

IRRIGATION IN PUERTO RICO — AND COMPARATIVE STUDY OF THE APPLICATION OF IRRIGATION IN NATAL.

By H. L. GARLAND.

The Irrigation Schemes in Puerto Rico are carried out on a very extensive scale. Huge Dams are built in the mountains which are dependent on the heavy rainfall (this would not apply in Natal as our rainfall is limited) and the water is gravitated down to the lowlands and electricity is developed as a side line and helps to pay towards the capital cost or interest thereon.

One of these dams was built 3,000 feet up in the mountains where they had upwards of 100 inches of rainfall, this was called the "Irrigation Service of the South Coast and utilization of the water resources." This scheme served 35,000 acres of land besides supplying electricity to a large district. I will not go into detail of this large scheme as this is given in reports elsewhere.

The capital outlay in the various irrigation schemes is enormous and is backed by the Government.

All the irrigation is done by gravity, except numerous deep well pumps in the South where the water is pumped direct on to the land.

The sugar land in Puerto Rico lends itself to irrigation as it is all fairly level, very different to the conditions prevailing in Natal. Here the Topography of the country and the rainfall is such that irrigation must be dependent on pumping and storage dams.

The actual applications of the water in Puerto Rico is carried out on the Hawaiian system which is simply level ditches every 100 to 200 feet according to the steepness, with laterals running down every 30 to 40 feet apart and the water runs down each line of cane. The irrigator admits to one of these ditches as much water as he can handle which varies from $\frac{1}{4}$ cusec for ground with pronounced slopes to $\frac{1}{2}$ cusec for flat or nearly flat ground. Water is taken into each furrow by plugging the ditch just below the furrow with a few shovelfuls of dirt. After the furrow is filled as desired, the inlet is closed with dirt—this process is repeated with each furrow.

This method of applying water is very economical but whether it can be applied successfully on our steep slopes is a matter for further investigation.

Since my return from Puerto Rico we have carried out a number of experimental plots on this system on fairly level ground and there is no doubt that this is the best method as it means economy of water in that you have better control and can cover

the ground quicker than the method that we have adopted of trying to cover the surface of the ground between level ditches.

Fertilizing, planting, and irrigating are practically done in the one operation, generally the fertilizer is applied in the furrows before planting (some Estates apply the fertilizer at various intervals after the cane has come up) then the tops are laid in the furrow and covered over very slightly with soil and the water is turned in as soon as possible afterwards, followed six days later with another application of water, this ensures a quick germination, and then at regular intervals of fortnightly applications.

It has been proved by a very detailed experiment carried out by the Isabella Experiment station that frequent light applications with an interval of a fortnight produces the best results.

In the Isabella district where there was an average of 54 inches of rainfall the irrigation water supplied was 48 inches or 4 ac. feet at the rate of 2 inches per fortnight this would make a total of just over 100 inches. It is possible in these countries with an even temperature, for this amount of water to be applied, but here in Natal with our 3 to 4 months of winter 70 to 80 inches including our rainfall would be sufficient.

There are many problems attached to irrigation particularly in this country where conditions are peculiar to our own special province—the most important of which are as follows:—

1. The variety of cane to suit the soil.
2. The analysis of soil.
3. The right quantity of fertilizer to apply.
4. The right time to apply fertilizer.
5. The right time to apply water.
6. The right quantity of water to apply.
7. The best method of applying water.

The most important thing of all in irrigation or anything else in connection with cane culture is the "time factor." It is necessary to do all the multiple operations on time or the proper time and then you will get the maximum benefit.

There is no doubt that the primary factor for the growing of cane in Natal is water—fertilizing and everything else follow if we have sufficient water.

If the Puerto Ricans find it necessary to spend huge sums on irrigation with 50 inches of rainfall, how much more necessary is it for us where we have such a low rainfall.

We have plenty of water in Natal with our rivers flowing away into the sea and with the help of the Government (we have a Minister of Irrigation) the same co-operative scheme for planters could be worked as in Puerto Rico.

I am convinced that we could double our output in Natal with irrigation and so compete successfully with the other sugar producing countries in the world.

As an example I give the results of an experiment on the varieties issued by the Experiment Station. The canes were irrigated under the Hawaiian system of irrigation and cut as 12- 13 months old plant cane and I also submit a record of the rate per acre in the same field reaped as two year old unirrigated cane previously over five cuttings for comparison:—

Experiment of Varieties carried out under Irrigation.

Planted end of September, 1932. 12-13 months old.
30 inches of water applied per acre.

34 ac. Flat.

Variety	Tons Cane per acre	Tons Sucrose per acre	Purity	Sucrose % Cane	Fibre % Cane
Co. 290	35½	4.14	89.6	13.3	12.34
P.O.J. 2878	39.3	5.9	90.7	15.01	10.97
P.O.J. 2725	35	5.4	94.0	15.53	12.27
P.O.J. 2727	25	3.75	91.6	15.00	12.74
P.O.J. 2714	18.37	2.89	92.7	15.75	11.42
CH. 64/21	15.37	2.009	88	13.07	15.57
Uba	9.55	1.345	89.7	13.95	13.57

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CHAIRMAN: I am sorry Mr. Garland is not here to reply to any questions which are going to be put. I am grateful to Mr. Fowlie for reading the paper. Mr. Garland was sent over by his firm to Puerto Rico to the last International Technologists' Association meeting, and from what I can see of it, it has certainly been money well spent, even if he had gone on irrigation only. There has not been very much irrigation done in South Africa on this scale—he says that in Puerto Rico they do it in patches of 25,000 acres at a time. They must go in for it pretty extensively. I understand that the information he gained there has been very valuable. This is a pretty good instance of how this industry here could benefit by sending men about the world for study and information. You cannot help learning. This paper is now open for discussion.

Mr. DYMOND: I took on the convenership of the Irrigation Committee, not because I know anything about it, but because I hoped to be able to get together the irrigation people and get some-

34 acre Flat Field Results.

	Tons Cane per Acre
1924 Plant	29.4
1926 First Ratoons	19.5
1928 Second Ratoons	31.8
1930 Third Ratoons	27.2
1932 Fourth Ratoons	19.5

Cost of water applied per acre.

30 inches @ 25/6 per acre foot 63/9

Cost of application per acre.

12 applications @ 2/- per application 24/-

87/9

No cultivation was done except by hand. The soil is heavy clay soil and a fair average throughout with no great variation in soil type. The pH. showed on the acid side and an application of 2 tons of lime per acre was applied.

The yield per acre in Sucrose of the three leading varieties P.O.J. 2878, P.O.J. 2725 and Co. 290, can be said to equal that of any part of the world, especially in view of the fact that this was 12-13 months plant cane.

thing out in the way of papers this year. But owing to locusts and various other matters, these papers were delayed. Eventually Mr. Garland stepped into the breach with his contribution as a basis for discussion. One resolution was passed by the Committee, and that was that we should ask the industry to set aside about 100 acres of land for the purpose of experiment on irrigation in this country, and I should like this meeting to pass a resolution that this idea be passed on to the general committee for their consideration, and that the right people be approached to carry out this idea during the next year.

Mr. J. MURRAY: I was rather surprised at Mr. Garland's remark about his not having adopted this Hawaiian method of irrigating cane previous to his visit to Puerto Rico. I was in Hawaii some 20 years ago, and the method there then was such as Mr. Garland describes. He missed telling us that first of all you have got what they call a main ditch, along which the water is pumped. The water

has got to be taken from this main ditch to the level ditches. The level ditches are probably 600 feet apart, but in some parts of the country they are about 50 feet—they have to follow the contour. Laterals, as he says, run down from the level ditches every 35 feet. No cultivation could be done by animals or any sort of plough. It has all to be done by hand. The yield is so enormous that it pays to do it in this way. I think myself in a hilly country it would be a very expensive arrangement to irrigate cane where there is any fall at all. If it is not put in a cement culvert or something of that sort, it will wash away the ground. I have seen it going down 10 to 15 feet in no time. Great care with the water has to be taken from one level ditch to another. You can quite imagine the main ditch being at the top of the field and these level ditches every 200 or 600 feet down to the bottom of the field, for that water to be led into each of the level ditches requires great care. The water must be led to every part of the field. It is a most intricate business, irrigating cane fields.

CHAIRMAN: The last information I got from Hawaii, was that they have changed all their systems of irrigation; they are doing entirely differently from what they did ten years ago. They have tried overhead irrigation and devised a spray with nozzles. I do not think it was very satisfactory. They have now changed all their ideas of irrigation. What they are doing exactly, I do not know. But I understand, too, that the Hawaiian people now are cutting out the ratooning of cane altogether. They are getting down to canes which grow very quickly and mature very quickly. It pays better to plant up every field every year than it does to handle the ratoons. They find it is cheaper to plant the cane with the appliances they have got for planting, than it is to tackle the ratoons. All the planting is done mechanically. They do the ploughing and planting more or less at the same time.

Mr. DODDS: I think this is a very valuable and interesting paper from Mr. Garland, as far as it goes. I should have liked to see it go a little further. Mr. Garland, I know, spent a lot of time in Puerto Rico concentrating on the study of irrigation, and he gained a lot of very useful facts and figures. I would have liked him to have given us a little more specific information; perhaps he will do so on a future occasion if we press him. The experiments described here and further explained by Mr. Fowlie also are instructive up to a certain point, but it is not mentioned whether there was any replication of the plots. As a matter of fact there was, not, so I think the figures must be accepted with some amount of reserve, because of the very large experimental error that would most certainly occur where you only have one plot of each variety, and which cannot be calculated without replicated results. However, it is sufficient to show, even taking into consideration this and

also the difference in soil that has been referred to, the very great potential advantages to be obtained from irrigation. I think Mr. Garland's claim was perhaps a little overstated where he says "The yield per acre in sucrose of the three leading varieties . . . can be said to equal that of any part of the world." It is well known that in Hawaii and Java for a 15 months' crop they get an even larger yield of sucrose per acre than is recorded in these figures, and these are plantation averages, not the maxima that can be obtained from selected fields. With proper study of the matter, therefore, even greater increase in crop yields could be obtained. That brings me to another point that Mr. Dymond mentioned, the necessity of doing work on irrigation lines. There is perhaps no one direction in which experimental work could be more fruitful in this country than if devoted to irrigation work, where conditions in so many respects are almost ideal for getting the maximum results from irrigation, and I have long maintained that one of the first aims of the sugar industry should be to establish systematic experimental work in irrigation. Unfortunately, it has not met with the enthusiastic support of a considerable portion of the industry, who feel, perhaps, that they are not in a position to use irrigation themselves and therefore are not directly interested—perhaps even fear its competition. Nevertheless, in the interests of the industry as a whole, this work ought to be done, and I hope that the committee of which Mr. Dymond is convener, will push this matter in the future, and they can count on getting whatever support we can give them from the Experiment Station. We have already established one or two co-operative experiments under irrigation, especially at Umfolosi, under the charge of Mr. Murphy, but very little has yet been attempted in this direction. Concerning many questions of fundamental importance in this matter we have no information whatever, and have not begun to acquire that knowledge. Mr. Chairman, you mentioned the position in Hawaii. Present irrigation practice seems to be largely in a state of transition there. In a recent report from Hawaii on methods of irrigation, I noticed that there were perhaps 12 or 15 different systems of applying water in use. Not one of them was applied for more than 18 per cent of the total area under irrigation, so evidently they are experimenting on a large scale there, even with the vast experience they have already accumulated. One outstanding fact was that spray irrigation, of which we heard so much in the case of Hawaii, has by this time shrunk almost to vanishing point.

Mr. METCALF: I would like to ask—what was the nature of the subsoil in which these experiments were carried out? and secondly, whether the irrigation was supplementary to the rain, or was it systematically applied throughout the season?

Mr. FOWLIE: These experiments were carried out on a nearly flat piece of land where the top soil was heavyish with a little bit of sand in it, but more clay. The underlying stratum was heavy clay at not very great depth.

With regard to irrigation, as it is quite close to the Experiment Station, we have been able to see what has been going on. They have kept it wet practically the whole year. If they had rain sufficient to make irrigation unnecessary, the irrigation was delayed until such time as the rainfall was more or less used up. At no time was it allowed to become really dry. I think the irrigation was done at approximately about three-week intervals.

Mr. METCALF: Each application of water, would it be equivalent to a three-inch rainfall?

Mr. FOWLIE: I am not prepared to say definitely how much it was. I think they reckoned that it was more nearly approximate to a two-inch rainfall, and I should say, from my own experience of irrigation, that this would be the case, taking the nature of the soil into account. They used enough water to run it along each furrow, a matter of about 35 or 40 feet, and then shut off and went into the next row.

Mr. FOWLIE: With regard to Mr. Dymond's proposition, I would like to support, with my own little word of commendation and appeal, the idea that further facilities should be given for irrigation experiment. As another member of the Irrigation Committee, I do not think I am giving any secrets when I say that Natal Estates, Ltd., are now very

keen on having irrigation experiments carried out, and I have reason to believe that they would consider assisting us in various ways if the Experiment Station were to undertake to carry out irrigation experiments.

CHAIRMAN: There is just one point I would like to mention concerning irrigation. Most people who go in for irrigation have not much money. They may have £1,000 or £500. When a man goes in for irrigation and pumps water on to flats—I do not know whether he is right or wrong. This is a point that should be investigated. In dry weather the flat will keep its water long after the hillsides do. It might be better to pump the water on the hillsides to keep the cane alive, and let the flats look after themselves. I think that is a point which the Irrigation Committee should go into. In 90% of cases people irrigate the flats.

I think this paper has brought forth a lot of useful discussion. I would ask Mr. Fowlie to convey our thanks to Mr. Garland for it. I am sorry he could not be here to read it himself. We thank Mr. Garland for his paper, and I would ask you to signify your approval in the usual manner. (Applause.)

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Mr. B. E. D. PEARCE, the President, presiding.

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The Chairman called on Mr. Dodds to read the first of his papers: "A Field Trial of certain Coimbatore Canes."