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Some Ploughing Experiments

By V. RAMANATHA AYYAR, S. SUNDARAM AYYAR,
and
N. C. TIRUMALACHARI.

Cotton Breeding Station, Coimbatore.

Every text book on agriculture emphasises the importance of preparatory cultivation for the raising of crops and every farmer will testify to the efficacy of the precultivation methods. In fact, the practice has become so time-worn and well established that any demand for proofs will be deemed as an outrage on truth. Yet it is true that an agronomist wishing to build up the science of cultivation will find little data to help him on while planning improvements. For example, the black soil farmer in the Bellary district uses a grubber for the preparatory cultivation, while his neighbour in the Nandyal valley prefers to plough his fields every year with inversion ploughs. On the other hand, the ryot in Tinnevelly district cultivates his land, only with a country plough. Again, there are variations in the time of doing these operations. In the Ceded districts, all precultivations are mostly done soon after the harvesting of the crop in contrast to the practice in the Southern districts, of waiting for a soaking rain to start ploughing. There are no evidences to indicate whether these methods are followed because of the fact that the fore-fathers were in the habit of doing these and the sons should adopt them as a matter of tradition. Further it is not clearly known which operations are essential for crop production and what frequency in each will prove most remunerative. The lack of knowledge on many of the fundamental points precludes one from getting the maximum benefit from each cultivation operation, from substituting the non-paying one by a better method, and from omitting altogether the superfluities. It can be said that the existence of such lacunae stands in the way of the rapid spread of improvements of cultivation in India.

Recently some of the accepted practices were tested on the black soils of the Agricultural Research Station, Koilpatti in Tinnevelli district in connection with the experiments conducted in the Madras fodder cholam* scheme financed by the Indian Central Cotton Committee. It is proposed to present here some of the results obtained therein, with the object of stimulating other workers to study these aspects in their tracts.

In one group of experiments, the effects of changes in the depth and in the time of ploughing on the yields of succeeding cotton were compared. In the case of studies in depth, one set of plots was ploughed with a monsoon plough to a depth of 4"—5" and another worked with a turn-wrest plough to a depth of 8"—9". In the two seasons of trial, the differences between the two variants were (*vide* table I) within the limits of random error

* Andropogon sorghums.

signifying that the changes in the depth of cultivation did not engender any marked effect on cotton yields under the conditions obtaining at Koilpatti.

TABLE I. Depth of ploughing.

Crop. Rain-grown *karungani* cotton (G. arboreum).

No.	Nature of treatment	Yield of kapas in lb. per acre. 1933–34 I	1933–34 II	1934–35.
I	Deep ploughing (8–9")	308	304	508
II	Shallow ploughing (4–5")	340	293	448
	Critical difference.	60	55	77
	Conclusion.	Treatments are not significant.		
	Number of replications.	6	6	8

This conclusion is in agreement with those arrived at by many workers. Allan (1) after reviewing all the results of cultivation experiments conducted in Madras, Bombay and Central Provinces has stated that there is no real evidence to support the belief that deeper cultivation is essential to secure the best economic returns from crops raised on heavy soils during the monsoon, and that it will be sufficient if these soils are periodically ploughed deep. Russell and Keen (11) working at Rothamsted state that there is no virtue in ploughing to a depth of more than 4 inches.

In the experiments relating to the time of ploughing, the effect of ploughing in the stubbles with a monsoon plough soon after the harvest of the crop in February-March was compared during five seasons with that done in May-June soon after the receipt of the rains and also with ploughing late in August—September. The results are set forth in Table II.

TABLE II. Time of ploughing. (Yield in lb. per acre).

No.	Nature of treatments	Years. 1933–34 I	1933–34 II	1934–35	1935–36	1936–37	1937–38
1.	Ploughing early (soon after the harvest of the crop)	304	296	479	...	...	...
2.	Ploughing season (soon after receipt of the first rains)	331	305	477	217	381	528
3.	Ploughing late (just before the sowing of the next crop)	338	295	...	226	406	516
	Critical difference	74	68	77	38	27	65
	Conclusions	3,2,1	2,1.3	1,2	3,2	3,2	2,3
	No. of replications	4	4	8	6	12	8

Once again the differences between the treatments were not significant. Such a finding is puzzling in view of the statements made by Russell (9) on the formation of soil crumbs. It is said that if ploughing is done at a critical period necessary for the maintenance of a proper regime for water

and air movements, a larger proportion of water resistant conglomerates is formed. Based on this, one will expect that the treatment—ploughing after the receipt of summer rains—would prove more effective. The data in the present experiments do not, however, support reasonable anticipations. The above results are also not in harmony with the recommendations made by Allan (1). He has suggested that ploughing the land soon after the harvest of the crop will be more advantageous than preparing the seed bed late in the season. In the present experiments, variations in the time of ploughing have not caused any differential effects. Possibly his recommendations may hold good in cases of deep ploughing where more time is needed for the weathering of the clods.

In a third set of experiments, the plots prepared with the monsoon plough were compared with those worked with *guntaka* (blade harrow). It is needless to say that in the former, there will be soil inversion, (though only to a small extent), and greater penetration of the implement. It will be evident from the data in table III (a) that very little difference in yield exists between the two methods of preparing the land. The above conclusion is further corroborated by the data secured in another series of experiments, where the same set of plots were precultivated in the same fashion year after year for four consecutive seasons so that the cumulative effects of the treatments were left in them. It will be seen from their data (table III-b) that except in the year when sorghum was grown on the plots, no distinct differences were noticed between the yields of plots prepared either with *guntaka* or with the plough. This is in agreement with the observations made in parts of Bombay presidency (5), but is at variance with those reported in the Central Provinces (2) and at Nandyal Agricultural Research Station in Madras (4) where increased yields are recorded by the use of implements causing soil inversion. Russel (10) however, remarks that no difference will result between ploughing and grubbing, provided that these operations are done at the critical period.

TABLE III-(a). Comparison of ploughing and guntaka working.

(Yield in lb. per acre).

No.	Nature of treatment	1928–29 Cumbu	1928–29 Cotton	1929–30 Fodder cholam	1932–33 Cotton	1933–34 Fodder cholam	1934–35 Cotton
1	Ploughing	473	352	1891	595	5049	450
2	Working with guntaka	475	354	2151	608	5568	493
Critical difference		46	36	Not possible to work.	48	Not possible to work.	81
Conclusions		1=2	1=2		1=2		1=2
No. of replications		6	6	2	8	2	4

TABLE III-(b).

No.	Nature of treatment.	Permanent cultural experiments. 1935-36 Cumbu*	1936-37 Cotton	1937-38 Fodder cholam	1938-39 Cottom
1	Ploughing every year	274	231	2178	328
2	Working with guntaka every year	307	240	1950	351
Critical difference		30	18	124	44
Conclusions		2>1	1=2	1>2	1=2
No. of replications		6	6	6	6

* Pennisetum typhoideum.

In a still another series of experiments ploughing was compared with no ploughing for four seasons (table IV). Much to our surprise, ploughing did not produce any increase in yield in any of these years. On the other hand, the treatment 'no ploughing' gave a significantly higher yield in one year (1935—36).

TABLE IV. Ploughing versus no ploughing (Yield in lb. per acre)

(a) (b)

No.	Nature of treatment.	Koilpatti Agricultural Research Station. Cotton 34-35	35-36	36-37	37-38	Koilpatti Agrl, Res. Stn. Permanent cultural Fxpts. Cumbu 35-36	Cotton 36-37	Irungu Fodder 37-38	Cotton 38-39
1.	Ploughing	450	261	396	528	274	231	2178	328
2.	No ploughing	433	302	380	505	275	243	1917	347
3.	Working with Guntaka					307	240	1950	351
	Critical difference	81	38	19	65	30	18	124	44
	Conclusions	1=2	2>1	1=2	1=2	1=2 3>2 3>1	1=2 =3	1>2 1>3 2=3	1=2=3
	No. of replications	4	6	24	8	6	6	6	6

(c)

No.	Nature of treatment	District trials Kalukachalapuram Cotton 38—39	Kallupatti Cotton 1938—39
1.	Ploughing	280	512
2.	No ploughing	246	459
	Critical difference	39	37
	Conclusions	1=2	1>2
	No. of replications	8	6

A somewhat similar behaviour was noticed in the permanent cultivation experiments mentioned in the previous paragraph. They contained three treatments, viz., one ploughed every year with monsoon plough, the second not ploughed at all and the third worked with *guntaka* every year. In the 'not ploughed' plots, stubbles and weeds, if any, were handpicked and the

seeds were drilled and covered by *guntaka*, as in the other two treatments. When the data of the 'ploughed' were compared with those of the 'not ploughed' it is seen (table IV-b) that the yield levels of two treatments were similar except in one year when ploughing proved beneficial to the fodder cholam that was raised on them. No difference is also observed except in 1935—36, when the 'guntaka worked' and 'not ploughed' series were compared.) It is plain from these that preparing the land either with *guntaka* or with monsoon plough is not an improvement over an undisturbed fallow. It may be stated here that these operations were performed at the normal time by experienced labourers who were actually farming their own lands before they were entertained on the agricultural station and as such the lack of difference could not be ascribed to any ignorance on their part in the art of ploughing.

Apart from these, two other experiments were carried out on farmers' lands in the nieghbouring villages on the advice of the agricultural demonstrators. Their data are set out in table IV-C. It will be seen there that in both cases, ploughed plots gave better results than not ploughed, but when analysed statistically one of them alone proved really more productive.

Now, these data relate to a number of crops for a number of seasons and point out definitely that preparatory cultivation practised on the black soils of Koilpatti farm needs reconsideration with regard to the desirability of discontinuing the superfluous operations with the ultimate aim of cutting down the cost of cultivation. Such a step will run counter to the age-long experience gathered on the effects of ploughing and will make all the farmers proclaim with one voice that there should be something wrong somewhere to get these unbelievable results. It can only be said that all precautions and care were taken in the layout and the conduct of the experiments and the agricultural operations were all done as stated previously by experienced men and at the normal time. It may also be pointed out that similar conclusions were arrived at by other workers. Ducker (6) cited an instance in the third conference of cotton workers held in London last September. He said that in Nyasaland, fields left without any cultivation till the planting time yielded as much as those receiving normal cultivation. Bradfield (3) remarked that we should look upon tillage operations, as we do a surgical operation, indispensable at times, but to be avoided whenever possible. Parbury (8) declared that annual cultivation is not good. Garner (7) stated that in Cambridge the effect of cultivation on yield was interesting since the same result was not obtained in two consecutive years and it would be better to plough in one year and to cultivate in another year. Workers at Rothamsted (11) concluded that cultivations in excess of those needed to produce a seed bed and to keep down the worst of weeds did not confer any further benefit and might even produce a reduction in yield, and that it was only where the soil conditions were very poor, it would be possible to produce a positive effect by cultivations.

An explanation for the strange results may perhaps be found if the purposes served by cultivation are examined. Every student of agriculture knows that preparatory cultivation is done in the tropics with a view to get a good seed bed, to facilitate easy penetration of rainwater and to produce tilth such that optimum conditions for plant growth prevail. Russell and Keen (11) state that according to Von Nitsch the fundamental usefulness of cultivation operation can be measured by the increase in the pore-space brought about during the growing season and that for every increase of one percent in the pore-space in the growing season, an increase of 2·5 to 3 percent in yield would result. One would infer from the negative results obtained at Koilpatti that the necessary requirements for a good seed bed and easy absorption of rain water exist in the heavy black soils and that the good tilth which is expected out of ploughing is not present there.

Now according to the recent findings obtained chiefly in U. S. S. R, a soil will maintain its tilth in good condition as long as soil aggregates remain without crumbling. The agents that destory the aggregates are cultivation, alternate wetting and drying, presence of injurious salts and also certain cropping systems. But it must be mentioned at the same time that when the land is ploughed at a critical period of moisture content (i. e. at what is called the sticky point), soil crumbs resistant to the action of water and implements are formed to the maximum extent and tilth is built up. It is only ploughing under dry conditions that shatter the aggregates to fine particles which block up the pores. On this basis it looks that ploughing the stubbles soon after harvest of the crop will be prejudicial to the formation of water resistant soil crumbs and that the practice of the farmer of the southern districts of Madras to wait for the rains to start ploughing seems to be sound in principle.

The failure of ploughing and grubbing to produce increased yields has, according to above statements, to be attributed either to the absence of any addition to the existing proportion of water-stable aggregates or to the non-stability of the particles that are actually produced during the process of cultivation. It is not known clearly which of the facts are really operative in the soils at Koilpatti. If it is the former, it will mean that the implements used are not performing the functions expected of them, and the cost of cultivation is being increased without any compensatory improvement in the soil. It may be perhaps worthwhile to test other implements with a view to select those that will lead to an increase of crop yields. If on the other hand the conglomerates formed by these implements are of such a transcient nature as to be easily destroyed by rains or by the sowing operations, it may connote that a state of equilibrium between the agencies in the soil favourable for the production of stable crumbs and the capacity of the implements has been reached possibly by the cumulative effects of the use of mould board ploughs for the past 25 years and that the addition of ameliorants like humus, lime or gypsum alone will bring about further improvement in soil structure. Or it may also mean that the soil condition

chosen at present for the working of the implements does not lie near the critical point, however much the labourers may be experienced in the choice of optimum periods for starting preparatory cultivation. At any rate, one point becomes evident from whatever angle the problem is looked at. That is the fact that we are not in possession of exact knowledge of the cardinal points of tillage, viz., the relationship between soil tilth and crop yield, and the type of implement that will bring about that relationship to the maximum level. If we are to make headway in the improvement of cultural methods accumulation of sufficient data on each aspect of pre-cultivation is a necessary pre-requisite. It is therefore incumbent on the part of all officers in charge of agricultural stations to examine how far the methods of preculti-vation prevalent in each tract are justifiable and remunerative and which operation can be safely omitted with no loss in yield and with an eye to reduce the cost of crop production. In addition, experiments are to be initiated with the object of determining the implements that can perform them in a shorter time with no fall in efficiency.

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SEA WATER FOR IRRIGATION

Sea water is made suitable for irrigation by replacing the cations and (or) anions it contains for cations and (or) anions having a fertilizing action by passing through a suitable ion exchange. A part of the salt may first be removed by other means. The exchange is treated with a mixture of NH_3 and KOH to regenerate the anions and with a mixture of H_3PO_4 and HNO_3 to regenerate the cations :— The *Punjab Agricultural College Magazine* Vol. 7. (January 1940).