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Some Agronomic Experiments with Unirrigated 'Desi' Cotton at the Agricultural Research Station, Kovilpatti from 1901 to 1949

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I. INTRODUCTION

The Agricultural Research Station, Kovilpatti was opened in 1901. Among the various activities of this Station, breeding and agronomic experiments on the indigenous desi cotton known as *Tinnevellies* or *Karunganni* formed an important programme of work. Breeding investigations came to be intensified in 1949 under a special scheme financed by the Indian Central Cotton Committee. This work is in progress. The results of a large number of agronomic experiments concluded during the period 1901 to 1949 are summarised in this paper in order to serve as a guide to future investigations on problems of agronomical importance. The results are classified under the following sections.

A. CULTURAL B. ROTATIONAL
C. MANURIAL D. MISCELLANEOUS

II RESULTS OF EXPERIMENTS

A. CULTURAL :

(i) *Experiments on Preparatory Cultivation :* The local practice is to work the indigenous wooden plough for preparatory cultivation as often as weather and soil conditions permit. This plough does not penetrate enough to exterminate deep rooted and pernicious weeds like the 'hariali' *(Cynodon dactylon)*. Therefore, the farmer incurs extra expenditure every year to dig out these weeds by engaging manual labour with crow-bar during summer immediately following the previous cereal. In an observation study conducted on the station for a few years ending with 1911—12, cotton soil plough (a heavy iron plough) was compared with the wooden plough. The mean yield of seed cotton in lb./acre was 147 for the wooden plough and 266 for the iron plough. It is recorded

that the plots which had received shallow ploughing were foul with 'hariali'. The poor yield might have been due to this weediness. Based on this finding, farm lands were deep ploughed following a systematic programme for a few years after acquisition. It is believed that the cumulative effect of these operations was a general improvement of the farm soil in regard to weed infestation compared to the condition of the fields in the farm neighbourhood, so much so that an experiment in which the monsoon plough was compared with the 'guntaka' (an indigenous blade harrow) conducted over a five year period ending with 1930—31 failed to show the expected yield improvement in favour of deep ploughing. It was apparent that deep ploughing was not necessary for fields kept on such high levels of cultivation. Actually the mean yied in lb. of seed cotton per acre was 489 for the 'guntaka' plot compared to 466 for the monsoon plough.

In order to secure more definite information on the comparative merits of the available methods of preparatory cultivation an experiment named 'Permanent Cultural Experiment' was conducted over a twelve year period from 1935—'36. There were three variants namely (a) no cultivation (b) working the 'guntaka' and (c) working the monsoon plough. These were randomised and replicated six times. The net experimental area was three cents. Cotton occurred once every other year following a four-course rotation, cumbu (Pennisetun typhoides)–cotton–irungu (Sorghum dochna–a variety of fodder cholam)–cotton. The implements were worked in July–August each year since this period was the earliest fallow coming after harvest of all the major crops. Weeds were removed as part of farm routine in all the plots. Cotton yields for six years during the period of the experiment indicated that no spectacular effects were evident because of deep ploughing. The mean yield (Average of six years) ranged between 300 lb. for control (no cultivation) and 313 lb. for fields worked with monsoon plough. These trials proved that *there was no substantial yield increase by deep ploughing with the monsoon plough.*

(ii) *Experiment on frequency of inter-cultivation:* On the station, cotton is sown in drill lines 18 inches apart. Bullock power with the 'danthi' is the usual source of interculture to the crop. In order to know how many times the crop needed to be intercultured thus, an experiment was conducted during the period 1934–35 to 1936–37. Four variants, namely interculturing once, twice, three

times and four times were compared with no intercultivation (control). The five variants were randomised and replicated six times. Experimental areas ranged between 1·5 and 2·5 cents, it was constant for all the variants in any year. The interval between successive intercultures ranged between 3 and 4 weeks. The data for the smaller number of intercultures were fixed with reference to the needs determined by prevailing soil and weather conditions. In none of the seasons studied were the yield differences significant. The mean yields for the period of study ranged between 389 lb. to 410 lb. of seed cotton for varying frequencies of interculture and 420 lb. for no interculture. *It was apparent from these studies that frequent intercultures to line sown cotton crop were unnecessary.*

(iii) *Experiments for spacing in line sowing:* The local method of sowing is bradcasting using a seed rate of 15 to 20 lb. But on the station, almost since its inception, line sowing with the indigenous seed drill has been adopted successfully for cotton and the cereals. The spacings adopted was 18" x 8" as in the Ceded districts using a seed rate of 12 lb. With the establishment of drill sowing attention was turned to the possibilities of varying spacings between lines and in the lines for maximising cotton yield.

Preliminary studies during the period 1906 — 1938 gave indications of late harvests with spacings, wider than 18" x 8" and early harvest with closer spacings. Very close spacings tended to lower yield. It was also noted that crop yield was as good with line sowing as with broadcast sowing. Systematic experiments with combinations of spacings both in lines and between lines were carried out for three consecutive seasons ending with 1940–41. Following were the combinations.

Between lines. 9", 12", 15" and 18"

In the lines. 4", 8", and 12" in each.

The twelve variants thus obtained were randomized and replicated. There were six trials, three after cumbu and three after irungu. In two of them broadcasting the seed was included as an additional variant. The yield data are summarised in Table I.

TABLE I

Spacing Experiment — Line and Plant Spacings — Combined Summary of Yields over Seasons.

Spacing between lines and plants and particulars	Yield in lb. of seed cotton per acre							
	after Cumbu				after Irungu			
	1938—39	1939—40	1940—41	Mean over seasons	1938—39	1939—40	1940—41	Mean over seasons
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
9" x 4"	408@	378@	57	281	456@	97@	123@	225
9" x 8"	544	471	130	382	578@	147	187	284
9" x 12"	590	480	118	396	581	162	216	320
12" x 4"	508@	469	74	350	458@	141	191	263
12" x 8"	507@	445	79	344	560	150	218	309
12" x 12"	569	428	133	377	612	178	232	341
15" x 4"	602	522	162	429	572	164	201	312
15" x 8"	650	476	96	407	594	153	283	343
15" x 12"	648	433	139	407	561	173	238	324
18" x 4"	597	481	136	405	553	181	219	318
18" x 8" (Control)	607	486	92	395	618	179	233	343
18" x 12"	541	398@	210	383	497	175	205	392
Broadcast	..	..	73	..	..	..	193	..
Significance P = 0·05	Yes	Yes	Yes		Yes	Yes	Yes	
Critical difference in lb./acre	88	53	58		82	38	48	

Note: 1. Underline denotes significantly higher values than control.

2. @ Denotes significantly lower values than control.

3. Column 4—low yield due to inundation from excessive rains in the field in which this trial was laid.

It will be observed that *no combination had any special advantage to merit preferential recommendation to the established spacing of 18" x 8" adopted on the station.*

(iv) *Experiments on 'Bunding':* Though the farm soils are relatively better placed in respect of general topography and total rainfall than then the dry farming areas of Bombay or elsewhere in the tract, some seasons are known to be much below the normal of 30 inches of rainfall and some much in excess. In order to know how far methods for conserving rainwater such as bunds and scoops help in enabling cotton to yield more, preliminary experiments were conducted during the period 1936—'37 to 1942—'43. The results were, inconclusive and there were technical defects on account of layout, and plot size. A systematic trial was started in 1943—'44 and continued till 1946—'47. The object was to secure information on the comparative effects of bunding to cotton following irungu and cumbu. Three variants namely, no bunding, bunding on four sides,

and bunding all round with cross bunds were compared. The gross area of each plot was 10 cents from which a central area of 5 cents was demarked so that this area was well beyond the range of influence of the adjoining variant in the randomisation. The three variants together with the two cereal rotations formed six in all, and these were randomised and replicated four times. The varieties used were K.1 cotton, K.1 irungu and K.1 cumbu. The results *showed that none of the methods of conserving water helped in improving cotton yields appreciably.*

B. ROTATION:

(i) *Harmful after effects of fodder cholam on cotton yield:* Comparative observations on yields of cotton after the major cereal crops for a three year period ending with 1909–1910 showed that the mean yields were 374 lb after cumbu, 303 lb after irungu, and 341 lb after cotton. The indications were thus in favour of a rotation with cumbu. *Cotton after irungu suffered a reduction in yield by about 16%.* Later, examining the yield data for cotton after these cereals over a period of 31 years at the Agricultural Research Station, Ramanatha Iyer and S. Sundaram (1941) confirmed this finding.

(ii) *Systematic studies on rotation:* A series of rotation studies was conducted during the period 1927–'28 to 1933—'34 with the object of fixing a suitable pulse for rotation with cotton. Beyond a general indication that cotton after pulse tended to yield more than after the cereal no useful recommendation for general adoption came out of these studies. A more systematic study adopting a randomized and replicated technique was undertaken in 1934—'35 in which cotton yields, were compared in the following schemes of rotation.

1. Cumbu – Cotton – Irungu – Cotton : Four course rotation.
2. Cumbu – Cotton – Cumbu – Cotton : Two course rotation.
3. Irungu – Cotton – Irungu – Cotton : Two course rotation.
4. Pulse – Cotton – Pulse – Cotton : Two course rotation.
5. Cotton – Cotton – Cotton – Cotton : No rotation.

The study was continued over 12 years. The varieties used were K1 cumbu, K1 irungu and unselected bulk pulse 'Pillipesara' (Phaseolus trilobus) in the first four years, and blackgram subsequently. There were six replications. The plot area for cotton was 1·5 cents. The average yields for cotton in the different systems of rotation over the twelve year period are summarised in table II.

TABLE II.

Rotation for Cotton - Summary of Yields over Seasons
(Yield in lb. of Seed Cotton per acre).

Season	Four course rotation (Control)	Two course rotation with			No rotation
		Cumbu	Irungu	Pulse	
1	2	(3)	(4)	(5)	(6)
1934—'35	..	..	..	..	315
1935—'36	352	299	288	260	237
1936—'37	..	..	..	..	230
1937—'38	392	510	426	581	395
1938—'39	..	..	..	..	331
1939—'40	415	401	279 @	458	249 @
1940—'41	..	..	..	..	141
1941—'42	370	532	353	666	309
1942—'43	..	..	..	..	472
1943—'44	811	644 @	551 @	921	554 @
1944—'45	..	..	..	..	565
1945—'46	794	765	719	1154	667
1946—'47	..	..	..	..	112
Mean	522	525	436	673	381

Notes: Cotton yields in all the rotations were analysed statistically in each of the six years in which comparable data were available. The differences were significant for P=0·05, except in 1935—'36. Significantly higher yields than the control (four course rotation) are underlined. Significantly lower yields have been marked thus @.

The results showed cotton yields were highest after black gram but the most desirable was a four course rotation on grounds of farm economy.

C. MANURIAL:

(i) *Early trials:* In the beginning, research was directed towards an assesment of the comparative values of organic manures like farm yard mannure prepared in different systems, sheep manure and prickly pear compost. Cotton responded well to all these manures. As the supplies were limited, usefulness of artificial like ammomium sulphate was exploited. Indications were obtained that increased yields followed applications of artificials, that application in instalments was not necessary and that a single application prior to sowing was enough to evoke good response. But information on aspects of placement of manure, dosage on nitrogen basis and relative values of different forms of nitrogenous manures on crops raised on lands of low and high fertility levels was wanting.

(ii) *Systematic investigations :* In order to obtain information on these points a series of trials was arranged during the period 1943—'44 to 1945—'46. The variety used was K. 1. cotton. Different doses of nitrogen ranging between 0–100 lb. per acre, supplied in the form of cake or ammonium sulphate and applied by broadcasting immediately before sowing or drilled close to the seed lines were compared. In drilling the manure, care was taken to see that it was worked a little away from the seed line. This precaution helped in securing normal germination and stand. For cake, groundnut and *Neem* cakes were employed. Neem cake was included in the third year of trial. The variants were randomized and replicated four times. Each year the trial was arranged in two different fields, one after irungu, and the other after cumbu representing low level and high level fertility respectively.

There were thus six trials spread over three seasons. In all the years direct manuring at 20 lb. nitrogen raised cotton yields for both the levels of fertility. The increase was significant in low level fertility land in all the three years. In the high level fertility fields also the manured plots recorded increases, but the increases were not significant. In table III are summarised mean yield of 13 manurial variants common for all the three years for each level of fertility. Data on values of extra yield over the control and net gain after deducting cost of manure have also been furnished.

TABLE III

Mean Yields of 13 Manurial Treatment Over-seasons for two levels of fertility and average for both levels.

S. No.	Kinds of manure	Dosage in lb. of nitrogen per acre	Yield in lb. of seed cotton per acre				Extra yield	Value of extra yield over control	Cost of Manure	Net gain after deducting cost of manure.
			Method of application	Low level fertility	High level fertility	Average				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
		lb.						Rs.	Rs.	Rs.
1	Ammonium sulphate	60	Drilled	657	780	716	232	40	42	— 2
2	Ammonium sulphate	60	Broad cast	638	766	702	218	38	42	— 4
3	Groundnut cake	60	Drilled	620	780	700	216	38	68	— 30
4	,, ,,	40	,,	626	740	683	199	35	45	— 10
5	Ammonium sulphate	40	Broad cast	649	709	679	195	34	28	6
6	Groundnut cake	60	,,	647	706	676	192	33	68	— 35
7	Ammonium sulphate	40	Drilled	593	746	670	286	32	28	4

Table III (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
8	Groundnut cake	40	Broad cast	567	711	634	150	26	45 —	19
9	Ammonium sulphate	20	Drilled	571	681	626	142	25	14	11
10	,, ,,	20	Broad cast	571	669	620	136	24	14	10
11	Groundnut cake	20	Drilled	584	641	613	129	22	23 —	1
12	,, ,,	20	Broad cast	495	658	576	92	16	23 —	7
13	No. Manure (control)	..	..	431	537	484	..	..	..	..

Notes : 1. Seed cotton valued at Rs. 43/- per *pothi* of 257 lb. (Mean of prevailing market rates for the period 1943—'44 to 1946—'47)

2. Value of ammonium sulphate at Rs. 14-1-0 per 100 lb. (Mean of market prices for the period 1943—'44 to 1946—'47)

3. Value of groundnut cake @ Rs. 9/- per 100 lb. (Mean of market prices for the period 1943—'44 to 1946—'47).

The data on yields and net profit are revealing. Though increased yields were obtained from all dosages *20 lb. nitrogen in the shape of Ammonium sulphate was the most desirable dose as a net profit of rupees ten to eleven was possible with this dose. Allowing rupees two as cost of application there was a net profit of rupees nine per acre with drilling the manure.* This was the recommended dosage worthy of adoption on cultivators' holdings.

D. MISCELLANEOUS :

(i) *Mixed cropping with coriander :* The problem of a suitable form of mixed cropping with coriander and cotton under line sown conditions was studied experimentally for two seasons namely ; 1934–'35 and 1935–'36. It was concluded that *a small quantity of coriander seed (about three lb.) broadcast in drill lines of cotton was profitable* in that it gave a mean yield of 507 lb. of seed cotton along with 173 lb. of coriander whereas in a pure crop of cotton alone the mean yield was 525 lb. of seed cotton.

(ii) *Sun drying cotton seed :* In 1942—'43 an experiment was conducted with the object of comparing yield of cotton raised with seed sundried in different ways with seed stored without drying from ginning to sowing. The object was to verify if there was any truth in the local belief that seed sun-dried gave poor yields. The results showed that sun-drying did not adversely affect cotton yield. The mean yield with seed sundried for one to two days and once every month was 504 compared to 534 with seed not sun dried. The differences were not significant.

(iii) *Use of summer harvested seed for sowing :* There is a strong belief among the cotton farmers in Kovilpatti taluk that 'Kodai' seed (seed harvested in summer) does not give a good crop compared to normal seed. The truth of this was investigated in 1933—'34 and 1934—'35 and again in 1951—'52. Seeds from season and summer harvests were compared for yield. The results were presented in a paper by Kalyanaraman etal in 1953. The authors have reported that no difference was noted in yield and quality of the crop raised from season and summer seed. Use of summer seed was recommended safely for sowing purposes at least in years when on account of adverse season, the crop did not yield enough seed to meet sowing requirements.

III EVALUATION OF THE RESULTS

Cultural : The experiments on prepatory cultivation and interculture described give the rather curious result that this practice can be done away with. For it cannot be denied that one or two ploughings by way of prepatory cultivation done timely do help in rain water penetrating lower levels of soil, so that it would be available to the deep rooted cotton at a later period in its growth. As Ramanatha Iyer *etal* would put it, " the pratice of preparatory cultivation has become so habitual and well established that any demand for proofs will be deemed as an outrage on truth ". Absence of expected increase attending preparatory cultivation on the farm is possibly due to the fact that years of systematic ploughing of all the lands on the station obviated need for elaboration in their operations. It would therefore be safe to interpret the findings of the experiment described more as a pointer to the need for a judicious restriction of the preparatory cultivation than as a total negation of the practice. *Considering the fact that farm lands are on a higher state of cultivation than what usually obtains in the neighbourhood, it would be necessary to conduct these trials on a regional scale on selected cultivators' holdings so that recommendations could be made to suit needs of specific areas of the tract.*

A perusal of the results on spacing experiments furnished in Table I showed that no variant was consistantly better than the control namely 18" x 8". Very close spacings were not economic as the crop was stunted in growth, forced in earliness, sparse in branching and poor in yield. The spacing of 15"x8" appeared to have certain virtues. Judging from the final over all mean yields, and barring the unusual behaviour in 1940—'41 one could reckon the performance on this spacing as more desirable than the rest because of the following advantages over 18"x8".

1. The crop matured slightly earlier.
2. It forestalled reduction in population from the ground weevil (Atactogaster finitimus), grass hopper and wilt which accounted for 10 to 20% loss in population.
3. In parts of the tract use of 15" gorru, was already in vogue and so it was easier to push on propaganda for this practice in other areas.
4. It was apparent that brodcasting as practised by the ryots did not have any special virtue to commend it; on the otherhand it needed a higher seed rate

The results of bunding experiments demonstrated the super-fluity of the dry farming practice for lands like those as at the Agricultural Research Station, Koilpatti which receive a well distributed rainfall and which are generally free from undulation and slopes. A similar experience has been recorded at Nandyal. *But it is necessary to survey the Tinnies tract for locations of regions with soil-climate complex different from that of the station and similar to conditions obtaining on dry farming areas. Bunding trials are to be conducted on such locations. It is only after these regional trials are conducted that the tract can be cut up into areas which need bunding to maximise cotton production and those like the station which do not need this practice.*

Rotation: It was evident that the best rotation was a two-course rotation with pulse (black-gram). But on considerations of farm economics and fodder needs for cattle such a rotation was uneconomical. Among other rotations, cotton yields were more or less similar in the four-course rotation and two-course rotation with cumbu. Cotton raised without rotation was poorer than cotton in rotation, and the poorest was cotton after irungu. In view of the need to arrange the cropping scheme of the holding in such a manner that cotton (money crop) cumbu (staple food crop) and irungu (fodder) were all available in the same year, a four course rotation of cumbu-cotton-irungu-cotton was more frugal and had everything to recommend it for general adoption than any of the other rotations studied.

Manurial: In recent years as a result of intensified propaganda on the findings of the experiments, and supply position of ammonium sulphate being easier than before, the cotton grower in Tirunelveli has become more and more manure minded. The official figures for

Madras State places the total area under cotton in Tirunelveli district at 2·3 lakh acres with an output of 57,920 bales (392 lb. of lint). This can be stepped up by at-least a third as much more if the area in the district adopts manuring with ammonium sulphate at 20 lb. nitrogen per acre.

IV SUMMARY

Results of a large number of agronomic experiments conducted from 1901 to 1949 on the Agricultural Research Station, Kovilpatti representing the Tinnies cotton tract in Madras State are summraised under section heads like Preparatory cultivation, Rotation and Manure. The results are reviewed and their value for cotton extension service on cultivator's holdings discussed.

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