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EDITORIAL COMMENTS.

The J.A.S.T. Journal is now in its twelfth year of existence. Last year it was decided that the Journal would be improved by confining its publication to one annual issue to contain the entire proceedings of the Association for the year. At the same time, provision was made for publication of supplementary issues from time to time, for articles or papers of special interest, not presented at meetings of the Association.

This year, the form and size of the Journal have been changed to conform more to the publications of other technical bodies connected with the Sugar Industry. Change, often a sign of progress, can of course be for the better or worse. It is hoped that the present change in our Journal will be regarded as being for the better and also a sign of progress. From our own point of view, the printing of this particular issue has meant a lot of headaches and we very much regret the considerable delay in its publication. This year's experience, we hope, will assist us in having next year's issue off the press at a much earlier date.

This issue has as its frontispiece, the photographs of the President and Past-Presidents of the Association. While we in the Jamaica Sugar Industry know these gentlemen, who have done so much for the progress of our Association, it was felt high time that other readers of our Journal, outside Jamaica, should be helped to know better the persons responsible for the able administration of our Association over the past twelve years.

We conclude by repeating the appeal, made by the President in his annual address, to all members to give support to the Association during the coming year, by making more active contributions in the form of papers for presentation at meetings of the Association. Study of the Journal for the past few years will show that the bulk of the matter printed in it is the result of the efforts of the same small group of members who appear to be tireless in their attempts to place matters of interest to the Industry before the membership of the Association. There appears to be a feeling amongst our members that presentation of papers should be left to those of our Association who perform investigational or research work, either on a whole or part time basis. This is an attitude which may check the progress of the Association. The J.A.S.T. was formed so that knowledge about the growing and processing of sugar cane could be disseminated throughout the Industry in Jamaica and our meetings are intended to give **all** members an opportunity of presenting the knowledge they have gained to the other members of the Association. Papers on research or investigational work, are largely based on reporting a series of observations. Observation is a gift not confined to research workers alone. Any member can record his observations of unusual happenings in the field or factory, which would be of interest to other members and might be of considerable value to the Industry by indicating possible lines of future investigations. The Jamaica Sugar Industry has derived benefit by the interchange of information amongst those persons that constitute it. All members are urged one again, to make greater contributions to such exchanges of information.

Hon. F. M. Kerr-Jarrett thought that the problem was perhaps being tackled from the wrong angle and that a small factory having no steam problems should perhaps be investigated first and the results applied to the less efficient units. He quoted the case of Richmond which had no steam or fuel problems.

Mr. Sharp said that Richmond was in the fortunate position of having a good water supply, was compact and well balanced and observations there might not be applicable at Rose Hall.

Mr. Davies pointed out that another factor was bagasse percent cane. For instance that at Barnett was about 22% as against 32% at Richmond.

The Chairman asked Mr. Scott about the possible effects of peak loads on steam economy.

Mr. Scott said that the only serious over load was caused when two stills in the distillery were started up together.

The Chairman then thanked Mr. Davies for presenting his paper and all who had taken part in the discussion.

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Induced Fermentation in Rum.

G. W. P. STRETTON, B.Sc., F.R.I.C.

Fermentation Chemist, Sugar Research Department, Sugar Manufacturers' Association (of Jamaica) Ltd.

(Mr. M. B. Floro in the Chair)

The Chairman stated that Mr. Stretton was unfortunately absent due to ill health, and that Mr. Sexton had kindly agreed to read the paper in his stead.

He suggested that Mr. J. G. Davies, who had collaborated in this work, would be able to answer any questions.

Mr. Sexton then presented the following paper on behalf of Mr. Stretton:—

It has hitherto always been the practice of distillers in Jamaica to rely on spontaneous fermentation. The composition of the wash is controlled but no attempt has, in general, been made to govern the organisms causing it to ferment. These organisms consist of the yeasts indigenous to the region of the particular distillery. They lie dormant in the out-of-crop season until the time when they are required to work in the vat house. It is then customary to set up a puncheon of cane juice, in which large numbers of these yeasts are to be found, and to pitch the first vats with it when it has begun 'working'. In this way, the vat house is seeded. Each successive wash becomes inoculated with yeast remaining in the vat from the one before or carried to it in the air by dust or by spray from the heads of washes 'working' nearby. In some places, instead of supplying yeast from cane juice, fermentation is started by introducing some form of baker's yeast into the first vats set up.

In either case, the yeast is then left to do its work and no further steps are taken to renew it or to ensure that it continues to be present in sufficient quantity to effect rapid and complete fermentation.

When a commercial yeast is added it has sometimes been noticed that the yield of spirit is good at first but later falls off. Then, after a while, conditions improve by themselves and yield increases again. This suggests that the original yeast type has died out and has been replaced by native yeasts.

Far too often, however, fermentation weakens after a good start and does not recover. The washes are seen to 'work' more and more feebly until, after standing half dead for days, they eventually die at a high Brix. The dunder itself ferments in the cooling tanks and this dunder in turn has a bad effect on the yeast when added to subsequent washes. While fermentation gets progressively less active, other reactions take place as undesirable organisms face less and less competition from the yeasts. Finally, after such expedients as lowering the live wash density or even adding lime have been tried, it is found necessary to start the whole process again with a fresh pitch of cane juice or yeast. Fermentation begins actively once more and yield improves. But unfortunately, as likely as not, the same thing will happen again, for there is no reason why it should not.

The explanation is to be found in yeast population. Efficient fermentation with good attenuation cannot be achieved if too few yeast cells are present in the wash. When a start is made with cane juice or commercial yeast, the wash is pitched with a crudely developed yeast culture and quite good attenuations may be obtained. But if this process is not repeated, if no further steps are taken to add yeast to the wash, then each vat starts with only the very small number of cells accidentally reaching it. Now, yeast multiplication in the wash takes place only during the first few hours. After fermentation

has begun, the increase in yeast population is negligible. Thus if fermentation is to be carried out by an adequate number of yeast cells, the wash must receive a sufficiently large number of them at the beginning. Spontaneous fermentation, or "accidental pitching" to give it a more descriptive name, cannot be relied on for this, and once the yeast begins to fall away in strength and amount, a progressive worsening of the situation in the vat house is almost certain to result. The only true remedy is to ensure that sufficient yeast is added to each wash. This process I have called "Induced Fermentation" in contrast to the other procedure.

A comparison of the results given by the two methods is furnished by the figures obtained in Barnett distillery during the 1947 and 1948 crops.

In 1947, fermentation was begun with commercial yeast and then left to proceed by itself. The results fell off during the 5th. week when (Figure I) the "lbs. R.S./gallon Abs. Alc. in wash" rose to 33.49 and after distillation of these washes the "Recovery % Theoretical" (Figure II) for the 6th. week fell to 44.61%. The washes at this time had the typical appearance of a "sick" fermentation and it was suggested that a thorough cleaning should be carried out and a fresh start made. This was done and improvement resulted. The "lbs. R.S./gallon Abs. Alc. in wash" for the 7th. week fell to 26.51, with a "Recovery % Theoretical" of 50.44% and 69.62% for the 8th. and 9th. weeks respectively.

This improvement was not, however, maintained and the fluctuating values of "lbs. R.S./gallon Abs. Alc. in wash" and the drop in "Recovery % Theoretical" after the 7th. week are seen in the diagrams. During the 10th. week the former had risen to 30.28 and the "Recovery % Theoretical" for the 11th. week was only 48.81%.

It was at this stage that induced fermentation was introduced. This was done, one might say, on the spur of the moment and without the construction of any special apparatus.

Four gallons of molasses and water at 10.5° Brix were made up in a small oil drum. After the addition of 0.1% of Ammonium Sulphate, the pH was adjusted to 4.8 with Sulphuric Acid and ¾ lb. of soft Fleischmann's baker's yeast was added. Fermentation began after 1½ hours and, after 5 hours, the mixture was pitched into 50 gallons of molasses and water at 15° Brix and pH 4.7 in a puncheon. After standing overnight, this was found to be fermenting quietly. It was then added to 500 gallons of wash at 15° Brix containing dunder, in a vat. The pH was 5.1 with the dunder alone but was brought to 4.5 with Sulphuric Acid. This began to "work" after 2½ hours and, after a further 4 hours, the surface had a thick golden head. It was then topped up to 2000 gallons with wash at 17° Brix and, after standing overnight, was seen to be fermenting vigorously. Five hours later it had almost died down.

Meanwhile another vat had been set up at 20° Brix which was pitched with 200 gallons of activity fermenting wash from the first vat. This process of cross-pitching from vat to vat was continued until the alcohol yield began to deteriorate. Experience showed that it was advisable to start a fresh yeast culture twice a week, on Mondays and Thursdays, cross-pitching in between.

The fermentation was conducted in this manner until the end of crop, for the last five weeks of which, "Recovery % Theoretical" averaged 67.29% and "lbs. R.S./gallons Abs. Alc. in wash" averaged 21.35. From diagrams I and II it will be seen, also, that fluctuations in these values were greatly diminished during the 13th. — 17th. week.

The results obtained at Barnett during the 1948 crop will be referred to later.

During 1947, also, the use of a commercial yeast in the distillery was being explored quite independently elsewhere. Mr. Owen Clarke designed and carried out at Worthy Park a series of trials more extensive than the Barnett experiment. The yeast which he used was a dry yeast described by the manufacturers as being good both for baking and for alcohol production. The results were very satisfactory and it was decided that further trials should be made of this method during the following crop by the Research Department.

The procedure in use at Worthy Park is as follows:—

> A 400-gallon culture vat was constructed having an outlet to the mixing cistern; wash can also be pumped back into the culture vat from the mixing cistern. 2 lbs. of the dried yeast are creamed up and put into 40 gallons of molasses and water at 16° Brix containing ¾ lb. of Ammonium Sulphate or Phosphate. After 3—4 hours, when it has begun to "work", this is pitched into 400 gallons of wash at 18° Brix, containing 11% dunder, in the culture vat. As soon as this begins to ferment strongly, half of it is added to 2000 gallons of wash in the mixing cistern. The quantity so removed is immediately replaced by pumping back 200 gallons of the same wash from the mixing cistern into the culture vat. The rest of the wash (2000 gallons) is then taken to a fermenting vat. Thus, in effect, two dilutions of the original yeast culture are made, each of 10%.
>
> It was found that, to obtain the best results, a new culture of yeast should be made every day; also that it is important not to allow the wash in the culture vat to attenuate more than three or four degrees. If, through a delay in wash-mixing, the culture is left too long, the result is a less efficient fermentation.

The work carried out at Worthy Park in 1948 was designed to express quantitatively their previous findings and to determine the effect of differing conditions on the efficiency of the fermentation. A number of trials were conducted with laboratory control. The results are shown in Table I.

TABLE I.

	LIVE WASH						DEAD WASH					
Trial	20° Brix	Sugar (% I.S.)	% Dunder	Gals H_2SO_4 in 2000	Lbs. $(NH_4)_2SO_4$ in 2000	pH	20° Brix	Sugar (% I.S.)	Attenuation	pH	% P.S.	Fermentation Efficiency
1	18.30	12.88	10	¼	0	5.10	6.40	0.78	11.90	4.55	12.12	83.23
2	17.70	11.88	10	1¼	0	4.70	6.20	0.82	11.50	4.40	11.50	85.63
3	18.30	12.12	10	2½	0	4.30	6.10	0.62	12.20	4.65	11.76	85.82
4	22.40	16.36	10	2½	0	4.65	7.70	1.60	14.70	4.55	14.73	79.64
5	21.80	15.52	10	½	10	4.85	10.85	2.52	10.95	4.40	12.65	72.09
6	22.00	16.36	10	0	15	5.40	11.45	3.96	10.55	4.30	11.30	61.10
7	18.50	13.92	0	2	5	5.20	5:60	0.28	12.90	4.60	12.73	80.90
8	20.70	13.44	15	1	5	5.10	10.00	1.70	10.70	4.25	10.02	65.95

From these, the following conclusions were drawn:

(1) **pH.**

Trials 1, 2, and 3 were designed to show the effect of pH. These three washes had the same amount of dunder and almost the same sugar concentrations. Differences in pH between them were owing to the addition of different amounts of sulphuric acid. They show that pH 4.7 is suitable and that the cost of further addition of sulphuric acid is not justified.

(2) **Sugar concentration.**

Trials 2 and 4 differ chiefly in the sugar concentration and show a decrease in efficiency for the higher percentage of sugar.

(3) **Ammonium Sulphate.**

It was thought worthwhile to determine whether the addition of ammonium sulphate would increase the fermentation efficiency in washes containing too little acid, thus economising in the use of sulphuric acid. Trials 4, 5 and 6 considered together have a bearing on this point. These three sets are graded so that. while the same amount of dunder and sugar are present in each, the amount of ammonium sulphate is increased as less sulphuric acid is added.

The figures indicate that the desired result was not forthcoming.

(4) **Dunder.**

Washes 7 and 8, while at the same initial pH (5.1) and sugar concentration, differ in the relative proportions of dunder and sulphuric acid added. Number 7, having no dunder, gave a much higher fermentation efficiency value than number 8, in which acidity was adjusted by the addition of dunder alone. It was not practicable to bring these washes to the optimum pH (4.7) by using only dunder or sulphuric acid. However, the results serve to indicate that dunder contains substances which depress fermentation. Further experiments on this point will be described below.

It is interesting to note the low figure (0.28%) given by number 7 for sugars in dead wash. This wash did not, of course, have unfermentable reducing substances added to it with dunder.

The same method of fermentation was then introduced into Barnett factory.

From the beginning of crop they had been continuing to use the process which had been tried in 1947. It will be seen from Diagrams I & II that this was still giving far better results than had been got early in 1947 by "accidental pitching", although a greater fluctuation in recoveries was taking place than one had expected.

The essential differences between this method and that used at Worthy Park may be summarised:

BARNETT.

1 Soft baker's yeast.

2 A fresh yeast culture set up twice a week.

3 Cross-pitching from vat to vat between fresh cultures.

WORTHY PARK.

1 Dry baker's yeast.

2 A fresh yeast culture set up every day.

3 All sets pitched from a culture vat.

A culture vat was set up at Barnett and the Worthy Park procedure was begun during the 8th. week of the crop.

Figures I & II illustrate that from the 8th. week, a good return with greatly diminished fluctuation was obtained during the subsequent eight weeks of crop.

The opportunity was taken while these trials were being conducted to test further the effect of dunder by varying the amount added and adjusting pH with sulphuric acid, sugar concentration being kept constant.

The results obtained were:—

TABLE II.

	% Dunder	% Sugar as I.S.	pH	Fermentation Efficiency
1	10	11.88	4.70	79.64 (average of 8 sets)
2	15	12.02	4.75	78.76 („ „ 5 „)
3	20	12.82	4.78	75.03 („ „ 4 „)

The addition of dunder would thus appear to result in a decrease in fermentation efficiency as compared with sulphuric acid. But it must be remembered that it affords the most economical way of acidifying wash to the desired pH and that it contributes to the characteristics which distinguish Jamaica rums from those produced elsewhere without the use of dunder.

At Rose Hall factory where induced fermentation was also tested, improved yields resulted as is indicated by the following average figures:—

TABLE III.

	Without Added Yeast	With Commercial Yeast Added
No. of vats	17	38
Live Wash °Brix	20.33	20.27
% Total Sugars in Live Wash	11.12	10.70
Dead Wash °Brix	9.87	9.06
% Total Sugars in Dead Wash	0.90	0.92
Attenuation °Brix	10.48	11.21
% Proof Spirit in Dead Wash	8.31	9.05
Abs. Alcohol % Sugars Used	36.20	40.89
Fermentation efficiency	71.66	81.12

The results obtained by these trials show clearly the effect on spirit production of maintaining a large yeast population and procedures such as those described have long been standard practice in distilleries making industrial alcohol. The manufacture of potable spirits is a more complex process since the nature and amount of secondary constituents determine the character of the product. The role played by micro-organisms in this important aspect of rum production has not yet been precisely determined though undoubtedly the action of bacteria is responsible for the higher esters present in a heavy rum. However, in the case of "common clean" rums such as are produced by almost all distilleries nowadays, these effects are of much less importance than formerly; and it is felt that the results so far achieved by inducing a rapid fermentation with a large yeast population indicate that this technique has much to recommend it as compared with "spontaneous fermentation" in the efficient production of light bodied rum.

DISCUSSION.

Mr. McFarlane congratulated Mr. Stretton and the Managements concerned on their original work and was glad to see that culture yeast was being adapted to rum production. He compared the process described to that in use in big distilleries, where wash of 8°Brix with less yeast was used, as against wash of 10.5°Brix as described. In addition to sulphate of ammonia, the big distilleries also used phosphate in the seed stages and aerated the seed to assist in the development of the yeast. A yeast population of 180 million cells per c.c. in the fermenters was maintained. He noted that dunder had been thought to inhibit fermentation, and enquired if the unfermentable sugars in the dunder had been taken into account in calculating fermentation efficiency.

Mr. J. G. Davies pointed out that sulphuric acid had been in short supply during the experimental period and was also very expensive.

Mr. Owen Clarke said that trials had been planned to determine whether sulphuric acid would be beneficial, but the quantity required was uneconomic.

Mr. H. Suberan said that during the warmer months of the year at Caymanas, they had trouble with fermentation and tried out Mr. Stretton's method. They added 2 lbs. of yeast to 200 gallons of cane juice at 12°Brix and left it to ferment. When it had attenuated 10° it was added to 4,500 gallons of wash containing 10% of dunder. The percentage conversion rose from 88 to 94.

The Chairman described the Melle process in which instead of using a pure yeast culture the yeast normally found in a distillery was used. It was separated in a centrifugal separator and the yeast cream used to start another fermenter. This had the effect of minimising the consumption of carbohydrate for the multiplication of yeast cells, thus making it available for the production of alcohol. With the yeast already acclimatised to the distillery, there was no drop in fermentation efficiency, and the process was so simple that it could be used in

any distillery. Another method of seeding had been described to him by Dr. Thaysen in which starting with 10 gallons of wash and doubling it instead of building up from 10 gallons to 50, 200, etc., the time required for building up was considerably reduced. He suggested that the population density to be maintained in our distilleries should be investigated.

Mr. J. G. Davies said that this investigation had been planned and that the apparatus was on its way.

The Chairman questioned what type of yeast could survive in acid dunder and if it had been identified. He thought that it must be a different type of yeast from the ordinary rum yeast.

Mr. McFarlane referred to the Melle-Boinet process that had been mentioned by Mr. Floro, and stated that cane molasses had not been found suitable for that process.

Hon. F. M. Kerr-Jarrett said that in the old days when Mr. Cousins was investigating rum manufacture at Hope, it had been found that the Trelawny yeasts were either top or bottom fission yeasts. They had deliberately made acids with cane juice to induce them to multiply. This was in connection with continental flavoured rum.

Mr. Dalley described his experience during the past crop at New Yarmouth. He said that before the rains, they had had no abnormal trouble with scaling of still coils, but after the rains considerable difficulty had been encountered. The yields had dropped, and the distillery had had to be stopped for cleaning out, and a fresh start made. This had no effect, so the cleaning was repeated and sulphuric acid was used instead of dunder. The dunder fermentation was foaming and dirty, whereas the sulphuric acid fermentation was relatively clean, but apparently the scale forming substance, instead of being worked off the head during fermentation, was deposited on the coils. It was necessary to clean after two days operation. They reverted to dunder fermentation, found that the scale formation had lessened but that the yields were low.

The Chairman recommended that Mr. Dalley should send a sample to the Research Department on the next occasion when he noticed a frothy fermentation so that they could ascertain if the substance were not dead yeast cells. It was everybody's experience that after a dry season solids in water increased and so did the calcium content. The addition of sulphuric acid would increase the percentage of calcium sulphate present, and induce the formation of a heavier scale on the coils.

Mr. Scott referring to Mr. Dalley's experience, said that he had observed a similar condition at Rose Hall where the fermentation also had a dirty head. This was ascribed to bad clarification in the factory. Mr. Davies had recommended the use of superphosphate which had done a lot of good to the clarification, but the dirty head was still observed in the distillery. The wash started to ferment quite cleanly but developed the dirty head after dying off. This suggested that a secondary fermentation might be occurring. Fresh starts had been made but the trouble continued.

Mr. H. Suberan said that he had experienced the same difficulty which he had overcome by diluting molasses with hot condensate water to 45°Brix and allowing it to stand overnight before mixing wash with it. He had noted a slow fermentation, an increase in attenuation and the absence of scale on the still coils.

Mr. Gangadeen expressed doubt as to the value of figures reported by several distilleries. There were more total sugars % solids in the live wash than in the molasses from which it was made, and there were also other discrepancies to be noticed. He enquired what proportions of the deposits on the coils were due to calcium sulphate and what to dead yeast.

Mr. J. G. Davies referring to the distillery analyses and methods, stated that a J.A.S.T. Committee on Comparative Factory Returns had been set up. They had recently completed a set of standard methods which had been recommended for factory control, and were now working on a similar set of standard methods for distilleries. He noted that more and more distilleries were using chemical control. In comparison with the rapid formation of scale at New Yarmouth, he gave an example of a continuous still in Trinidad in which 3/8" of scale had been formed in three days. The scale consisted mainly of calcium sulphate which was easy to be recognised because the crystals were formed through the scale. The organic matter present was probably sludge and dead yeast cells.

Mr. Dalley said that the scale at New Yarmouth was more like a mud deposit and a ½" to 3/8" was formed in two days. White crystals were present but not in large proportions. Scale formation was worse when the fermentation was clean.

Mr. J. G. Davies pointed out that sulphuric acid increased the SO4 ion in the wash, and would tend to increase the formation of calcium sulphate scale. The gummy matter was probably incorporated in the scale during the crystillization of calcium sulphate.

Mr. McFarlane stated that calcium salts were generally less soluble in hot water than in cold water. Many distilleries now removed calcium before fermentation using either the Arroyo or Reich processes.

The Chairman asked Mr. Dalley how long was his wash settled before distillation, and at what level was it drawn off.

Mr. Dalley replied that they used 1,500-gallon vats and drew off the dead wash 3½" from the bottom. Fermentation was complete in 24 hours and the wash was settled 6 hours after it had died off. By visual observation it appeared to be well settled. They had tried increasing the draw-off level to 6" but later reduced this 3½", because clean wash could apparently be obtained down to that level.

The Chairman thanked Mr. Stretton for starting this work which he hoped would be continued. He also thanked all those who had taken part in the discussion.

DIAGRAM I

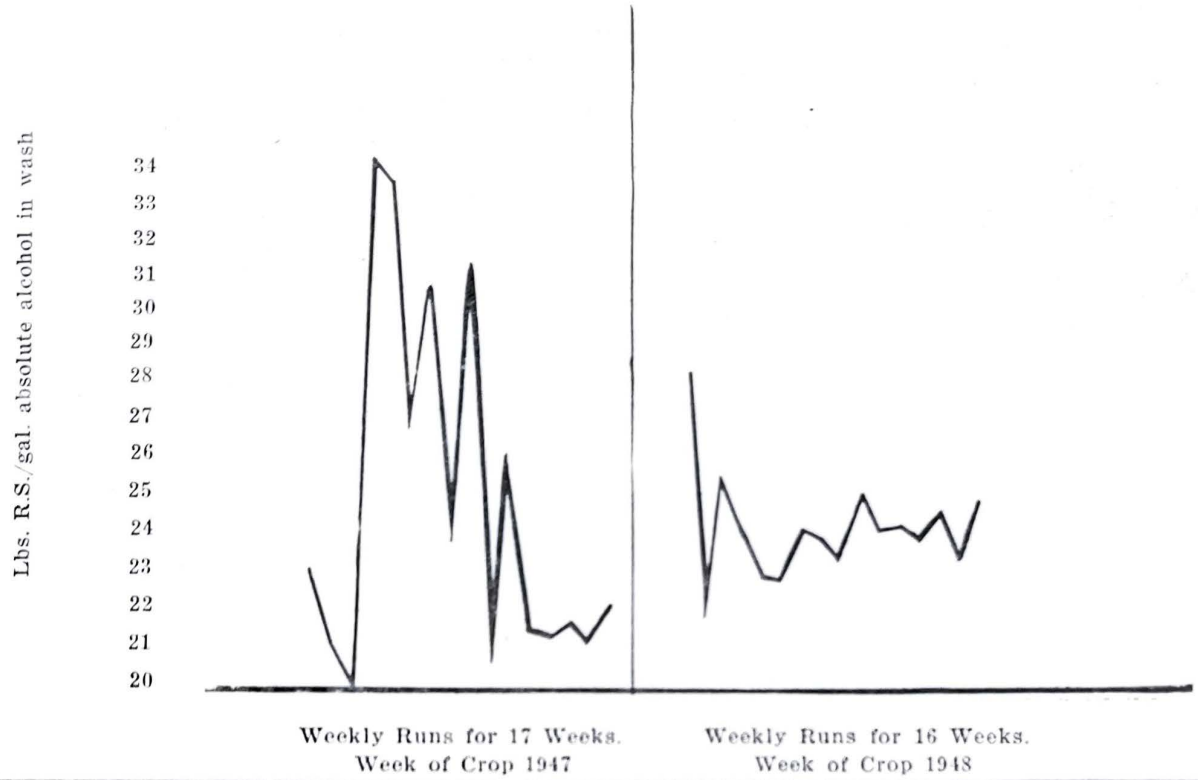

DIAGRAM II