MECHANISATION SYMPOSIUM

THE FUTURE OF MECHANISATION IN SOUTH AFRICA

By G. S. BARTLETT

South African Sugar Association Experiment Station

An earlier paper in this Symposium has dealt in detail with the present utilization of man and machine in the South African sugar industry, and with the potential savings which can be incurred through the application of sound management principles and techniques. There should be little doubt that this thinking is basically sound and that the ideas and suggestions put forward are worthy of serious consideration and action, especially when one considers that the main reason for producing sugarcane is to make a profit. That these principles and ideas are often ignored or misunderstood in practice is evident from the situation which exists on many cane farms today, and by the ideas regarding labour and machines which are propounded by some cane growers.

It is a fact that with time, the rising costs of manual labour and the need for increased mechanisation will force changes in the sugar industry. The rate at which this evolution will take place depends to a large extent on the rate at which cane farm managers are able to introduce sound labour management principles. The longer cane farm management can satisfy labour's demand for increased purchasing power by increasing labour's productivity, the longer it will delay the arrival of the day where mechanisation of all operations will become an economic necessity. To ignore basic labour management principles will merely maintain the status quo which will mean courting an eventual confrontation, which could result in labour completely rejecting cane work, especially harvesting, as an acceptable or profitable form of employment. This would necessitate the introduction of "crash programmes" for complete and indiscriminate mechanisation, thereby raising production costs considerably.

In examining this subject of labour and machines, and means of increasing their productivity, it is apparent that acceptance of the principle of increased labour and machine productivity is tied directly to an increase in the productivity of unit of land per unit of time. Work study data indicate quite clearly that the output per unit of harvesting labour is dependent on the stand of cane which is presented to the cutter at harvest. The desire for increased cutter productivity can, therefore, be a motivating force for better cane husbandry. This, in turn, could start a move towards greater overall farm productivity and profitability.

The previous speaker has clearly indicated that labour and machines should work in co-operation rather than in competition with each other. This is essential if both labour's demand for increased purchasing power and guarantee of employment, and the growers' need for profitable cane production, are to be satisfied. If ever there was a need for evolution rather than revolution, then it exists in the South African sugar industry's road towards complete mechanisation. The advantages of the one, and hazards of the other, are surely evident if one examines the history of other sugar producing countries in the world which have already had to face these problems. However, it is a major function of this symposium to examine mechanisation, not only in the form of a philosophical discussion which deals with its importance or otherwise, but also its feasibility and the practical effects which mechanisation will have on the sugar industry as a whole. While mechanisation of planting and cultivating operations is not general practice as yet, it is felt that the problems involved are not nearly as complex and difficult to overcome as those experienced with the harvesting operation. In fact, it is essential, if costly mistakes are to be avoided, that much thought and pre-planning be given to the consequences of mechanical harvesting well in advance of its actual introduction. It is certainly not too early to establish both short and long term industrial objectives in this regard and to establish an overall policy as to how these may be achieved.

The introduction of mechanical cutting will naturally depend on the availability of a suitable, production-built machine, the design of which will be influenced by field and crop conditions. However, before any work on the design or selection of a cane harvester can commence, a decision must be taken on whether it is to be used to harvest burnt or trashed cane. The reasons for this are obvious as for these purposes there will be basic differences in design.

From the designer's viewpoint and for practical reasons, it is easier to design and build a machine to harvest burnt cane. In fact, there are many such machines already available in different parts of the world. Two of the most successful, namely the J. & L. Bluebird and the Crichton were imported into South Africa in 1964 by the sugar industry. Development since then has improved the performance of these and other machines now being mass-produced in Australia and the United States.

While much work on the design of trash harvesters has been done in the past, and is still continuing, no economical production harvester is as yet commercially available. Experience indicates, however, that if a trash harvester is eventually developed, it is most likely to be a "chopper" harvester. This type

of machine has outstripped the "whole stick" harvesters for general use with burnt cane in Australia, due to its ability to handle lodged cane. All indications at present, therefore, are that the trend in all harvesting development, whether for harvesting burnt or unburnt cane, is towards "chopper" harvesters.

This use of chopper harvesting calls for a re-design of transport systems to handle not only "short" cane, but to ensure that the cane reaches the mill within 24 hours of cutting. This is necessary in order to reduce the risk of dextran formation by Leuconostoc, which causes processing difficulties. In other words, the advent of chopper harvesters would require a major overhaul of cane transport systems in South Africa.

Summarising the foregoing, therefore: if trash is to be conserved then in all likelihood chopper type harvesters will be required, which in turn will require a major change in our present systems of transport. If the cane is to be burnt, the mechanically less complicated whole stick harvesters can be used, but they are not suitable for badly lodged cane. Two successful machines have been imported to date and the Experiment Station has re-designed the Crichton, and had this built locally. Development overseas is proceeding at a rapid rate and improved machines are being designed and produced as each year passes. These could be imported into South Africa if required.

A major factor affecting the economics of mechanisation is the machine's work capacity and its annual utilisation. In South Africa, the average grower cuts about 4,000 to 5,000 tons of cane per annum or 25 tons of cane per day. Yet one of the cheapest and simplest cutters we have tested, namely the Sugarmech Crichton, cut last year, under near ideal conditions, 620 tons at an average rate of 38.4 tons per actual clock hour of operation. Other larger machines can cut at rates of up to 60 tons per hour. The tons cut for each hour the Crichton spent in the field was 10.4, which gives an indication of the downtime involved in the form of breakdowns or just waiting in the field when there was no cane to cut. The trials were conducted on flat terrain in fairly erect cane, and it was found that the machine would have to be modified to handle lodged cane, to open up a field, or to work on steeper slopes.

It can be said, however, that any successful single row harvester will, in good conditions, cut cane at an average rate of at least 25 tons per hour. As such, the average grower (5,000 tons) will utilize it for only 200 hours per annum, and the grower producing 10,000 tons, for 400 hours per annum. Unless co-operative or contract harvesting can be introduced so that throughput can be increased to a level of say 1,000 hours per annum, the use of a conventional harvester would be grossly uneconomic.

Any move towards mechanisation in South Africa must be based on sound economics. It was said at the I.S.S.C.T. Congress in Taiwan last year that mechanical harvesting should only be considered when manual cane cutting costs reach approximately 50 cents per ton. Overseas figures show that actual harvesting costs vary from about 35 cents to R1.40 per ton. The most optimistic calculation for ideal conditions shows that it would theoretically be possible to harvest cane mechanically in South Africa for as little as 20 cents per ton, because labour costs are low. Practical experience has shown however, that this figure is unlikely to be achieved in normal practice. In contrast with these figures, experience with manual cutters has shown many times that it is possible in South Africa, to obtain labour to "cut only" from as little as 8 cents per ton in burnt cane to as much as 20 cents per ton in trashed cane.

One of the main reasons for mechanising the cutting of sugarcane is the threat of a labour shortage. However, it has been said that there is never really a labour shortage, but rather a shortage of money to pay the labourer the wage he demands or requires. In other words, if a labour shortage is experienced, it surely means that the job concerned offers very little incentive to labour.

In Australia, in spite of the fact that the cutting labour is white and their society very advanced in comparison to that of our cutters, they were until very recently still able to attract people to cut cane. It seems they have now reached the point where, at a cost of R1.60 per ton it has become uneconomic, at the present price of cane, to meet their demands.

Cane growers in South Africa will continue to compete successfully for labour with other industrial enterprises, so long as we can meet labour's needs for an increased standard of living. We know that we can afford to pay up to 50 cents per ton to cut burnt cane before mechanisation is required. If cutters can cut 10 tons of burnt cane per day, this gives an income of R5.00 per day. At 15 tons per day, it is R7.50 per day.

Since terrain plays such an important part in the design and construction of a successful cane harvester, and since a substantial part of the cane crop in Natal is grown on steeply sloping lands, every consideration and effort must be given to retaining the services of the manual cutter for as long as possible. There should be little doubt that the earning potential of a cane cutter, "cutting only" in burnt cane using the long handled cane knife and dropping the stalks in a "windrow", will motivate him to compete economically with mechanical cutters for many years to come. To do this, however, the manual cutter must be dissociated from the loading or stacking operation. This can and is being done by using loaders even on some of the steeper sloping lands. Furthermore, development work with a cable loader promises the eventual mechanisation of loading on the steepest land.

Despite these developments, it must be accepted that should the cutting operation eventually have to be mechanised, then much of our steep land and probably all land with a slope in excess of 1 in 3, will have to be taken out of production. Various levelling mechanisms used in grain harvesters are, of course, well known, but these machines usually work on a cutting face of 10 to 20 feet in width, and this width invariably increases their stability. When cutting cane at 4 feet 6 inches row spacing, the narrowness of machine width (it cannot

be made too wide with the whole stick cutters as by extending into the already cut field it will be obstructed by bundles or windrows lying on the ground) presents a major stability problem. It has, therefore, been suggested that a two-row machine be designed to give added stability. This can be done, and two-row cutters of different types were in fact available in Queensland in 1963. However, this type of machine becomes a good deal more complex and therefore more expensive, while its cutting capacity is doubled. This means that travelling at only 1 mile per hour, it would cut 45 tons of cane per hour in 40 tons per acre crop. Since speed of operation is a function of economic cutting, this figure is likely to be exceeded.

In the light of the foregoing, it is possible to set certain objectives, both short and longe term, in regard to labour use and the mechanisation of cane harvesting.

Firstly, there is labour to consider. It is a fact that there are many Bantu males in the reserves and rural areas who are potential cane workers. If our industry is to enjoy a peaceful and stable existence, these people must be provided with employment. This employment, however, must be economic and capable of meeting their demands and their needs for a decent standard of living. This can be achieved by raising the productivity of employees, and this can be considered as an immediate objective.

Secondly, it is necessary that we try to preserve our existing cane lands for as long as it is economically possible. Since a substantial area of steep land is under cane, attempts should be made to ensure that this area will not suffer unduly from labour shortages. This can be achieved by introducing new harvesting techniques so as to increase labour productivity. This is an immediate objective.

Thirdly, it can be generally accepted that the main reason for being a cane farmer is to make money, and that it is essential, therefore, that any new systems of crop removal should be economically sound. For this reason cane growers should be made aware of the economic implications of mechanical cutting and loading, and the eventual need for co-operative or contract harvesting when machines are eventually required. This is an immediate objective.

Fourthly, it is necessary that provision be made to ensure the eventual transition from manual to mechanical crop removal. In the case of cane cutting this should be a long term objective since the eventual need for mechanical harvesters is possibly still 8 to 15 years away, especially if the first consideration is adequately taken care of during the interim period. Cane loading, however, is an immediate objective since it will release at least 50% of our harvesting labour, and will enable cutters to increase both their productivity and earning power.

In order to achieve these objectives, it is recommended that the following steps be taken:

1. That immediate encouragement be given to
   (i) the development of various types of loading machines for both gently sloping and steep terrain;
   (ii) the use of method study techniques in cane cutting and handling, coupled with correct selection, training, control, and motivation of labour;
   (iii) grower awareness of the economics of manual and mechanical cane handling plus the management techniques required to exploit existing labour and machinery assets to the full;
   (iv) a continuous and growing awareness of the need for development, use and study of the problems of mechanisation by growers and machinery suppliers alike, both locally and overseas.
2. That a long term policy be established towards
   (i) determining the types of harvesting systems which will eventually be required, i.e. choppers vs. whole stick, and to determine what effects these will have on existing harvesting systems, transport systems, quality of the harvested cane, and methods of cane reception at the mills;
   (ii) the development or acquisition from overseas of suitable harvesters and allied machines for study, as an insurance against the eventual need for complete mechanisation.

Discussion

Mr. Rogers: What is the weather like during the harvesting season in Australia?

Mr. King: It is usually fairly dry between July and November, particularly in the Bundaberg area. However, unless very heavy rain falls the mechanical harvesters are able to operate under wet conditions.

Mr. Wilson: In Australia, how much cane is transported by rail as opposed to road transport?

Mr. King: Although the figure is decreasing, most of the cane is still carried on rails, i.e. Government transport or mill tram lines.

Mr. Stewart: Mr. Morrow attributes a cost of 22% to weeding as against an actual allocation of labour of 40% for this purpose.

I think the figure of 40% is probably too high because when it is not possible for various reasons to carry out other operations that might have been planned for the day the labour force is diverted to weeding, whether it is required or not.

Mr. Morrow: When should weeding take place? A farmer is forced to employ excess labour because owing to climatic changes he cannot forecast peak conditions.

Therefore at times this excess labour will probably be used for weeding but improved farm management will help reduce this problem.

Mr. Wise: I was surprised at Mr. King's remarks about loading. Our experience is that a man can

cut cane for three quarters of a day and load this amount in the remaining quarter.

We use anyone for loading but only the best are used for cutting.

Mr. King: Loading is more arduous than cutting. When a cutter loads ten tons of cane it is harder work than cutting it, even though it may not take as long.

In Australia the cutter has to lift up a bundle, shoulder it, carry it over to a cane truck and place it transversely on the truck. As the truck fills up he may have to mount a small ladder and this is not easy when carrying an eighty pound bundle.

When a cutter is relieved of loading, his output increases considerably.

Mr. Andries: I would like to amplify some of the comments in Mr. Dent's paper.

This season at Ubombo Ranches we are hand cutting and mechanical loading into 10 ton four wheel trailers with a turntable. The trailers are extracted singly from the field and marshalled at the edge where they are linked in threes and taken to the mill by heavy tractor.

We have at the same time revised cane handling. Cutters and loaders have been split, as suggested by the mechanisation committee and as is done in many other parts of the world.

This has increased production tremendously. A specialist cutter is no longer wasted as a loader.

We have commenced area cutting and have adopted a unit called a line yard.

In accordance with the estimated stand of cane we determine the number of line yards that a man will be given per area. We have tried to establish the area as $2\frac{1}{2}$ tons which is small enough to encourage a man but not too small to become cumbersome in practice.

To cover his basic daily wage plus overhead (housing, medical services, etc.) a man must cut three areas, and thereafter it is up to him.

The areas are not in one place because as each is cut it is loaded and stacked so the cutters move on to the next block.

We also now use only the long handled Australian type cane knife.

We have only completed a month of the season but 5,186 tons of cane have been cut in 362 man days representing a production per cutter man day of 14.3 tons.

Stackers must stack 10 tons a day to cover basic daily wage plus overheads and a bonus of $\frac{1}{2}$ cent per 100 lbs. is paid in excess of 10 tons. They are stacking 15 tons a day.

Cutting and stacking performance has been separated from transport performance, which has removed a hitherto limiting factor.

Possibly the most important thing to have come out of this is that the cutter is now convinced that he can attain such a high performance.

We have shown that two men can cut and stack 15 tons a day, whereas the figure last season was 10 tons.

Our last estimated cost of getting cane to the mill was—cutting and stacking 36.46 cents, infield transport 20.54 cents, craneage 8.38 cents and heavy transport 14.12 cents, making a total of 79.50 cents per ton. This includes supervision, indirect costs, depreciation and everything else.

Under the new system the estimates are—cutting 28.22 cents, transport labour 7.70 cents, infield transport 8.84 cents, mechanical loading 12.50 cents, infield carts 6.55 cents, main road transport 10.01 cents, making a total of 73.82 cents per ton, a 5.68 cents per ton saving on the old system.

The estimates were done in August last year and were based on a cutter performance of 9 tons a man day against the present 14.6.

Mr. Bartlett: What was the yield in tons per acre of the field concerned, and was the cane standing or lodged?

Mr. Andries: Twelve months old standing cane of N:Co376 variety, partly lodged, and giving 59 tons cane per acre.

Mr. Halse: A point that has not been mentioned is that mechanical loading guarantees even stack weights whereas with hand loading there is considerable variation.

Mr. Dent: This has not been our experience at Tongaat. Condition of cane has had the main bearing on weights of stacks.

If the cane is straight, with our type of loader, we get more cane into the baskets, say five tons, whereas with bad cane we might only get two tons, with roughly the same volume.

Mr. Wyatt: Australia is decreasing the time between cutting and milling whereas in Natal, without heavy terrain, we may increase the time by separating the tasks of cutting and stacking, and we will have to revise our tasks so that this does not occur.

Mr. Morrow: There should not be a long delay between cutting and stacking.

If sufficient carry-over of cane is allowed for each day so that stackers can start work at the same time as the cutters, the actual time delay should not amount to more than 3 or 4 hours.

Mr. Bartlett: We should aim at mechanical loading as this would eliminate any delays.

The splitting of the cutting and stacking operation is an urgent need, however, manual stacking or loading should be considered an interim measure until mechanised loaders can be introduced.

Mr. Tucker: How long can we continue to maintain trash management? More emphasis is being placed on cane quality and this comes back to the amount of trash and tops that will be accepted at the mill.

Mr. Dent: Our grab loader picks up only a small amount of trash. It is proportional to the quality of cane in the stand.

Of course the design of the push piler is also important. We are now using two tines instead of four tines.

If we introduce direct sampling of cane then we might have to work in burnt fields.

Dr. Cleasby (in the chair): It is a matter of economics which will be resolved either by direct cane sampling or a new cane payment system.

An individual using mechanical harvesters will then decide whether to send in trash with his cane or whether he will have to burn.

But at present the economics of conserving trash are very much in its favour.

Tongaat had moved from trashing towards burning but is now again trashing all fields except in exceptional circumstances.

Mr. Ardington: Does mechanical loading lead to any adverse effect on subsequent ratoons?

Dr. Hill: We put down an experiment at Tongaat last season in a wet field and our Crossman loader compacted the field very badly.

Compacted areas were fenced off and various soil amelioration practices were carried out, e.g. subsoiling in the other areas.

We were surprised that compaction gave a slightly increased yield.

We again found this recently in an Avoca soil series, which compacts almost like cement, where the compacted sites gave slightly better results.

Mr. Bartlett: There are certain points to be considered regarding cane quality when mechanical loaders are used.

Firstly, if the cane is short the cutter will leave the tops on to assist the loader.

Secondly, if possible, bigger windrows should be made by throwing 4 or 5 rows into the windrows instead of three so as to reduce the length of push-piling per acre.

Thirdly, the design of push pilers is most important and more attention should be given to this.

Dr. Cleasby: As technologists we must recognise the importance of cane quality.

In Mr. King's film of Australia it was obvious that attention was given to the effect of various operations on cane quality.

You will note from his paper that the Australian industry harvested 17,000,000 long tons of cane for 2,600,000 tons of sugar, whereas in our own record year we also harvested 17,000,000 tons of cane but for just on 2,000,000 tons of sugar.

Dr. Matic: Mr. King mentioned that one disadvantage of the chopper harvester was the fast deterioration of juice quality producing difficulties in the boiling house and in particular the formation of needle shaped crystals.

This is apparently attributed in Australia to bacterial formation of gums by *Leuconostoc mesenteroides.*

We have done work on production of gums in stale cane, both whole stick and chopped. We have established quite definitely that the gums produced in stale cane are not due to Leuconostoc. They are entirely different and represent, in fact, a new type of carbohydrate.

It would seem doubtful, therefore, that Leuconostoc is responsible for the production of these gums. Of course our laboratory conditions are probably different to field conditions in Australia.

Mr. King: I am not really qualified to answer this question. Our pathologists have been working on this for years, ever since chopper harvesting began and we got degradation of sucrose in the cane.

The Leuconostoc organism was identified early on in large numbers, present on the rind of the healthy cane, not the inside. At the moment of cutting the knife infects the fleshy portion of the cane.

The presence of Leuconostoc is always associated with increased acidity of juice, an increase in gum content and a lowering of purity and the bigger the delay between cutting and milling of cane the worse these effects become.

I cannot say that Leuconostoc is responsible for gum formation, but gums are formed and do increase. A dextran has been isolated from these gums and when it is put into fresh juice it promotes formation of needle shaped crystals.

Mr. Stevenson: Does Mr. King, knowing our terrain, think that we should stop research into mechanical harvesting and rely on overseas equipment?

Mr. King: I hesitate to give advice to any country on the basis of very brief experience of its problems.

In the ten days I have been here I have discussed this problem and I think you should maintain some experimentation of your own because of your own particular conditions.

But you can import machines and try them out, adapting them if necessary.

You should then be prepared for the change when it takes place.

I have heard it suggested that a cheap light machine be developed here for harvesting. All I can say is—forget about it. That is how we started fifteen years ago.

Sugarcane is a heavy crop and whether your daily allotment is ten tons or a hundred tons the machine must move and cut at the same rate.

Mr. Worthington: In the Natal Midlands we have split our cutting and stacking.

Although we have only just started, with burnt cane we have cut up to 24 tons and stacked up to 15 tons per day, in nine hours.

Mr. Bartlett: That works out at about $2\frac{1}{2}$ tons an hour for cutting. We have done time studies and, depending on the stand of cane, the manual cutters' output varies from $1\frac{1}{2}$ to 3 tons of cane cut and topped per hour.

Mr. Poree: I have found it very difficult to throw a windrow on a slope, using the Australian cane knife.

Mr. Bartlett: We have successfully used the Australian long handled knife on fairly steep slopes at Umzumbe.

The normal technique, however, has to be altered slightly. Cane must not be thrown downhill because it slides. It must be laid on the upper side, especially the third row.

Mr. Poree: But if you cannot keep the windrow straight you lose the advantage of using the straight knife for topping.

Mr. Morrow: In a poorly grown crop the stalk length will be uneven and therefore topping is a

problem anyway. Either more labour is used or more tops go into the mill.

Mr. Stevenson: I cut by hand and load mechanically and find it better to have the cane in small bundles rather than windrows.

This decreases extraneous matter in the cane and does not lessen the efficiency of the cutter.

Mr. Bartlett: This may also be necessary in very stony conditions to prevent picking up stones during push-piling.

Dr. Cleasby: From today's discussion various points have arisen. The role of the cutter is seen in a new light and new methods must be used to motivate him.

Also, we must evolve towards mechanical loading and ultimately mechanical harvesting.