Some Aspects of Ratooning in Sugarcane

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1. Introduction.

Ratooning Sugarcane is the growing of successive crops from one year's planting after every harvest and is practised in many of the sugarcane-growing countries of the world, as for example in Louisiana, Mauritius, Cuba, West Indies, British Guiana and in Hawaii islands. In India the practice was not common due mainly to lack of suitable varieties, but the position has now changed, with the introduction of hardy seedling canes from Coimbatore. It has now become a general practice in many places to ratoon canes. In places like Valavanur in South Arcot District of this Province even seventh and eighth ratoon crops are being taken with the variety Co 281.

2. Area under Ratoons.

No reliable figures are available with regard to the area under ratoons. In the Season and Crop Reports (2) the percentage of area under ratoons is said to vary from 5·83 to 12·48% of the total area under sugarcane. In order to assess to a fair degree of accuracy the extent of ratooning that is practised, the area under plant crop and ratoon in a few villages in Gudiyatham taluk were ascertained. The figures are given below :—

TABLE I.

Serial No.	Year	Name of Village	Total area under cane in acres	Area under Ratoons in acres	Percentage area under Ratoons to total cane area
1.	1947	Thalayatham	94·90	45·22	47·64
2.	1944	Cheruvanki	97·64	49·45	50·64
3.	1944	Melalathur	31·69	9·03	28·49
4.	1944	Kil Vaithanankuppam	104·95	50·18	47·78
5.	1944	Mailpatti	73·35	44·72	60·96
6.	1944	Ithampet	87·98	56·72	64·48
7.	1944	Kailasagiri	70 25	41·59	59·20
		Total.	560 76	296 91	52·94

Thus the area under ratoons varied from 28·49 to 64·48% with an average of 52·94% of the total area under sugarcane. Dutt (7) has pointed that the percentage of area under ratoons has shown a considerable increase during the last few years, and the figure is now more than 30% of the total area under sugarcane.

3. The Present Position of Ratooning.

The reasons for the increasing popularity of ratooning is the saving in the cost of cultivation as the expenses towards preparatory cultivation and planting are avoided and also the ease with which a fairly good crop can be grown without taking the trouble of planting again. Yet opinions with regard to the economics of ratooning vary, and are sometimes even conflicting. Some experiments have already been done on this aspect in some Research Stations like Anakapalle, Palur, Samalkot and Gudiyatham in this Province and in Mushari in Bihar and Kalai in the United Provinces. In an earlier experiment done at Anakapalle (1934—'35) it was stated that the general growth of cane, density of crop, ripening, and tonnage are better in the ratoon crop than in the plant (3) while in a subsequent trial with a standard method of layout with the variety Co 419, ratoons were found to yield less than plant crops and it was found economical to take only one ratoon crop (6). At Palur (1935—'36) ratoons were shorter and less in yield than plant crop and were also more susceptible to insect pests and diseases (5). At Samalkot thin canes were found to be better ratooners than thick canes (4). In Mushari. Bihar, no reliable conclusions could be drawn with regard to the growth and yield of cane owing to the abnormally poor crop (7). At Muzaffarnagar some indications were obtained that for ratooning the best time for harvest is late February or March. At Kalai it was possible to get as high yields from the ratoon crop as from the plant cane and the cost of cultivation of a ratoon crop was also much less than that of a plant crop. At Gudiyatham with increasing doses of manure the first two ratoons of varieties like Co 213 gave higher yields than plant crops.

4. Ratoon Experiment at the Sugarcane Research Station, Gudiyatham (1936—1939)

Three varieties Co 213, Co 414 and J. 247 were ratooned successively for three years and compared with a plant crop every year. The layout was 2 x 3 x 6 randomised blocks (split-plot design) with ratoon and plant crops as the main plot, and varieties as sub-plots, with six replications. The area of each sub-plot was 2 cents. The manurial doses were as given below:

Plant crops	...	150 lb. Nitrogen (100 lb Ammonium Sulphate and 50 lb. as groundnut cake.)
1st Ratoon	...	200 lb. Nitrogen (100 lb. as Ammonium Sulphate and 100 lb. as groundnut cake)
2nd Ratoon	...	250 lb. Nitrogen (150 lb. as Ammonium Sulphate and 150 lb. as groundnut cake)
3rd Ratoon	...	300 lb. Nitrogen (150 lbs. as Ammonium Sulphate and 150 lb. as groundnut cake)

All these were over a basal dressing of 10 tons farmyard manure and 2 cwts. superphosphate per acre.

Results: (i) *Yield.* The yields of cane from plant crops and ratoons of the different varieties are given below:—

TABLE II

Yield of cane in tons per acre.

	Ratoon crop.			*Plant crop.*		
	Co 213	Co 414	J. 247	Co 213	Co 414	J. 247
I. Ratoon	62·32	52·54	11·70	52·05	45·98	40·92
II. ,,	54·87	42·56	12·44	46·99	41·02	43·45
III. ,,	49·75	41·74	6·43	47·12	42·57	36·47

In Co 213, the first and second ratoon yields were significantly higher than their plant crops by 19·8% and 16·8%, but the yield in the third ratoon though 5·5% more than the plant crop, was not significant. Co 414 first ratoon was significantly more in yield than its plant crop by 14·2%, while the second and third ratoons were more or less similar. J. 247 first and second ratoons were very poor crops with only 28·6% of the yield of plant crops while its third ratoon recorded the lowest yield, being only 17·6% of the plant crop.

Co 213, a medium cane proved the best ratooning variety. Co 414, though a thick cane was also found to ratoon well, though not as good as Co 213. J. 247 was a total failure as a ratoon. It has to be noted that there was a gradual decline in yield in the case of subsequent ratoons, but yet even the third ratoon crops of Co 213 and Co 414, with increasing dose of manure were as good in yield as their plant crops.

(ii) *Number of canes per acre.* It can be readily conceded that the yield of cane from a plot or acre will depend upon the number of canes per acre and the individual development or weight of cane. The number of canes per acre, taking other conditions as normal, will depend on the germination and tillering or ratooning capacity of the variety. When the cane stool is harvested or ratooned, the tendency is for each of the underground portion of the secondary shoots as well as the main shoot to produce new shoots in turn. It is therefore reasonable to expect a larger number of shoots in a ratoon crop. This is borne out by the figures given below :—

TABLE III

Showing the number of canes harvested per acre

	Ratoon crop			*Plant crop.*		
	Co 213	Co 414	J. 247	Co 213	Co 414	J. 247
1st Ratoon	76,025	42,392	11,908	59,058	35,033	40,133
2nd ,,	68,967	32,700	10,300	56,892	31,542	37,600
3rd ,,	61,917	28,967	6,400	61,517	32,250	85,633

The number of canes per acre in the case of first ratoons of Co 213 and Co 414 were 28·7% and 21% respectively more than their plant crops. The number of canes in the second ratoon of Co 213 was also more by 21·3% while that of Co 414 was only 3·6% more than its plant crop. There was however a gradual decline in the number of canes per acre, with

successive ratooning, probably owing to the tendency for the older parts to die away. The period of profitable ratooning of any variety will therefore depend on this feature. Here again the unsuitability of J. 247 for ratooning was brought about by the miserably poor stand of the first, second and third ratoons which were only 29·7%, 27·4% and 18% respectively in number of the plant crops.

At Anakapalle the number of canes per acre of the first ratoons of certain varieties were said to be more than their plant crops (6). The results at Gudiyatham are in conformity with these results.

(iii) *Developmeut of canes.* It is a resultant of the length and thickness of cane, which in turn depends on the variety, soil, climate and conditions of growth.

(a) *Growth.* At Anakapalle (6) it was stated that ratoons receiving the same dose of 100 lb. Nitrogen as the plant crop were always shorter than plant crops. At Gudiyatham ratoons which received higher doses of manure than plant crops, (varying from 200 to 300 lb. Nitrogen), were not shorter than plant crops, but were even taller, except in the case of a poor ratooner like J. 247. Ratoons also made very vigorous growth in the initial stages.

(b) *Thickness of cane.* The average thickness of cane depends on the total number of canes per acre, and also on the manurial treatment. In the case of Co 213, 1st ratoon canes were definitely thinner, due presumably to an increase in the number of canes per acre, while in J. 247, ratoons were always thicker, owing to fewer number of canes.

(c) *Weight of Millable Cane.* This is the measure of the individual development of cane. In order to determine the difference in the development of plant crops and ratoons, the weights of millable cane were recorded for each sub-plot and the differences compared. The results are given below :—

TABLE IV

	Weight of Millable cane in lb.	S. E. of difference	
Co 213 Plant	1 995		
,, 1st Ratoon	1·838	0 055	Significant.
Co 213 Plant	1 848		
,, 2nd Ratoon	1·784	0·077	Not significant.
Co 213 Plant	1·719		
,, 3rd Ratoon	1·795	0·035	do.
Co 414 Plant	2·954		
,, 1st Ratoon	2·779	0·118	do.
Co 414 Plant	2·900		
,, 2nd Ratoon	2·818	0·157	do
Co 414 Plant	2·959		
,, 3rd Ratoon	3·221	0 067	Significant.
J. 247 Plant	2·344		
,, 1st Ratoon	2·121	0·147	Not significant
J. 247 Plant	2 578		
,, 2nd Ratoon	2·702	0·128	do.
J. 247 Plant	2·286		
,, 3rd Ratoon	2·205	0 048	do.

It can be seen that though the 1st ratoon of Co 213 was taller than the plant crop, the individual weight of the ratoon cane was significantly less than the plant crop, owing to the increase in the number of canes and consequent thinness. The differences in weight between plant crops and 2nd and 3rd ratoons were not significant. Similarly in the weight of millable cane of Co 414 first and second ratoons, the differences were not significant, while the 3rd ratoon was definitely weightier and better in development than plant crop. Differences in weight between plant crops and ratoons were not significant in the case of J. 247. Thus it is seen that under favourable conditions, ratoons are capable of making even better development than plant crops.

As mentioned before, the yield of cane is a function of the number of canes per acre, and the weight of millable cane and this fact is brought out by the tabular statement below :—

TABLE V

Treatments	Number canes % increase or decrease over plant crop	Weight of millable cane % increase or decrease over plant crop.	Yield of cane % increase or decrease over plant crop.
Co 213, 1st Ratoon	28·7	—7·9	19 8
,, 2nd ,,	21·3	—3·4	16·8
,, 3rd ,,	0·7	+4·9	5·5
Co 414, 1st ,,	21·0	—5·9	14·2
,, 2nd ,,	3·6	—2·9	3·8
,, 3rd ,,	—10·0	+8·8	— 1 9
J. 247, 1st ,,	—70 3	—9·5	—71·4
,, 2nd ,,	—72·6	+4·8	—71·4
,, 3rd ,,	—82·0	—3·5	—82·4

The increase or decrease in yield of ratoons over plant crop is more influenced by the number of canes, which is dependent on the ratooning capacity of the variety. Hence the success of ratooning depends upon the selection of a suitable variety that has good ratooning capacity, and giving it adequate manure for proper development.

TABLE VI

Frequency table of root system

Co 213 Plant crop.				Co 213, 3rd Ratoon.			Co 414 Plant crop.			Co 414, 3rd Ratoon.		
Class in inches.	Number of vertical roots.	Number of lateral roots.	Total.	Number of vertical roots.	Lateral roots.	Total.	Vertical roots.	Lateral roots.	Total	Vertical roots.	Lateral roots.	Total.
3″	70	...	70	55	..	55	26	...	26	61	...	61
9″	38	1	39	37	...	37	14	...	14	25	...	25
15″	12	..	12	27	1	28	10	..	10	48	2	50

	Co 213 Plant crop.			Co 213, 3rd Ratoon.			Co 414 Plant crop.			Co 414, 3rd Ratoon.		
Class in inches.	Number of vertical roots.	Number of lateral roots.	Total.	Number of vertical roots.	Lateral roots.	Total.	Vertical roots	Lateral roots.	Total.	Vertical roots.	Lateral roots.	Total
21″	10	1	11	16	...	16	6	1	7	28	...	28
27″	6		6	9	...	9	3	3	6	12	2	14
33″	...	1	1	4	3	7	1	2	3	4	2	6
39″	3	1	4	3	1	4	...	1	1	6	1	7
45″	1	1	2	1	...	1	3	3	6	2	2	4
51″	2	1	3	2	2	4	1	2	3	1	..	1
57″	...	1	1	1	3	4	3	1	4	3	1	4
63″	...	...	...	1	1	2	1	...	1	1	1	2
69″	...	...	...	...	1	1	...	1	1	...	...	...
75″	...	...	...	...	...	...	...	1	1	1	...	1
81″	...	...	...	...	...	...	...	1	1	...	..	...
87″	...	...	...	...	...	...	...	1	1	...	...	...
93″	...	...	...		...	...	...	1	1	...	...	
Total Nos.	142	7	149	156	12	168	68	18	86	192	11	203
Total lentgth of roots			1368″			2067″			1014″			2856″
Weight in ounces			3⅛			2¼			3¼			2½
Height of cane in inches			119			122			127			137

(iv) *Root system.* Roots have a direct bearing on the growth of any plant as they are not only the anchors, but are also the feeders. The root-systems of plant crops and ratoons were studied in the plant crops and 3rd ratoons of the varieties Co 213 and Co 414. The root-systems were exposed intact by carefully removing the soil around the roots. Both the lateral and vertical roots were traced and their number, length and the depths to which they extended were noted. An exact diagram to scale of the root systems was also drawn, which is appended. The data presented in Table VI will bring out clearly the better root-system of ratoons as compared with the plant crop. The number, length, and depth, to which the roots penetrated were greater in ratoon than in the plant crop. Nearly two-thirds of the total number of roots were confined to the first 15 inches and the roots extended to a depth and length of 7¾ feet. Root development was best in Co 414, 3rd ratoon, in which the growth and development of cane was also the maximum. As the ratoons have a better root-system, it is only natural to expect them to make quicker and even better growth, provided they are adequately manured.

DIAGRAMS OF ROOT SYSTEMS

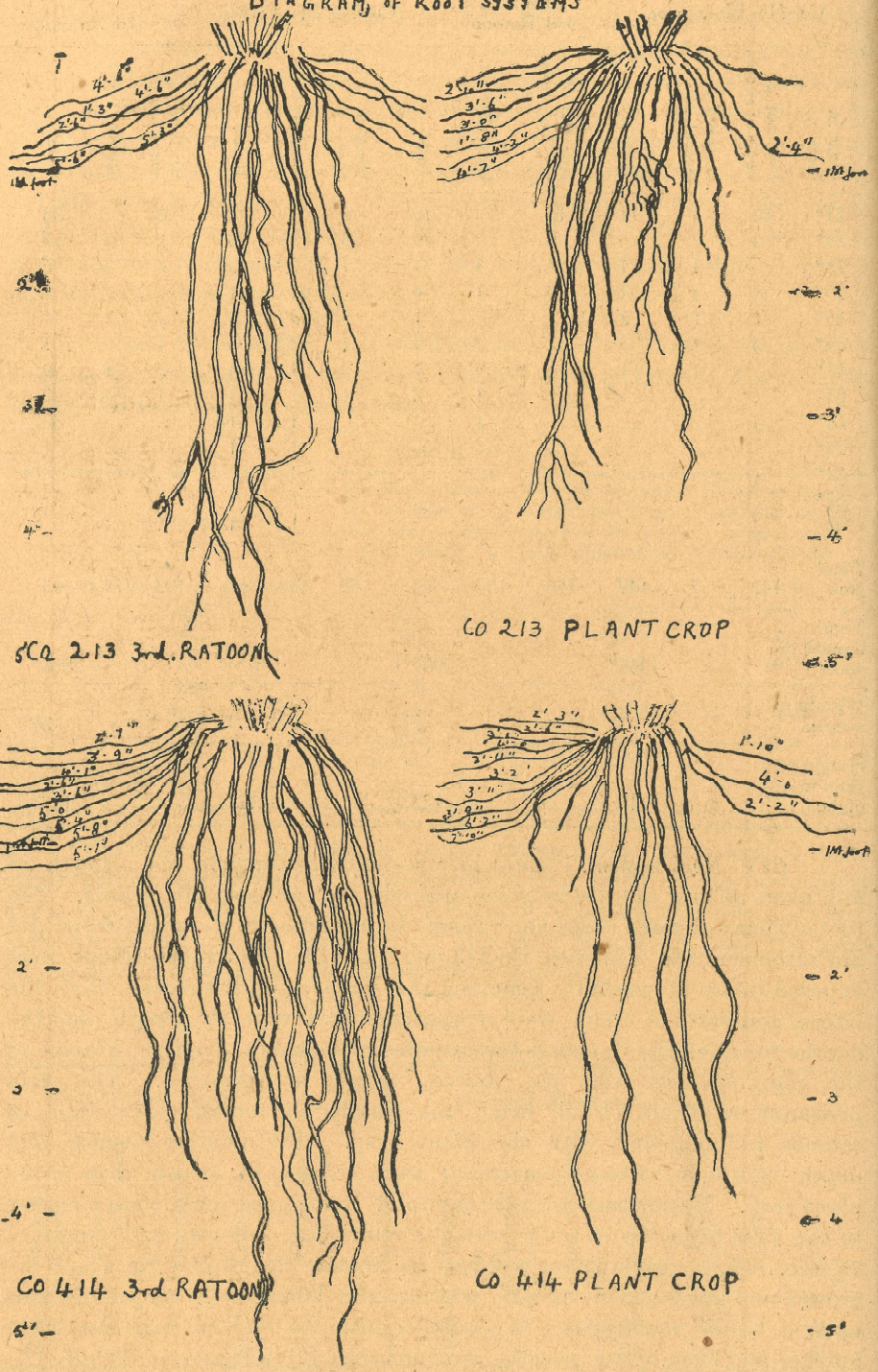

TABLE VII.

Juice quality and jaggery recovery in plant and ratoon crops

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Juice quality and jaggery recovery in plant and ratoon crops

Treatments	% Sucrose during					% Purity during					% Jaggery to Cane	Yield of Jaggery in tons per acre
	Oct.	Nov.	Dec.	Jan.	Feb.	Oct.	Nov.	Dec.	Jan.	Feb.		
Co 213, Plant	...	8·20	11·00	11·79	14·49	..	65·24	74·52	76·78	84 26	11·53	6·00
Co 213, 1st Ratoon	...	8·21	10·12	11·42	13·24	...	66·48	74·08	76·33	82·24	10·79	6·72
Co 213, Plant	7·68	11·11	12·40	11·13	16·65	64 97	75·06	78·47	86·34	87·14	12·27	5·77
Co 213, 2nd Ratoon	8·36	9·57	13·08	14·85	15·50	67·85	71·42	81·23	84·94	85·59	11·43	6·27
Co 213, Plant	9·14	11·26	12·79	15·50	15·68	70·50	77·59	81·79	86·18	87·28	11·09	5·23
Co 213, 3rd Ratoon	8·91	10·15	11·54	14·97	13·55	71·36	76·25	77·23	87·02	84·82	11·81	5·87
Co 414, Plant	...	11·04	14 41	14·77	15 77	...	74·78	82·08	82·69	84·70	12·46	5·73
Co 414, 1st Ratoon	..	12·52	14·09	15·07	14·85	...	76·52	81·96	83·58	83·96	11·80	6·20
Co 414, Plant	11·61	14·29	16·43	18·80	17·65	75·51	81·66	84·18	87·54	86·48	12·93	5·28
Co 414, 2nd Ratoon	12·20	15 19	16·46	17·15	16·91	75·70	83·35	85·78	87·44	86·24	12 40	5·31
Co 414, Plant	13·51	13·15	15·35	17·95	17·97	81·41	79·16	84·07	88·35	86·98	11·89	5·05
Co 414, 3rd Ratoon	12·59	13·35	14·89	15·88	16·37	80·13	82·58	84·43	85·29	85·25	11·63	4·85
J. 247, Plant	..	7·04	9·17	11·46	12·47	...	60·85	69·16	77·27	80·97	10·05	4·11
J. 247, 1st Ratoon	...	9·04	9·09	12 30	13·84	...	67·85	68·93	80·24	83·89	11·32	1·32
J. 247, Plant	5·28	7·38	9·72	13·41	15·75	53·22	63·19	70·96	82·83	86·50	11 85	6·15
J. 247, 2nd Ratoon	6·97	7·86	12·43	15·19	16·38	60·49	65·07	79·27	85·37	87·08	11·70	1·46
J 247, Plant	7·33	8·53	11·73	14·92	15·63	63·80	67·69	77·49	85·23	86·54	12·61	4·59
J. 247, 3rd Ratoon	9·36	9·82	11·32	15·27	12·54	70·86	72·59	75·93	87·22	75·23	11·33	0·73

Ratoons of Co 213 and Co 414 showed a lower purity and jaggery recovery than their plant crops owing to the higher dose of Nitrogen which the ratoons received. But deterioration started by February *i. e.*, a month earlier in the ratoons than in the plant crop thereby showing that ratoons mature earlier than their plant crops. However, the total jaggery yield based on cane weight and recovery was about 12% more in the case of Co 213 ratoons. Co 414 first ratoon was 8% more in yield than the plant crop.

(vi) *Pests and diseases.* There is a general belief that ratoons are more susceptible to insect pests and diseases than plant crops, but the results obtained at some of the research stations are rather varied. Among the pests of sugarcane, borers, *e.g.*, early side-shoot borer (Argyria sticticraspie H), top borer (Scirpophaga Nivella F.) and the internode borer (Diatroea Venosata W), mealy bugs, Pyrilea and termites are the most important in this Province. Early side-shoot borers which attack the crop in the early stages, are not considered serious, as the crops revive by better tillering or production of new shoots in the place of attacked ones. Top borers bring about the death of cane out-right as they burrow into the apical growing shoot and are therefore a serious pest. Internode borers, though they do not kill the cane, cause appreciable reduction in juice quality. Pyrilla or the leaf hopper is not such a serious pest in South India as in the North. At Palur, 52% of ratoons were said to be attacked by borers while the damage to the plant crop was only 10%. Cane-fly and mealy bugs were more in ratoon plants (5). At Anakapalle the Pyrilla attack was said to be more severe in ratoons in 1934—'35 (3) though their incidence was said to be more in plant crops in 1941—'42. Mealy-bug attack was more severe in ratoons, while in the case of borers, except during 1943—'44 plant crops showed a decidedly higher percentage of borer attack (6). At Gudiyatham the incidence of borer attack was generally more (10 to 33%) in ratoon. (Table IX). Mealy-bug attack was also more in ratoons. The percentage of borer attack in the third ratoon was also higher than in the first and second ratoons. Among the fungus diseases, Smut (Ustilage Scitaminea Syd) was found to be the most serious of the diseases. Smut which can be easily recognised by the terminal portion of cane turning into a whip-like structure was found to be definitely on the increase in the ratoon crops and the third ratoon of Co 213 had a very severe infection. The reduction in the number of canes in subsequent ratoons can also be partly due to the removal and burning of all the affected clumps. Of the three varieties (*viz.*) Co 213, Co 414 and J. 247 under trial, Co 213 was the worst infected with Smut while both the plant and ratoon crops of Co 414 were free. It is remarkable that the variety Co 414 although by the side of a heavily smut-infected crop of Co 213 was absolutely free from smut. The causes for the greater susceptibility ratoons of certain varieties and the comparative freedom of other varieties deserve special investigation and it is possible that the smut problem in ratoons could be solved by the selection of suitable resistant varieties.

However, in localities where the smut has assumed serious proportions, ratooning should be stopped and the disease should be controlled by roguing and burning of affected clumps, planting of healthy setts from a locality where there is no infection.

TABLE VIII

Showing the percentage of top-borer attack

	Ratoons			Plant Crop		
	Co 213	Co 414	J. 247	Co 213	Co 414	J. 247
1st Ratoon ...	18·6	24·5	19·4	20·0	19·8	16·2
2nd Ratoon ...	27·9	25·4	16·3	19·1	23·5	16·5
3rd Ratoon ...	31·9	37·8	25·4	19·1	26·5	18·5

(vii) *Cost of Production of Cane.* The cost of cultivation of cane for the plant crop and ratoons along with the cost of production per ton of cane are given below :—

Variety	Plant crop	1st Ratoon	2nd Ratoon	3rd Ratoon	
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A P.	
Cost of cultivation and harvest per acre.					
All varieties	+286 6 0	'238 3 4	* 290 0 8	243 10 2	...
Cost of production per ton of cane.					
Co 213	5 15 7	4 3 3	5 4 7	5 3 0	...
Co 414	6 10 3	4 12 3	6 13 0	6 0 1	...
J. 247	7 0 7	17 4 8	23 5 0	36 8 8	

N. B.— (a) Cost of cultivation above refers to pre-war rates during 1937—'38 to 1939—'40.

(b) Cost of cultivation excludes rental value of land.

(c) The figures for the plant crop is the average of the cost of production for three years.

(d) * Cost of cultivation of 2nd ratoon is high owing to greater expenses involved in lifting and tying up lodged canes.

Cost of cultivation as shown above is naturally reduced in the case of ratoons to an extent of about 15 to 17% as there is a saving in expenses towards preparatory cultivation and planting. Except in the case of J. 247, where the yield of ratoons was very poor, the cost of production per ton of cane was less in ratoons. The cost of production was less in first ratoons by about 30% as increased yields, were obtained with less of cultivation costs. It was economical to take even a third ratoon of Co 213 and Co 414 though the margin of difference between plant crop and subsequent ratoons got narrower.

5. **Future Lines of Work.** (i) It is clear that varieties differ greatly in their ratooning capacity, hence a search for better varieties, which possess good ratooning capacity has to be pursued in Research Stations and their profitable period of ratooning worked out.

(ii) The reported low yields of ratoons with similar dose of manure as plant crop at Palur and Anakapalle, and the higher yields of the first two ratoons with increased doses of manure at Gudiyatham, show that ratoons need heavier manuring and the optimum dose of manure required for ratoons has to be worked out.

(iii) The greater susceptibility of ratoons to insect pests and fungus diseases require investigation with special attention on the ultimate economics and effective control measures.

Smut appears to be the most important fungus disease affecting ratoons and as certain varieties are found to be resistant to smut, selection of resistant varieties which are desirable from other economic factors also would be a desirable line of investigation.

(iv) The best time to harvest the parent crop to be ratooned, so that the ratoon may get the best conditions for growth, deserves a special study.

(v) Harvesting the crop to be ratooned flush to the ground level or as low as possible is said to give vigorous sprouts. This aspect also needs investigation.

(vi) As ratoons mature earlier than a plant crop, if suitable early varieties themselves can be ratooned, the sugar factories can well start their work nearly a month in advance; work in this direction deserves attention.

(vii) The practice of burning cane trash *in situ* after harvest is rather a general practice with ryots and this is done mainly with the idea of saving the cost of labour involved in clearing the trash. This practice is believed to be harmful as it leads to loss of humus in the top soil and it may be advantageous not to burn the trash, but to compost them and return to the soil. The scientific and economic aspects of this have to be worked out to bring out the points of advantage and disadvantage more clearly.

(viii) The residual effects of ratoons on soil fertility need also investigation and a proper rotation has also to be worked out.

6. **Summary and Conclusions.** A brief review of the work done on ratoons is made and the experiment on ratoons at the Sugarcane Research Station, Gudiyatham, has been discussed in detail.

It was noted that varieties differ greatly in ratooning capacity and with increased dose of manure, the first two ratoons gave higher yields, than plant crops. It was economical to take third ratoon crops also, as the yields were similar to the plant crop, with a saving in the cost of cultivation.

As ratoons mature earlier than plant crops, they can take the place of early varieties in factory areas.

Ratoons were found to be more susceptible to insect pests and also to smut.

Future lines of work on various problems affecting ratoons are indicated.

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Literature Cited.

1. Cane sugar (1911)—Noel Deer.
2. Season and crop report (1941—'42 to 1943—'44).
3. Annual Reports of Agricultural Research Station, Anakapalle, 1934—'35 and 1940—'43.
4. Annual Report of Agricultural Research Station, Samalkotta, 1935—'36.
5. Annual Report of Agricultural Research Station, Palur, 1935—'36.
6. Vasudeva Rao, R. and Lakshmikantham, M. (1946) Ratooning Sugarcane in Madras. Madras Agricultural Journal, Vol. No. XXXIV, Nos. 1, 2 and 3.
7. Dutt. N. L. (1946) Report on the Survey of Sugarcane Research in India.