

SOME ECONOMIC ASPECTS OF IRRIGATION FOR GROWING OF SUGAR CANE IN NATAL AND ZULULAND

With Special reference to Overhead Spray Irrigation.

By W. W. JEX.

Mr. W. W. Jex read his paper on the above subject as follows:—

The drop in the price of sugar, and consequently of cane, over the past season, calls for a critical examination of our position. We look to Government to help us by providing the means of excluding foreign sugars from our market. We look to the commercial side of the industry to extend the sale of our sugar (in all its forms and by-products) within the Union, but, as a planting community, we must rely mainly upon a higher production of sugar per acre to secure for us a margin of profit to make our operations worth while.

Three considerations arise:—

1. Better cultivation.
2. Improved varieties of cane.
3. Irrigation.

The second and third are linked together, because I consider such improved varieties must be propagated and maintained for seed purposes for the industry by means of irrigation. Let us start at the Experiment Station. We see excellent and most orderly work in the laying out of the experimental plots of soft cane, but progress is hampered because irrigation facilities are not available. Other cane-growing countries have already a long lead of us. They dominate the sugar market because they have successfully developed improved varieties on a vast scale. It is recorded that P.O.J. 2878 was planted in Java in 1926 only to the extent of $\frac{3}{4}$ per cent. In 1927 the plantings were $12\frac{1}{2}$ per cent.; in 1928, $66\frac{1}{2}$ per cent., whilst the figure for 1929 is given as 93 per cent. This latter will cover 172,971 hectares. In Louisiana the industry was threatened with extinction, but a new variety of cane speedily saved the situation. Our aims should be to produce as quickly as possible sufficient seed cane of improved varieties to plant out on a commercial scale, so that we may get as nearly as possible to a competitive level. Instead, we are forced to loiter along trying to propagate such varieties on a fraction of the water supply to which they have been accustomed in their country of origin. The result must be to delay seriously the benefits we expect from these varieties, and I feel that we cannot afford to delay. What is the remedy? Obviously, an irrigation farm under the control of the Experiment Station. That must be our stud farm, and there we shall get our pedigree cane, and the stock must be kept up and improved. Bloodstock needs generous feeding. We cannot expect to win races

on a dry grass diet—but that is exactly what our present method means.

The advantages which may be expected to accrue from superior types of cane are:—

1. Increased production of sugar per acre.
2. Higher cutting and loading task from labour.
3. Better response to irrigation in growth and sucrose content.
4. Shorter season.
5. Easier factory operation, with less wear and tear on machinery.

You all know how difficult is the labour situation, and how inefficient the cutters are becoming, especially when debilitated by the ravages of malaria. The straight, heavy, soft canes, self trashing, would help greatly to improve the labour problem. In Queensland white labour working under tropical conditions perform a task of four to five tons of cane. We have to be content with something like a ton per unit. The consequence is that the season drags on a month or two longer than the economic limit, the sucrose drops, the fields do not get the attention they need at the right time, and the mills often have to stop for lack of cane. What is all this costing us as an industry? Could we not afford to establish an irrigated cane nursery with a tithe of the amount that could be saved? Having established such a nursery it would soon become self-supporting, and indeed be a means of carrying the Experiment Station along by sales of seed cane to estates and planters. At present we grow our own seed cane—Uba liberally streaked; but with soft canes the quality of the stock must be maintained, and that cannot be done by extensive cultivation methods. We need intensive cultivation in a scientifically controlled cane nursery with proper irrigation facilities.

An important feature to be studied is the nature and extent of fertilisers to be applied with irrigation in the growing of sugar canes.

Then we have to consider what diseases or pests may attack the soft canes, and what measures of prevention and cure must be put into operation. We shall be dealing with new canes and new problems under new conditions.

For these reasons, and others that are bound to crop up, we need an irrigation farm under the control of the Experiment Station, and I hope the Irrigation Committee will succeed in securing such an area.

The presence of Government representatives on our Committee is an indication of Government approval. We are very much indebted to Mr.

Ritchie and Mr. Hudson Spence for their valuable lectures and advice on irrigation matters relating to cane growing in Natal. Let us hope the Government will still further extend their support, because cane is not the only crop which can be grown successfully on the Coast under irrigation. Canned pineapples, for example, might help to use up quite a lot of our surplus sugar production, and would give our land a needed rest from cane. Bananas, we know, make a handsome response to irrigation, and I am glad to see also that Mr. Dodds is experimenting with Cape gooseberries.

RECORDS OF STATISTICAL AND OTHER DATA.—I assume that provision will have to be made for the collection and recording of statistics and data. This work, no doubt, could be undertaken by the Experiment Station, but it will need proper facilities, because it is surprising how quickly it grows, and we must put it up to the Industry that the necessary facilities be provided.

DRAINAGE is included within the scope of investigations, and here we may be of great service, not only in reclaiming and improving land, but also in helping to suppress malaria by getting rid of mosquito breeding swamps.

These are just a few indications, so that we may start towards a definite, practical programme. Our work, I think, is so important that it deserves the fullest support and encouragement both from the Sugar Industry and the Government, and, as an initial step, I suggest that a proper expression of such attitude would be the establishment of the irrigation farm I have indicated, where all the problems can be worked out for us and demonstrations given.

Mr. Royce, of Natal Estates, Ltd., went to very considerable trouble to prepare a practical scheme, with the kind consent of his Company, for setting aside an area of 50 acres on Natal Estates' land for irrigation experiments under the direction and control of the Sugar Experiment Station. This scheme has not yet been adopted. My recent serious illness prevented me from carrying on the work of the Irrigation Committee, but Mr. Royce very kindly stepped into the breach and submitted a paper to you at the last Congress reviewing operations. He dealt with the need and potentialities of irrigation so vigorously that I would urge all doubters to read his paper again. His thoroughness of attack and breadth of conception promise well for the success of the big scheme he is handling. One paragraph in particular is so striking and so prophetic that I beg leave to quote it:—

“The main objective is to cheapen the cost of production of sugar and show the importance of proper knowledge of the real generative element, water. The one and only element we can supplement is as yet practically unknown to us, and so long as we are prepared to sit back and abide by the present climatic conditions and admire the wonderful virtues under adversity of the Uba variety, then so surely shall we cease to

progress. Nothing stands still, so that we shall continue to feel the ever-growing world competition, virtually competition in the art of cane growing.”

We, as planters, would do well to ponder over these words.

The demand for new varieties of canes when released from quarantine was such as to prove most emphatically that planters are urgently seeking a better variety than Uba. This interest is most gratifying and indicates a new spirit of enlightenment and progress amongst planters largely fostered by the efforts of our Experiment Station.

Mr. Hudson Spence at one of our Committee meetings quoted from “Report of Indian Sugar Cane Committee as under:—

“There was, however, fairly general agreement that the cultivator habitually over-waters his crop, especially in areas irrigated by canals, to the detriment of both out-turn and soil, but it is obviously impossible to express definite opinion as to the extent to which the crop is over-watered in the absence of definite information regarding the optimum amount of water required. We consider, therefore, that the water requirements, not only of cane, but also other competing crops, require careful investigation, and recommend that this should be carried out on all agricultural stations in whose programme of operations work on cane is included.”

It takes on an average 3,898 tons of water to produce one ton of sugar.

Cane itself is composed of between 69 to 75 per cent. of water.

Water requirements, it will be clearly seen, are of paramount importance, and the economic use of water in cane growing must be carefully studied. The true value of irrigation is measured not by the amount of water that is applied to the soil, but by the amount of moisture that is retained by the soil within reach of the roots.

It is claimed that irrigation by means of sprays distributing the water to crops as mist or fine rain is the most economic method in the use of water, and also the most under control. The water can be regulated to give just the quantity required and then be shut off. Under one system, which I shall describe presently, this is done automatically, and the apparatus can be set to go off like an alarm clock, giving one, two or three waterings at certain intervals, and then passing on down the line to other areas.

The essential features of every system designed for spray irrigation are:—

1. A pumping plant or its equivalent.
2. Feed pipes.
3. Nozzles.

The initial capital outlay is the stumbling block to spray systems, but irrigation, however considered, is expensive, and, if we decide on having the water, we should be sure not to waste it, and the adoption of the spray method should soon pay

for itself by the saving of water and by the saving of labour, also by the avoidance of erosion so likely to happen on hillsides where water is led out of furrows.

First we must consider the class of soil to be irrigated. Sandy soils are most difficult to irrigate by furrows. The water is slow to run along the furrows because it penetrates downwards. The lateral seepage is small, and a great deal of the water goes down below the root area. On these soils, if they have enough fertility to warrant it, sprays are very suitable, but on heavy soils, too, there is the advantage that, the water falling as mist or fine rain, the surface does not become compacted, and the water being under control, even distribution is attained and the lower lying areas do not become water-logged as is often the case with seepage from furrows.

Soil fertility is an important factor. In a bulletin issued by the Department of Agriculture it states: "It will be found that crops growing on a fertile soil make more economical use of water than those on poor soils. This does not mean that the crops will use less water in the former case, but it means that for every pound of dry weight produced less water will be required, and as crops on rich give larger yields than those on poor soils, the total quantity required for the crop in the former case may be greater. Closely connected with soil fertility is the depth of the soil. Deep soils will be able to take up and hold larger quantities of water than shallow soils, which means that less frequent irrigation will be required. The deep soil will enable the plant roots to penetrate into a larger area of soil from which greater quantities of plant food and water may be drawn. This makes for thrifty growth and the economic use of water."

I mention these features to emphasize that spray irrigation, from its high initial cost, can best be considered in relation to fertile, deep soils.

Let us examine the working of the "Rain-Spray" system, the one I use. Barker & Smith, of Maritzburg, hold the manufacturing rights for South Africa, and to them I am indebted for the following simple description of this system. It consists of portable galvanized piping, 3 inches or 4 inches in diameter, with sprays set at fixed distances apart on 1 inch uprights. To combine durability with strength and lightness, the piping is made of 22-gauge steel sheets. The joints of this piping are remarkably simple arrangements which permit the lengths of pipe to be connected and disconnected with rapidity and ease. Each joint consists of a male or female flange of galvanized cast iron sweated to the ends of the pipe. The female end is recessed and carries a rubber ring. The joints are connected by a pair of hinged bolts, the male flange being slotted to receive them, and are tightened by wing nuts. The process of connecting and disconnecting the joints is the work of a few seconds

only, while this form of joint permits great flexibility and allows the pipe to follow the contour of the ground.

The spray heads are made of rust-resisting metal and fit on to a length of 1 inch galvanized pipe which screws into a brass seat sweated to the spray piping. The heads are fitted to the upright on the bayonet socket principle, and are removed by a fraction of a turn, so that grit, fibre or other matter clogging the perforations is easily removed.

Length of Pipes.—The main or supply pipes are made in two lengths, 23ft. and 17ft. 6in. respectively. The former is intended when conditions are such that water has to be brought some distance by pipe line before it is available for the spray lines. The idea is to reduce the number of joints, and also the initial cost. Where the spray lines commence, the main is then laid in 17ft. 6in. lengths, as also are the spray lines.

Spray Spacing.—Spray heads are spaced 12ft. apart along the spray line. The pipes being in 17ft. 6in. lengths, each is made to take either one or two sprays. When in use, pipes with single and two heads are laid alternately, so that a spray occurs every 12 feet.

Number of Sprays which can be operated on a known fall or head.—Where the supply is constant a 25 foot head on a 3in. main will operate 20 sprays. To obtain best results a pressure equal to 12 lbs. per square inch should be maintained in the spray lines. This ensures each spray watering a diameter of 35 feet, and at the pressure mentioned will spread 210 gallons per hour, equal to over 1 inch rainfall per hour. Thus a line of 20 sprays will distribute 4,200 gallons per hour over an area of 240ft. x 35ft. As long as the 12 lbs. pressure is maintained, the spray line can be extended until the pressure falls below that point, so that the number of sprays is governed by the head of water available. Twenty-five feet fall or head is the minimum recommended. Anything else would be reflected by a diminished area covered by each spray. A greater head would operate a larger number of sprays, but 50ft. should be the maximum. When considering these points it should also be remembered that the distance that the water flows through the main pipe-line until it reaches the spray line is a factor governing the number of sprays on the line. A 3in. pipe 1,000ft. long with a fall of 25ft. will deliver half as much water as the same pipe with the same fall over a distance of 300ft. Where over 40 sprays are required, larger diameter main pipe is necessary.

Lay-out of Installation.—When laying out a scheme it is much the best plan to divide the land into plots and run the main down the centre, using spray sections equal to half the width of the land. By dividing the length of these sections by 12, the number of sprays in operation is arrived at, and basing the distributing capacity of each at 210 gallons per hour, this quantity multiplied by the

number of sprays gives the total per hour distributed over an area equal to the length of the spray line x 35ft.

Mode of Operation.—Having laid the main pipe-line to the first section of land to be watered, at this point a two-way or a single junction with a stop valve is attached. (It should first of all be mentioned that there should be a control valve either at the intake of the main pipe or somewhere handy along its length so that the main supply can be cut off while transferring sections.) The spray line is then connected up, at either side of the main, if necessary, or only as a single branch. When the full extent of the spray line is laid and the stop end fixed to the last section, the valves are opened and the water allowed to flow for the period required. At the end of this period, the supply is shut off and the branch and stop valve disconnected, and another two sections of the main line connected up. While this operation is going on, the spray lines have been uncoupled and transferred to the end of main, ready for connecting up. This process continues until the whole of the land has been watered, and then the spray sections and branches are transferred back to the starting point.

One great advantage of the light, portable pipes is that they can easily be moved out of the way to permit cultivation, whereas furrows present decided difficulties, and besides the furrows encourage weed growth along their course.

Another system I have partially tried is Elder's Automatic Irrigation. This system consists in concentrating all available volume and pressure of water on a given area for any desired length of time, then automatically shutting it off and allowing it to pass on to the next area, and so on—the size of these areas depends on the water supply. With a pressure of 90 to 100 lbs. per square inch the No. 3 Sprayer is rated to throw 65 gallons per minute, covering a circle, the diameter of which is 160ft. to 170ft., thus it covers approximately two-thirds of an acre, distributing $\frac{1}{2}$ in. of water over this area in $1\frac{3}{4}$ hours. This sprayer is really a wonderful invention, but the objection I have to it is that it has moving parts which wear out. Possibly these wearing parts could be made of other metal to last longer, but even then oiling is necessary, and, as you know, that is apt to be forgotten by our class of labour. This sprayer requires a zin. pipe service, and with a number of sprayers in series the timing shut-offs, called regulators, turn off the sprayers in one series and transmit the whole volume and pressure on the same line of pipe to the next series of sprayers. It is thus possible to water 8 to 10 acres every night without handling or attention. I have not used the regulator, but have blue prints to show how it operates.

Spray irrigation has been tried on cane in Hawaii for some time past, and is being extended after favourable experience. "The Planter and Sugar Manufacturer" of 16th July, 1927, stated:—

"According to a recent statement issued by J. Henry Hind, of Hawi Plantation Company, the overhead sprinkler system of irrigation is a success. Mr. Hind reports that the overhead sprinkling experiment at Ewa plantation yielded 162 short tons of cane per acre, while cane grown under the old style gave 165 short tons. Notwithstanding the slightly extra yield under the contour system of irrigation we consider it a great victory for the system introduced in the district at Hawi. George Renton, of Ewa, is also optimistic and is still continuing the experiments recognizing that this system will eventually supersede the old idea of irrigation.

"On every plantation in the Hawaiian Islands irrigating labourers and expert ditchmen are becoming scarce, and it will not be many years before we see the end of the present old guard of Japanese who are careful workers. Mr. Hind states that the labour situation is rapidly approaching a condition where other measures will have to be taken in order to conserve water. The Filipinos, he states, will never make good irrigators.

"The overhead system is not a saver of water, but it carefully conserves it, and the plantation gets the most use from the water applied in this natural manner as is possible from a human manner. The large plantations in Oahu require an army of irrigators under the present system, and the housing of these labourers increases costs considerably. Under this overhead style, nearly 80 per cent. would be saved, as 20 men with the sprinklers can irrigate as much as 100 men can under the old style.

"Mr. Hind stated:—We are not contending that the system is perfect at this time, far from it, but at Hawi improvements are being made daily, giving better distribution of water, remedying mechanical defects in the sprinkler heads and laterals. It is proposed to do away with the wooden pipes as main feeders in the next field which will be placed under the system and substitute cast iron. Tests are being made daily on spacing width of laterals, pressure and average delivery per hour from the sprinklers. In consequence of these improvements the cane is looking better and growing faster, ragged spots are being ironed out and uniform growth, eagerly sought, is being realised. The plantation lands of the Hawi Mill & Plantation Co. are of a very peculiar nature in that they are exceedingly porous and of a very sandy nature. Under the old system of irrigation the water rapidly seeps down out of sight and very little of the water when conducted by unlined ditches reaches the cane roots. This overhead sprinkling system had been in operation for about six years on some of the worst fields and the management has gradually extended the various header lines to where about 200 acres are being irrigated in this manner." This statement by Mr. Hind is quite gratifying.

I have no information as to further progress in Hawaii, but Mr. Dodds may be able to tell us what has been done since 1927. Mr. Douglas Saunders

has seen the overhead system working in Hawaii and tells me the sprays are mounted on tall "risers" to throw a good jet of spray well over the top of the cane. I don't know the type of sprays used there, but one designed by Mr. J. Martyn, of Durban, which I now use, is the best I have so far seen. It works with a moderate pressure, has no moving parts, does not clog, and breaks up the water into a beautiful even mist and spreads it over a very wide area.

There are sprays with revolving arms designed to cover large areas, but unless the revolving arms stand very high over the cane (and then they would be rather top-heavy) they would not clear the cane except when it was small.

I hope I have said enough to stimulate interest in spray irrigation. I am only a beginner with it, and have a lot to learn, still I am greatly encouraged by the results so far attained. It may not pay (unless conditions are favourable) on cane at low prices, but it is certainly well worth considering for growth of fodder, maize, fruits, vegetables and flowers. Some of us may be forced out of cane, or may have to combine cane-growing with other classes of farming. To those who have a water supply available, and it is surprising what can be done with even a small stream or spring, I would recommend careful study of the possibilities of spray irrigation. I would like to see our Experiment Station equipped to carry on some experiments, and even a small plant would be very helpful in the propagation of new varieties of cane having large water requirements. Further the experiments now being conducted on breeding varieties on the spot suitable to Natal conditions, are so important and promise so much for us that they deserve the help of irrigation under easy control by the spray system.

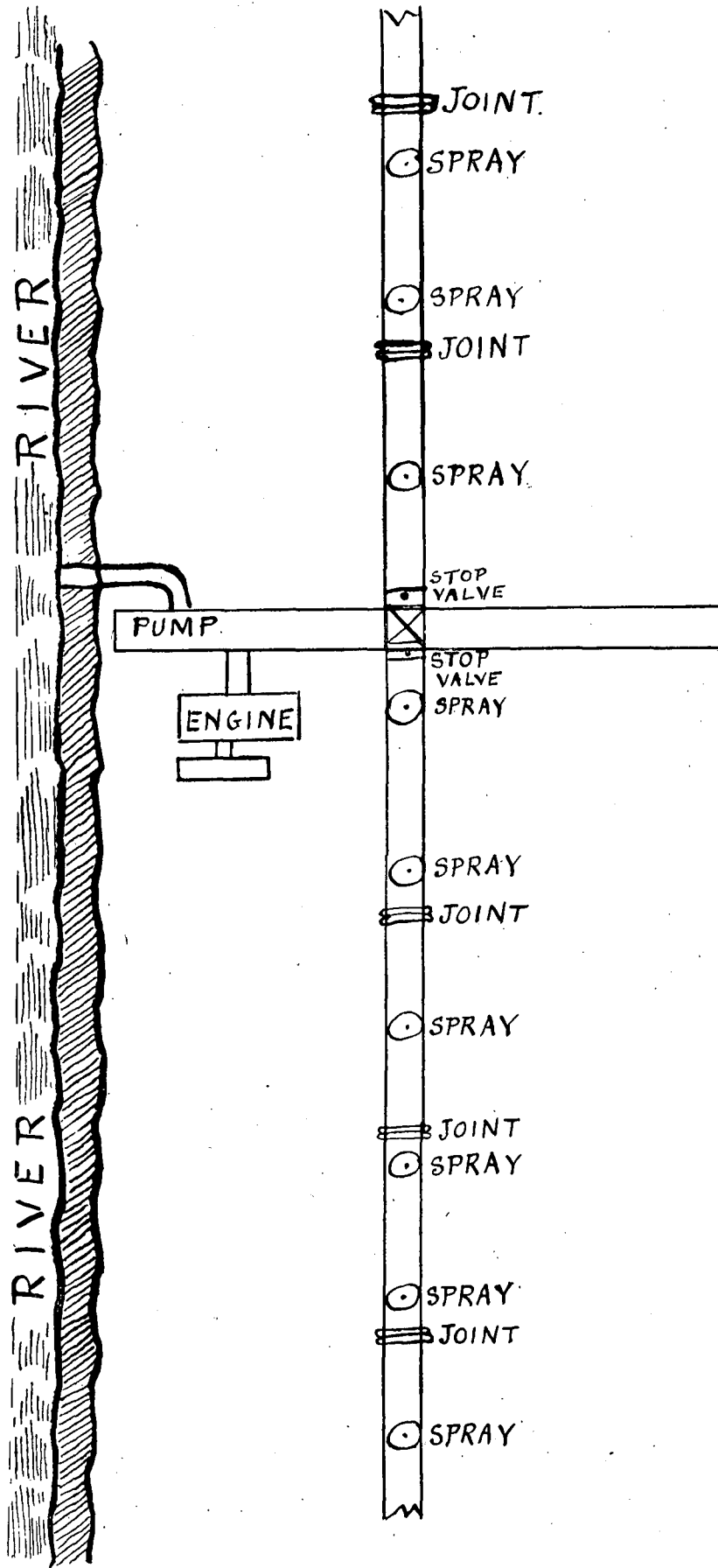
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CHAIRMAN: Mr. Jex has given us a very interesting paper on Irrigation—from a new point of view this time. We have had interesting papers on Irrigation in the last few years, but they have mostly dealt with furrow irrigation, and this is the first real talk we have had on spray irrigation which appears to have a good many points in its favour. One point appeals to me: anyone who has tried gardening knows the results you get from watering seldom equals what you get from the rain, the explanation probably being that there is not the same amount of oxygen in the water. This spraying of water in a fine mist on to your lands is probably going to improve the quality of the water.

Mr. DODDS: I find Mr. Jex refers to me for information on further progress in spray irrigation in Hawaii since 1927. I must say that I intended to look this matter up immediately before the Congress, but in the strenuous rush of the last few days it quite escaped me. A few days ago I received from Hawaii a set of advance copies of the papers

read at their recent Technologists' Conference, and I notice several of the papers deal with irrigation matters. It seems to me that the method of overhead spray irrigation is being advanced slowly in Hawaii, which seems to be the one place in the world where it has been found to be economical in application to sugar cane. In other places where it has been tried, so far as I know, the heavy cost of outlay on the apparatus has been against it. Whether this position is materially altered by the improved sprays that Mr. Jex mentions, I don't know. As he told you, we have written for further information on that matter.

Mr. PULLAR: We have to thank Mr. Jex for a very interesting aspect of irrigation. There are one or two points I should like to mention. There must be a big loss of water due to evaporation, because when using that system of evaporation for cooling of water it is found, under ordinary conditions, probably 5 per cent. is lost. You use the sprays with fairly high velocity and fine pulverisation, and pretty high up, too, on a windy day you surely must lose quite a lot of water. Further, the cane gets a lot of water on the leaves, and there again a lot of that does not reach the root. So that from that point of view there is also quite a loss of water. I should like to know whether the cane benefits more by the increased humidity than the actual water which reaches the roots, or whether that greatly assists in the case of spray irrigation? Probably the Experiment Station could find out something about that. These are points that need investigation, because if there is a big gain in putting water on leaves, then obviously the spray system shows some advancement. The great advantage over ordinary furrow method is that washaways and erosion do not result. Could that not be done by means of perforated pipes? The question of nozzles should not be difficult. Mr. Jex made a reference in the earlier part of his paper regarding the advancement of irrigation generally. One very important point is the cost of power. Then again, on the Coast, as we have said more than once, the mills all have a lot of power, and should have a lot of surplus power, and are generally near water. We have a big irrigation scheme which I am closely connected with, and I don't think I am divulging any particular secret when I say the cost of power for that purpose in conjunction with the mill is a figure which is lower than any power you can buy in this country from any power producing source, which is a very important thing. It is an aspect which ought to be considered. It shows that mills could afford to put in irrigation plant and sell power as a by-product. That could be used during the crushing and off-season. They would get benefit indirectly by the extra cane they would receive; but quite apart from that they could make a profit on the power. On the question of using sprays, of course you increase the head and increase the power by having pressure at the base of the nozzle.



Mr. JEX: I will deal with the last matter first. It opens up very large possibilities for the economic growing of cane. I am rather troubled; I have a 25 h.p. crude oil engine, and unless a man is an engineer things do go wrong at times. It is a worry, whereas if the mill could supply power centrally and distribute that power to a planter having irrigation possibilities, it would be of infinite benefit, and it would give the mills a better quality of cane for milling and a cane from which you could get a higher sucrose, because you could cut off the water and reap it at the optimum sucrose content. Mr. Dodds stressed that in his report. That has not been given the full consideration it deserves. It is an important feature of our work that we should get the sucrose while it is there. With irrigation and control of the ripening, by early ripening varieties and late ripening varieties, we could do that, especially with irrigation. It is for the engineers to work upon that. I am sure they will find a very sympathetic audience among the planters. Dealing with evaporation, I admit there must be considerable evaporation, but I have no knowledge as to what it is. That is why I should like the Experiment Station to take up the matter and test it. There are many experiments which are important, but Mr. Dodds must have the facilities for carrying them out. As regards application of water to the leaves of the plant, I have heard gentlemen state that following Nature's way is the most desirable way. What effect the moisture on the leaves has I can't tell you; that is for the Botanist to answer. Apparently Nature in her wisdom does the job the right way; she lets it fall on the plants in that gentle rain, and from my experience of applying the water in that way to cane fields, the plants show a much more stimulated growth than by the water suction to the roots from the furrows. It may be that it gathers atmospheric nitrogen and conveys that to the plant, or it might be that the humidity is increased and that has an effect on the plant growth, but these are things I should like investigated. I have not the time or knowledge to do it, but the Experiment Station would perform a very great service for us in that direction. As regards the nozzles themselves, there are different nozzles, and they are adjusted to degrees of fineness by different devices, but I am not able to explain the engineering principles involved. From the amount of work and thought and invention given to these sprays it is obviously the right way of applying the water. In the citrus crops in California and Florida there is a wonderful advance. I believe there are consulting engineers there who do nothing else but lay out these overhead installations, and they are fully occupied. The tendency is for the citrus growers to go over to this spray system. I don't know what type of nozzles they use, but it would be interesting for the Experiment Station to get the practice in all these different places. It needs someone to study it up and be deeply interested in it. If there were possibilities

of getting cheap current we would all jump at it. But let the Experiment Station give us the means of using that spray to the best advantage.

Mr. PULLAR: There must be something in Mr. Jex's principle of applying water with a spray. Some few weeks ago I was reading of the effects of irrigation, and the investigators arrived at the opinion that no matter how much water was available to the roots, unless the humidity of the atmosphere was fairly high, the result of irrigation on a really dry day was very disappointing. So I take it that by creating a false humidity and washing the cane leaves, the effectiveness of such a matter must be apparent on the cane itself.

Dr. HEDLEY: Mr. Pullar asks what is the reason for watering the leaves and points to a loss. The effect of putting the water on the leaves is the same as washing one's face after a dusty journey; the stomata of the leaves are washed free from the dust which is always in the atmosphere and settles on the leaves, and by doing so allows the plant leaves unhindered respiration and development. That I understand is one reason why overhead spray is so efficient. I have seen irrigation in citrus plantations. In some cases it is done by means of furrows. In others the water is carried in concrete pipes which effected an enormous saving of the water which seeped away. Now the best practice is considered to be the overhead spray system, for two reasons—washing the leaves of the plants underneath and above, and because the system saves water instead of allowing it to seep in places where it is not wanted. It has been suggested that spraying should be done at night. The reason is that evaporation loss is less at night; furthermore, if water is allowed to fall on a plant in the day the leaves will be burnt by the sun; the water acts as a lens, and one often sees tomatoes and other plants actually with spots burnt on the skins by the concentration of the sun's rays through the drops of water, before the drop becomes completely evaporated by the heat rays.

Mr. PALAIRET: Mr. Pullar has raised an interesting point about power, and I am very glad to hear it raised by a man of his standing, because there is no doubt that we ought to have cheap power. There is tremendous scope for it. I really believe that some of the younger ones of us here will see the day when the North Coast Railway is electrified. When that happens the demand for power is going to be so terrific that we should get it under a halfpenny a unit. When you get down to that there is going to be the most tremendous scope for irrigation. In connection with this spray system, it seems to me that you have got a very large number of pipes, sprays and things, and a great deal of labour carting them about. One's first impression there is that if you could use a higher head of water you are thereby covering a greater area and reducing the necessity for so many

pipes. Furthermore, you are reducing your labour for carting the pipes about; and another impression is that the extra cost of pumping to produce the higher head would more than offset that. I hope Mr. Jex will be able to answer that point. Also I would like some idea as to what the overhead costs in connection with these pipes works out at, because that seems to be the crux of it. The necessary amount of piping suggests a rather high capital expenditure which of course means a big overhead. I hope Mr. Jex will give us some indication as to the capital costs in this scheme and some rough idea of the overhead costs you have to meet and the amount of work necessary in transporting your pipes about and getting the thing going.

Mr. JEX: Those are very pertinent questions and I have anticipated them to some extent. I have worked out on a basis of an area of 20 acres. That would require 315 yards—that is 53 lengths of main pipe at 30/- per length, that is £80; 315 laterals with uprights and sprays—another £100. It works out at £9 per acre for piping and sprays. You are quite right as regards the extra coverage obtained with the higher pressure. That is a very desirable thing. The less pipes there are on the land the easier it is to do your cultivation operations. We reckon that using one length of laterals, that is an arm on either side of the main running up the centre of the plot, would necessitate 53 shifts of both those laterals. That is quite a lot of work. But it is not so much work as grading your furrows, maintaining your furrows, and letting your water out of the furrows. Of course the aim is to get a spray with a big coverage, and that is what I am after. I am on the track of a spray now with the wider arms. Now we have some remarkable engineers in the Sugar Industry, and I implore them to make us a suitable spray. I have an illustration of another spray made by Merryweathers. This nozzle projects the water to a horizontal distance of 200 feet or more and allows it to fall in an even curtain of spray.

Mr. PALAIRET: Have you any difficulty in handling the pipes after the cane has reached maturity?

Mr. JEX: Yes, there is; that is the idea of having those risers. I start with pipes about a foot high, then I got them 4 feet, and now I find I have to get

them about 8 feet. That ought to carry the cane along until it is pretty well advanced in growth. Still you want no interference by the leaves with the distribution. With these new canes they are growing at such a furious rate that at five months they are above the risers. That is a very good compliment to your new canes, Mr. Dodds. They are scarlet runners!

Mr. PULLAR: Dr. Hedley raised the point that if the cane gets its face washed, it is better. Now I should like to know why the fine spray is better than the coarse spray?

Mr. JEX: I have tried both, but I have not had the opportunity for much close investigation, and I don't see the potential principles involved sufficiently to be able to follow it up. That is what we need a scientist for.

Mr. PULLAR: I would like to emphasise that the mills ought to be able to make a profit out of selling power to the planters. It can be given straight away almost at a profit under the conditions at the mills.

Mr. WATSON: I would like to ask Mr. Pullar how he proposes to produce current during the off-season, which is the growing portion of the crop, to make it a paying proposition? The growing part of the year is from the end of October until the beginning of April. During that time I can't see how I am going to produce current at a cheap enough rate to distribute to planters during the off-crop.

Mr. PULLAR: I think in that respect there ought to be another meeting with our friends of Natal Estates who could give figures.

Mr. DODDS: Mr. Jex is evidently fully convinced of the need for further research in the Industry. Opinions to that effect have been freely expressed at this meeting, which I can only hope will eventually reach and influence the powers that be in the Industry. I should perhaps mention that during the discussion on this paper, Mr. Hudson Spence, the Circle Engineer for Natal, who is now located in Durban, and who gave us a very interesting and valuable paper on irrigation two years ago, was to have been present, but at the last moment urgent business has prevented him from attending.