TECHNOLOGIES DEVELOPED
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I. Sub-soiling for *in-situ* moisture conservation

Tillage and seed bed preparation are very important operations in ensuring the better crop productivity but these are most neglected operations in India. Though the primary tillage implements are available, farmer with somehow complete mind-set is getting compromised with cultivator-tilling (designed for inter cultural operation for tilling 5-10cm depth) for primary and secondary tillage. Moreover, under changed agricultural scenario **acute shortage of work force and** improved life standards of rural India, forces the **farmer to resort for** short cuts with available implements. The use of cultivator as primary tillage implement over years in rain-fed and irrigated dry crops and weathering action influences the soil crust to form hard pan(compacted soil) just below(10-15cm) so called tillage depth, thereby limiting the root growth. The harmful effects of compaction on the soil and crops have been documented and a wealth of literature is available on these aspects. The soil bulk density plays an important role on plant roots development and uptake of nutrients. A medium textured soil, having the bulk density of 1.2 g/cc, is generally favourable for root growth. In this case, a moderate amount of compaction can increase root branching and secondary root formation, allowing roots to more thoroughly explore the soil for nutrients, especially the non-mobile one such as phosphorus. Excessive soil compaction impedes root growth and therefore limits the amount of soil explored by roots.

The compacted layers, if exist, should be disrupted as soon as possible. The top 15-20 cm layers can be disturbed with normal soil cultivation operations but deeper pans must be broken by using special be disturbed with normal soil cultivation operations but deeper pans must be broken by using special type of equipment such as subsoiler. The practice of shallow tilling also restricts the rain water percolation in to deeper layers and ways out of the field, which fails in conserving moisture in deep layers in-turn, fails to support crop during long dry spells of rain-fed farming.

To overcome the difficulty and insuring crop against dry spells, one time sub-soiling (vertical tillage) in a year to the depth of 40-60 cm with single or three standard sub-soiler is experimented. The main objective was to break open the hard pan to ensure vertical cut to maximum possible depth with minimum disturbance on the surface. These vertical-cuts aids rain water entry in to a greater depth beyond hard surface so as to minimise lateral flowing rain water to percolate in to the same field where the rain occurred, which propels in-situ moisture conservation.

II. Sub-soiling in rain-fed pigeon pea (redgram)

The results of experiment in rain-fed pure pigeon pea (redgram) crop with prolonged dry spell during grand growth and pod formation periods shown very significant difference in yield attributes when compared to control plot(farmers' method) as well as establishment of roots and physiological retention of the crop stature. The results are as follows

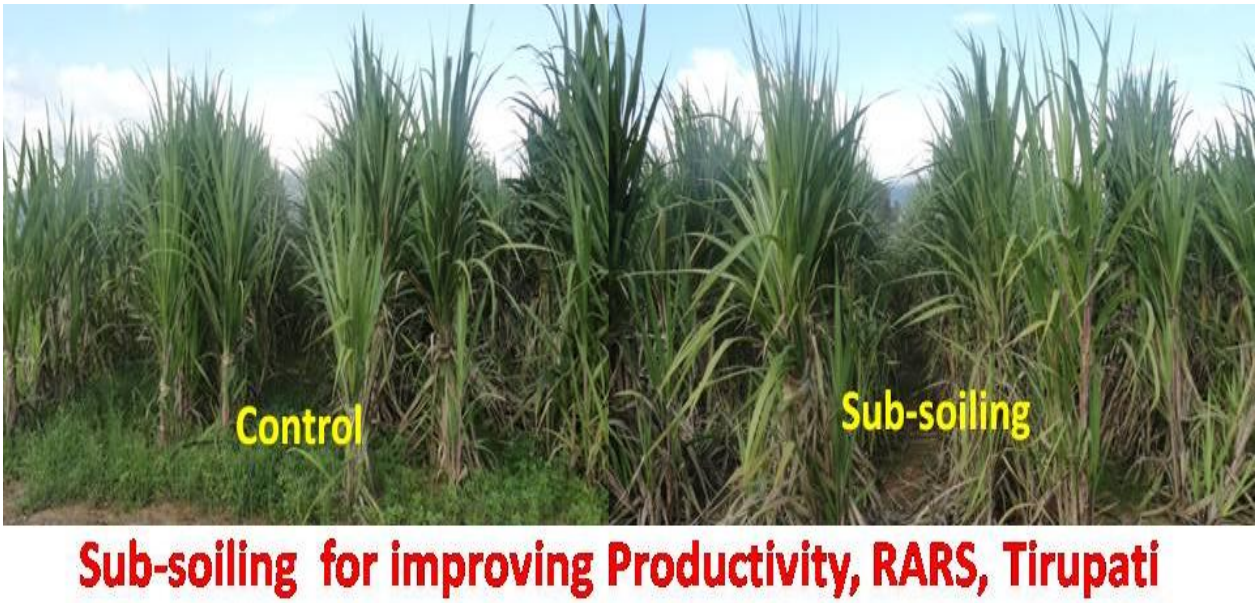
Effect of *deep ploughing* in red gram

Treatment	Control	Deep plough
Plant height (cm)	157.5	225.5
No. of branches	9.5	13.5
No. of pods	170	227
Pods weight(gm)	137.5	300
Seed weight(gm)	74.45	151.1
100 Seed weight(gm)	13.5	15.35
Leaf Area(c.m2)	2013.2	7902.8
Root Fresh net (gm)	57.5	245
Root Length	20.4	83

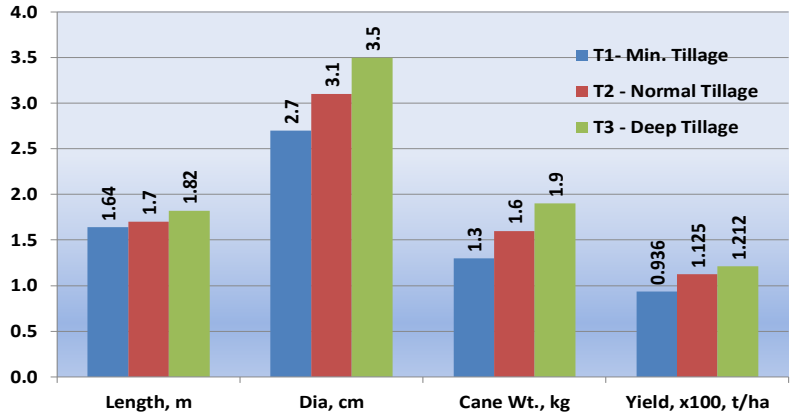
From the table it is evident that the treated plot yield attributes are significantly more when compared to control plot results. Hence, sub soiling could conserve moisture in deep layers of the field and created congenial soil environment for root growth to a greater depth, there by absorption of moisture and nutrients from the deeper layers made crop to sustain and maintain yield potentials.

III. Sub-soiling for improving Sugarcane productivity

The Sub-soiling was experimented in irrigated dry sugarcane crop and found to be very useful, data at harvest revealed that subsoil tillage significantly increased the mean length of millable cane (6.8%), diameter of millable cane (3.3%), no. of millable canes (10.35%), single cane weight (12.13%) and cane yield (26.1%) compared to check plot i.e., disk ploughing followed by rotovator. This result establishes the merit of using sub soiling by breaking up plough pan, promoting water storage in the soil and improving root activities that enhance anti-stress capacity of plants.



Method	No.of millable cane ('000/ha)	Length of millable cane (cm)	Diameter of millable cane (cm)	Single cane weight (kg)	Yield t /ha
Minimum Tillage(Blade harrow, Cultivator to make furrow)	80.24	164	2.7	1.3	93.6
Normal tillage (disk plough, Rotavator, Ridger)	80.86	170	3.1	1.6	112.5
Deep tillage (sub-soiler, Rotavator, Ridger)	81.33	**182**	**3.5**	**1.9**	**121.2**



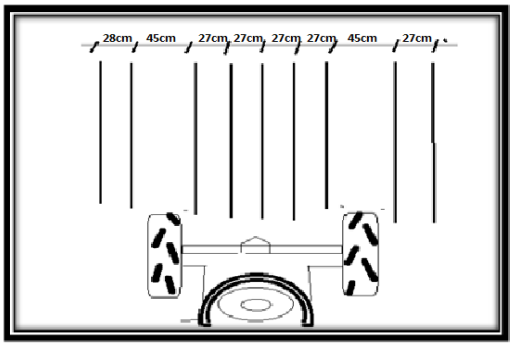
Effect of deep tillage up to 75 cm (with subsoiler) on sugarcane productivity

IV. Control Track system of cultivation for complete mechanization in field crops like groundnut, red gram etc.,

It is evident that dearth of agricultural labour is growing day by day due to various reasons like urbanization, changed life style, rural population shifting to cities etc., is making the agriculture very difficult or impossible without mechanization. Even though the mechanization process initiated in India, very essential operations like land preparation, harvesting in rice etc., are being taken up by the farmer. The other operations like seeding, intercultural operations, plant protection measures (spraying) etc., are being carried out by manual labour or even skipped at the cost of yields. This is mainly because of the non-availability of operation specific implements or poor purchase power of Indian farmer. In this regard the research was conducted technology "**Control Track system of cultivation**" was developed with available implements and equipments by doing minimum changes in sowing pattern, so as to run the available Tractor even during crop period and administer the inter-cultural operations.

a. **Control track system in Groundnut:** Groundnut being field crop recommended spacing of 30X10cm as it is it can be planted with available seed drills. But once planted the tractor with ordinary tyres cannot be run between 30cm rows, hence the two row spacing of seed dropping at tyre run-location was altered as 405 cm depicted in the fig.1. This manipulation of seed dropping will envisage tractor tyres to run on the created track so as to avoid trampling of crop in the field.

This system helps in complete mechanization of field crops like groundnut, Bengal gram etc., At the same time the cost of cultivation is being reduced to the extent of Rs. 6,000/ i.e., about 40%, moreover dependency on agricultural workers were



CONTROL TRACK SYSTEM OF CULTIVATION

operation	Mechanized method Rs./ac	Farmers method Rs./ac	Savings by mechanized method Rs./ac
Field preparation	1300	1200	100
Fertilizer(fert application)	1000	1200	200
Seed cost	(50 kg) 2500	(50 Kg) 2500	-
Sowing (Bullocks+5 labour/seed drill)	1000	2500	1500
Weeding(Labour/Cultivator)	1000	2000	1000
Pesticide + application cost	600	1000	400
Harvesting	800	1500	700
Stripping	1200	3000	1800
Cost of Cultivation	**9,400**	**14,900**	**6,000**

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