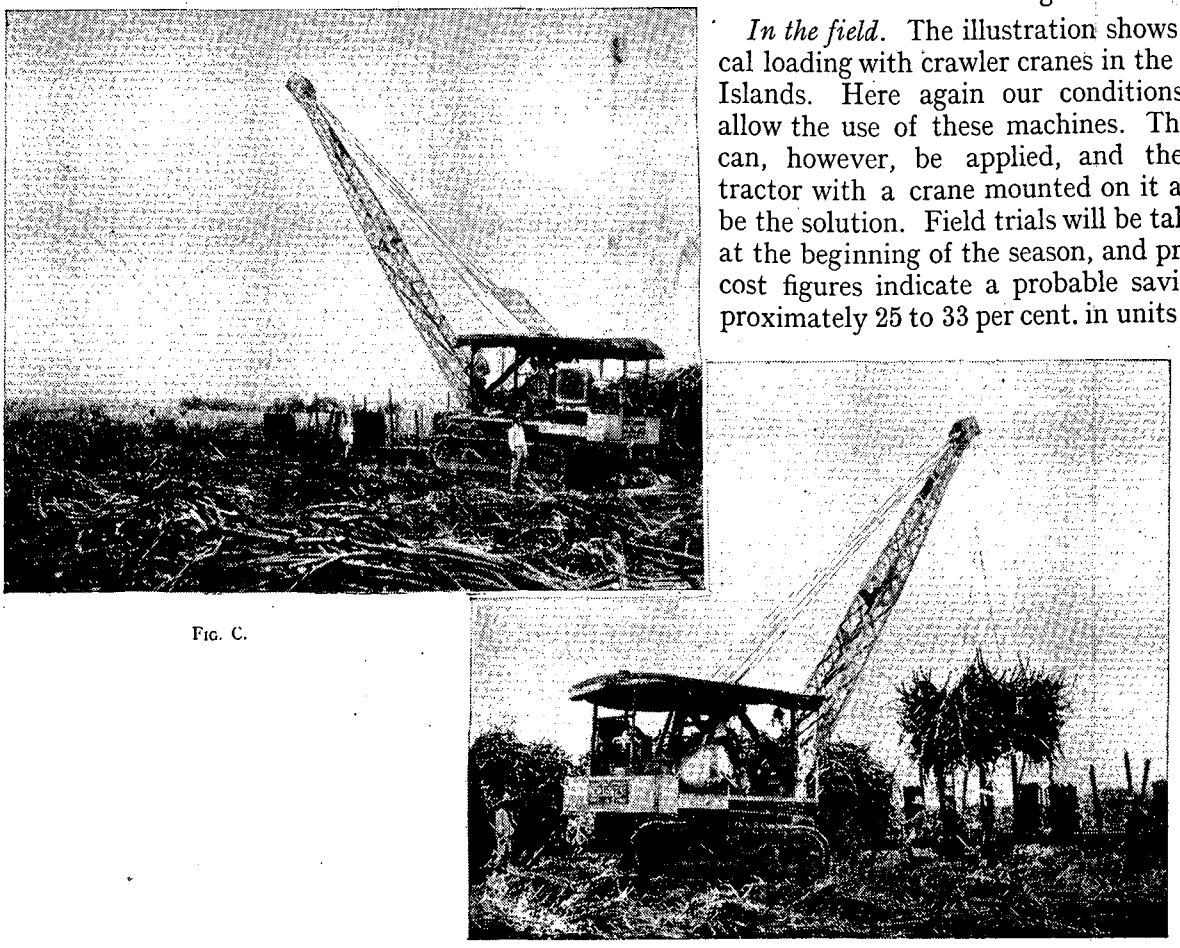

FIG. C.

SCHEDULE 1.—**Estimated Hourly Costs of Owning and Operating various sized Outfits.**

Size of outfit	25 h.p.	35 h.p.	(1) 55 h.p.	(2) 55 h.p. with Heavy Harrow.
Total estimated cost of outfit	£1,018	£1,291	£1,950	£2,040
Fixed and operating costs per hour—	s. d.	s. d.	s. d.	s. d.
Depreciation (over 10,000 hours)	2 0	2 7	3 11	4 0
Interest (5 per cent. on average investment)	0 6	0 8	0 11	1 0
Repairs (including labour)	2 0	2 7	3 11	4 0
Fuel—Diesel	1 2	1 9	2 1½	2 1½
,, Petrol	0 3	0 3	0 3½	0 3½
Lubricating oil	0 4	0 5	0 6	0 6
Grease	0 3	0 4	0 5	0 5
Operator	1 0	1 0	1 0	1 0
Total fixed and operating costs per hour	7 6	9 7	13 1	13 4

SCHEDULE 2.—**Estimated Cost per Ton of Cane Produced for Ploughing, Harrowing and Ridging.**

Acreage per season	75				100				150			
Size of outfit—horse power	**25**	**35**	(1) **55**	(2) **55**	**25**	**35**	(1) **55**	(2) **55**	**25**	**35**	(1) **55**	(2) **55**
Total acreage ploughing	225	225	225	300	300	300	300	400	450	450	450	600
Acres per 8-hour day	3	6¾	9	15	3	6¾	9	15	3	6¾	9	15
Days ploughing	75	34	25	20	100	45	34	27	150	67	50	40
Total acreage harrowing	225	225	225	75	300	300	300	100	450	450	450	150
Acres per 8-hour day	6¾	13½	27	27	6¾	13½	27	27	6¾	13½	27	27
Days harrowing	34	17	9	3	45	23	12	4	67	34	17	6
Total acres ridging		75				100				150		
Acres per 8-hour day	3	6	8	8	3	6	8	8	3	6	8	8
Days ridging	25	13	10	10	34	17	13	13	50	25	19	19
Total days all operations	134	64	44	33	179	85	59	44	267	126	86	65
Total weeks (5 dys.) all operations	27	13	9	7	36	17	12	9	54	26	18	13
Total hours all operations	1,072	512	336	264	1,432	680	472	336	2,136	1,008	688	520
Cost per hour	7/6	9/7	13/1	13/4	7/6	9/7	13/1	13/4	7/6	9/7	13/1	13/4
Total cost	£402	£245	£220	£176	£537	£326	£309	£224	£801	£483	£450	£347
Yield over 3 crops (tons)		5,625				7,500				11,250		
Cost per ton	1/5	10½d.	9½d.	7½d.	1/5	10½d.	9½d.	7½d.	1/5	10½d.	9½d.	7½d.

From lorry or wagon to railway truck. Either the travelling gantry or jib crane can be used for this purpose, although here again the tonnage to be handled per season would be the deciding factor from an economical point of view.

Hauling.

Hauling cane over tramlines is the most economical method where the running costs alone are considered. Where, however, the question of laying spurs to a number of fields to be cut, maintenance of track and length of carry from field to truck are taken into consideration, then the alternative methods of lorry and wheel or crawler tractor haulage should be closely studied.

Generally speaking, crawler tractor haulage is the most economical method up to three miles; from three to eight miles the wheel tractor or lorry is cheapest; and for distances above eight miles the tramline offers the lowest costs.

It is essential to bear in mind that these suggestions are based on estimated average costs and that each application should be treated on its peculiar merits.

Costing.

As stated in the opening paragraph of this paper, costs per unit of production are all-important, and the following figures are given to indicate how these figures are obtained.

Schedule 1.

Schedule 1. illustrates how the cost per hour of the three most generally used outfits is obtained. Each outfit consists of tractor plough, harrow and single ridger unit, with the exception of the last column, where the disc plough is replaced by a heavy ploughing harrow.

Schedule 2.

Schedule 2. shows the costing of the three different operations, namely 3 ploughings, 3 harrowings and 1 ridging against a 75, 100 and 150 acre per annum ploughing-out and preparing programme. The assumption is that the conditions are average hillside with trash on the field. The old cane stools are to be ploughed out and the ground to be prepared for a green crop. This crop is to be ploughed in and the field prepared for cane planting. In the case of the fourth column under each acreage the heavy harrow outfit is used and allowance is made for a double operation before the first harrowing and planting of the green crop, as explained in the paragraph under the heading "Breaking-up" trashed cane field.

It should be seen that true depreciation is taken into account, in that each outfit is only charged with the actual depreciation that it has sustained and not a fixed figure per annum. The yield is based on an average of 25 tons per acre over each of three crops, and the total cost of the preparation is charged against the total yield.

The final figures reveal the following facts ;—

1. The larger the outfit the lower the unit cost of production.
2. The total number of weeks to complete the job indicates the additional time available to do other work.
3. A considered recommendation can be made as to the most suitable and economical sized outfit to employ.

Conclusion.

The cycle is thus complete; but it should always be remembered that any form of mechanisation is dependent on the skill of the operator. This skill can be obtained by the training of semi-skilled persons at some central depot, and I suggest this scheme for your consideration. It is also necessary to bear in mind constantly the balance between quantity, quality and cost, and it is suggested that a qualified consultant for this purpose be employed by the planters.

Summary.

Mechanisation is entirely possible in the sugar farm in South Africa, but a great deal of study and experimentation will be required first.

Means should be provided for the development of equipment and implements for maximum efficiency under South African conditions, and thus reduce the amount of adaptation that is necessary to use implements designed for altogether different applications with the consequent increased costs.

Trained operators must be provided for the equipment.

Reference.

1946 : Mechanical Cane-cutting. S.A. Sugar Journal, **30**, 33.

THE PRESIDENT said that this paper was most appropriate in view of the rising labour costs. As regards mechanical harvesting we have always considered that it should be both mechanical and automatic. He had often wondered whether we were not expecting too much and whether we should not rather try and get a mechanical system of harvesting which was only semi-automatic and did not eliminate the human factor entirely, but would considerably increase the capacity of a single human agent. What he had in mind was, for example, a rotary saw at the end of a handle, driven by a flexible tubular drive which could be used first for topping the cane as it stood and then for felling the cane in a second operation.

He agreed with the author that harvesting machines designed for and used in other sugar producing countries would not be suitable here, but he thought something could be evolved here to meet our requirements. He therefore suggested that the South African Sugar Technologists' Association should attempt to solve this problem.

Mr. DYMOND suggested that instead of topping the cane mechanically in the fields, this operation, he thought, might be done at the mill and the valuable cane tops could then be utilised as a feed or for making compost.

The author of the paper did not mention trailers as a means of cane transport, but the speaker had seen in Louisiana where trailers were used to transport enormous quantities of cane. One of these trailers on rubber wheels carried from ten to fifteen tons of cane and was drawn by a tractor.

Mr. PALAIRET maintained that we were in need of a really efficient planting machine that could deal with cane setts. He did not think that the cost of hand-cutting cane was very much greater than could be expected from a mechanical harvester in this country, but he considered that a great deal could be saved if a more efficient way of gathering the cane could be devised, and that, he thought, was an immediate necessity. Mechanical loading would be most desirable, but he thought that neither the present railway or tramline trucks lent themselves for this purpose and he thought their reconstruction was a prerequisite to mechanical loading, and that would only be done if mechanical loading became general.

He agreed with Mr. Dymond that topping and probably also trashing should be done at a central place, either at the mill site or at the railway siding. The tops could then be used as a feed and the trash for making compost. It was agreed that compost was most valuable but the cost of gathering the trash and tops from the fields often prove to be prohibitive. If this operation could be centralised then compost making would, in his opinion, become economical.

Dr. DODDS considered mechanisation on the cane fields in South Africa had to be developed if South Africa were to keep her position in the world sugar industry. When he had visited Queensland he found it was considered essential that the mechanical cane planter should also cut up the cane in setts. To complicate matters further it was now found advisable in this country for cane setts at the time of planting to be treated with fungicides. He described two types of mechanical harvesters that he had seen at work. The difficulty was to get a machine capable of dealing with the topping operation efficiently. Strangers to the sugar industry who were familiar with the efficient types of harvesters for other crops often wondered why mechanisation had not been applied for this laborious work here. Sugarcane differed very greatly from other crops. Each stick

of cane had to be topped at the right place and the sticks were nearly all of varying length. If it were decided to transfer the topping problem to the factory it would mean increasing the bulk of material to be transported very appreciably and the accumulation of tops at the mill site would soon assume enormous proportions.

Mr. GOODMAN, referring to mechanical harvesting, loading and transport, said that these problems in other fields of agriculture had probably been as troublesome as those of the cane industry, but they had been overcome eventually through determined efforts made by technologists. He thought the idea of cutting cane in this country by means of a circular saw with a flexible drive had distinct possibilities. Before the problem of mechanical harvesting was examined it was necessary, however, to make a close study of the contour of the terrain. Some of the existing types of loading machines might be so altered as to be suitable for loading sugarcane.

Mr. GOBLE, replying to various points raised in the discussion, said that he thought the cutting arrangement suggested by the President was quite feasible, but there was one factor to be constantly borne in mind, namely, that the cost of harvesting would be multiplied by the number of separate operations necessary to harvest the cane. If it was necessary to cut the cane in one operation, top it in another and trash it in a third, the total cost was bound to be high.

As regards trailers the speaker reminded Mr. Dymond that he had referred to them under tractor-trailers. In Louisiana they used six to eight ton trailers, but the terrain was flat and the trailers were not subjected to jack-knifing on steep slopes which could not be overcome. He recently examined the possibilities of tractor-trailers for handling 50,000 tons of cane a year over an average distance of three miles and he compared the cost against lorry transport. The tractor-trailer haulage came to $6\frac{1}{2}$d. per ton mile as against $11\frac{3}{4}$d. for the lorry transport, but the capital outlay was far greater.

As regards equipment specially suited for South African conditions the manufacturer first of all required a reasonable home market. No big manufacturing country would develop equipment especially for the limited South African market. We would have to develop our own equipment according to our requirements. The type of harvester that would top the cane at the same time as felling it was probably the best. The problem, however, required a great deal of study and could certainly not be done part-time. Such equipment had, however, been developed in America.

Dr. Dodds' statement re cutting of setts on the planter itself was quite correct. There were two types of planters which cut the cane itself while conveying it, but his last information was that these types have been abandoned and they were now cutting cane separately and then transporting it in short lengths to the planter.

One speaker maintained that efficient harvesters had been manufactured for other crops and could see no reason why the same could not be done with cane. America had designed maize harvesters for their large, flat maize belt and as our conditions were similar we could use the same implement. America has also made cane harvesters, but again for their own conditions, and unfortunately our conditions were quite different, consequently we could not use the same machine. It was clear that the large manufacturing countries designed implements primarily for the domestic market and unless conditions in that country were similar to our own we could not use them economically.

THE PRESIDENT in closing the discussion said that he looked to see some developments taking place as a result of this paper. Possibly we could develop something to suit our own peculiar requirements. Our aim should be to explore the possibilities contained in each paper and to get something concrete done so that we could benefit from the valuable suggestions made.