Before planting sugarcane, cross channels are created to help with monsoon water drainage.

Improved method of sugarcane planting

Ring-pit method

Ridge and furrow method

In intense irrigated sugarcane cultivation, the ridge and furrow planting method is the best. South India also use this technique. The method allows for simple irrigation, efficient soil aeration, and enough plant support. When the earthing up is done properly. Furrows and ridges are created on carefully prepared fields using tractor- or bullock-drawn ridges, maintaining a gap of 60 to 135 cm between each furrow. The most typical distance is 90 cm. For short duration early and shy tillering cultivars, low soil fertility, moisture stress or waterlogging, and late (summer) planting conditions, a closer spacing of 60–75 cm is preferred. In high fertility condition with effective irrigation systems and for long-lasting, high tillering varieties, wider spacing is advised. To enable automated planting and harvesting processes, spacings of up to 150 cm can be used.

The distance between the top of the ridge and the furrow's bottom is kept at 20 to 25 cm. A few days prior to planting, the ridges and furrows are constructed. A few days prior to planting, the ridges and furrows are constructed. To create a healthy seed bed, the bottoms of the furrows are loosened to a depth of around 10 cm. Channels for drainage and irrigation should be properly supplied. At a distance of 20 to 25 metres from the furrows, irrigation channels are installed (Lal and Singh, 2007). In order to lift irrigation, the distance might be lowered. If the field is level and not graded in one direction, an irrigation channel can be used to water the furrows on each side. In these situations, the irrigation water is diverted to irrigate the furrows on either side, and a small bund across the furrow is required to check flow at regular intervals. In heavily watered areas, drainage systems are crucial.

Ridge and furrow method of sugarcane planting

Sugarcane planting by ring-pit method

Tillers in sugarcane crop start emerging after about 45 to 60 days of the emergence of the mother shoots, so these remain comparatively weak and develop into millable canes of lesser length, girth and weight. To accommodate more numbers of mother shoots in the same place, tillers need to be suppressed. Hence, more number of setts are planted in circular pitts at relatively greater depth and the mother shoots are allowed to grow with very less or no tillers. This method is called as 'Ring – pit planting' because sugarcane is planted in pits of circular shape. This technology is also called 'No tiller technology' or 'Mother shoot technology'. Pits of 75 cm diameter and 30 cm depth are dug with a mechanized pit digger. The centre to centre distance is kept at 105 cm and in this way, the numbers of pits dug per ha are 9,000. The dugout soil is kept on the periphery of each pit. Twenty pieces of 2-budded treated setts are placed in each pit in a similar pattern as of spokes in a cycle wheel. *Trichoderma* 20 kg mixed with 200 kg of FYM or press mud per hectare is applied over the setts. The recommended dose of fertilizers are applied. The pits are filled with the dugout soil up to 5 to 7 cm depth at 4^{th} leaf stage(50 – 55 days after planting in autumn and 40 – 45 days after planting in spring).This technology is suitable for drought prone areas, undulating topography, light textured soils, saline - sodic soils, multiple ratooning and high yielding, tall and thick cane varieties. By this method, cane yield is increased by 1.5 – 2.0 times (up to 125 t/ha) and irrigation water is saved up to 30 – 40 per cent. Water use efficiency is increased by 30 – 40 per cent and nutrient use efficiency by 30 – 35 per cent. The technology also results more ratoons (3-4 ratoons) and higher sugar recovery (by 0.5 unit) resulting in higher profit to farmers. Lodging and uprooting of clumps is also reduced due to deeper planting. The benefit – cost ratio in sugarcane farming by adopting this method is 1.83. The advantages of adoption of Ring pit method, the sugarcane productivity is increased by 30-40 per cent as compared to the conventional method (Yadav, 2007).

In this method, only the pits are irrigated and the space between two rows is not irrigated, resulting in saving of 30-40 percent of irrigation water. Due to the use of nutrients in the pit, the efficiency of utilization of nutrients increases by 30-35 percent, due to which the yield of sugarcane is also obtained. Due to deep planting, the problem of falling of sugarcane along with the root at the spot is also solved.

Spaced Transplanting Technique

Sugarcane planting by spaced transplanting

In conventional planting of sugarcane using three bud setts, genetic potential for tillering is not fully exploited. Inter-plant competition and unevenly distributed solar radiation tend to affect tillering. Occurrence of higher mortality, adversely affected stalk density and crop productivity, per *se*. In addition, transportation of bulk seed material and slow multiplication rate (ratio being 1:8 to 1:10) are important constraints for the seed multiplication programme. Based on the sound physiological understanding of germination (sprouting), tillering *vis-a-vis* inter and intra-plant competition, a scientific crop management procedure, the Spaced Transplanting Technique (STP) has been developed for synchronization of tillering and quick seed multiplication of sugarcane. This technique ensures higher stalk population (number of millable canes) with a uniform crop stand and higher average cane weight. In this technique, a nursery is raised in small area nearly a month before the actual transplanting, preferably near the field to be transplanted. Land is prepared to a depth of 15 cm and small plots (1 sq.m) are made. Before dibbling setts, chorpyriphos @ 1 kg a.i. /ha is applied. Single buds setts (from upper half of the cane) are cut just above the growth ring and leaving 9-10 cm of the internode below the bud followed by dipping for 30 min in 0.2% Carbendazim (Bavistin). The setts are dibbed vertically (600 – 800 setts/sq.m) in the irrigated nursery. Trash and paddy straw is spread over the setts and then mulched with pulverized soil. Most of the buds sprout and in 3 – 4 weeks, produce 3 – 4 green leaves. Settlings are carefully removed and leaf laminae detopped. These are dipped in 0.2 % Carbendazim (Bavistin) suspension for 30 min.

Transplanting of settlings is done in trench or flat system, in rows with 90 x 60 cm spacing (19,000 settlings) or 75 x 45 cm spacing (29,000 settlings). Settlings are dibbed and covered with soil leaving at least 5 cm of the shoot above the ground level, followed by an immediate lifesaving irrigation. After 10 days of transplantation, the gaps, if any, are filled by the nursery kept in reserve. Normally, 5 – 10% mortality takes place. This technique is a boon for rapid multiplication of seed cane. The STP technique is very useful for rapid seed cane multiplication. It is highly effective in saving seed cane to the tune of 4 t/ha. It maintains relatively higher population of millable canes (>1.2 lakh canes/ha). It improves the ratio of seed cane to output from 1:10 to 1:40. Ratoon of a (preceding) plant crop raised from STP gives higher cane yield (Shrivastava and Rai, 2007).

Mechanized trench method

The germination of sugarcane is limited up to 30% due to the flat method's reduced irrigation. The trench approach is especially helpful when there is no irrigation. After planting, sugarcane germination in the trench method is rather high. To plant sugarcane using the trench method, create trenches that are 20 cm deep and 40 cm broad, keeping the center of each trench and the other parallel trench 90 cm apart. After adding compost prepared from cow dung or pressed manure, carefully combining it, and then covering the trenches with 4-5 cm of soil, three-eyed pieces of sugarcane are planted in them.

Immediately after planting, a light irrigation is done in the trenches and after few days, a blind hoeing is done, which results in good germination. After the germination of sugarcane, according to the growth of the crop, soil is put in the trenches, by doing this, a ridge is formed in place of a trench and a trench in place of a ridge which is used for drainage during the rainy season. By this method, along with good yield of planted sugarcane, the good yield of ratoon crop is also obtained. In this method, up to 70-75 per cent germination is achieved.

In this method, one or one and a half month before planting, about 25 cm deep trenches are made for winter sugarcane at an interval of 90 cm and for spring sugarcane at 75 cm interval. Cow dung or pressed manure of sugar mill is applied @ 5-10 tonne per hectare in this prepared trench. The soil is prepared well by pouring irrigation and hoeing. After the sugarcane germination, along with the gradual growth of the crop, the soil of the ridges is dropped on the roots of the plants in the trench, which eventually forms a ridge in place of the trench and a trench in place of the ridge, which along with the irrigation trench, gets water during the rainy season. Also performs the function of drainage. This method is suitable for loamy land with high compost level and abundant input availability. This method not only gives a higher yield, but at the same time, the consumption capacity of irrigation water and nutrients also increases (Lal and Singh, 2007).

Sugarcane planting by mechanized trench method

Paired row method

Sugarcane planting by paired row

In this method, at the interval of 90:30:90 or 120:30:120 or 150:30:150 cm, about 10 cm deep furrows are prepared in the field. In this method, the quantity of setts can be increased from normal to less than normal on the basis of rows and this method is suitable for more fertile cultivation in availability of abundant manure and water (Lal and Singh, 2007). This method gives higher yield of sugarcane. By adopting paired row method, farmers can harvest more sugarcane yield as well as earn more profit by adopting companion cropping. By adopting this method and by promoting mechanization in sugarcane farming, cultivation can be done successfully even in the case of labour scarcity.

FIRB (Furrow Irrigated Raised Bed) method

(a)
(b)

FIRB (Furrow Irrigated Raised Bed) method

(a)- Mechanical Preparation of FIRB,

(b) Germination of Sugarcane on raised beds

The ICAR-Indian Institute of Sugarcane Research, located in Lucknow, invented this technique. This technique involves planting sugarcane in a furrow and wheat in raised beds. The western regions of Uttar Pradesh, where sugarcane is planted after wheat, benefit more from this technique. Wheat-sugarcane-ratoon-wheat is a typical sugarcane-based cropping pattern in the north-western region of subtropical India. It is estimated that 14% of the country's sugarcane land, more than two thirds of which are in western Uttar Pradesh, is farmed using this method.

Sugarcane is planted at a distance of 90 cm in the furrows and wheat is sown at a distance of 15-17 cm in three rows on a raised bed of about 60 cm wide between two cane furrows. In order to sow wheat/sugarcane by this method, the Institute has developed tractor operated “Raised Bed Seeder” machine by which wheat is sown on raised beds (Lal and Singh, 2007). This method is adopted in two ways. If wheat is sown in November, then after the first irrigation in the wheat, setts of sugarcane are pressed with feet in the wet furrows. That's why it is also called wet method. In second way, about 50,000 three-eyed setts of sugarcane are required. If wheat is sown in December, then sugarcane is planted in the furrows in February in the standing wheat crop. In this method, after irrigating in the furrows, the sugarcane setts are buried at the same time or the next day when the soil is wet or before irrigation, the sugarcane setts are crushed in the wet state by hand pounding the soil of the furrows (Singh K et al. 2012).

Benefits of FIRB Method

1. For sowing of wheat and sugarcane, there is no need of separate pre-planting irrigation.

2. In addition to the almost normal yield of sugarcane, there is no adverse effect on the yield of wheat, due to which the farmer gets additional income.
3. Increases water use efficiency. About 25% nutrients and irrigation water are saved.
4. Crops faces less infestation of weeds. The requirement of quantity of wheat seed is reduced from 100 to 120 kg to 75 to 80 kg/ha.

Sugarcane Seed Multiplication Technique

Bud-chip Sowing Technique

Generally, the planting of sugarcane is done in two- to three-eyed setts in the cut-out cistern, 60-80 quintals per hectare is required for planting sugarcane by this method. Time and labor are also spent in harvesting, transporting, cutting setts, planting etc. Due to excessive weight, farmers are not able to treat sugarcane effectively, due to which effective control of seed borne diseases is not achieved. Seed cane minimization techniques like STP, single bud planting, single bud seed or bud chip seedling, sowing of seedlings prepared by tissue culture method for higher yield per unit and for setting up micro irrigation unit *etc.* can be used. Among the methods described above, single bud seedlings or bud-chip seedlings are gaining popularity. Planting of sugarcane by preparing seedlings by this method can save about 80 percent of sugarcane seed. Therefore, this technology is another option for farmers to earn more profit by reducing the cost. In this method, the sugarcane bud should be removed and prepared in the nursery and the rest of the process should be done like poly bag or cane node method (Solomon and Sharma, 2014).

Poly bag method

Polybag method is also very effective in the case of shortage of seeds of improved varieties. By this method, 18-20 quintals of sugarcane is required per hectare. For sugarcane growing areas after harvesting of wheat, higher yield can be obtained by planting sugarcane by poly bag method. Because a month before wheat harvesting, its nursery is prepared and planted in the main field. For preparing nursery in poly bag, first the soil mixture is prepared by taking equal quantity of soil sand and cow dung manure/compost and mix it well, after that 10 ml of Chlorpyrifos 20 EC mix one quintal of soil. This treated soil mixture is filled in a polythene bag of size 5 inches long and 5 inches wide. Some holes are made in the polythene bag all around and at the bottom, so that the excess water after irrigation will drain out and thus the setts of sugarcane will be saved from rotting. To prepare the nursery, the upper 2/3 part of the sugarcane is cut into pieces with one eye, their cut pieces are immersed in 5 litres of water by mixing 100 grams of Bavastin for 15-20 minutes. After this, the cut treated pieces are kept in a polythene bag in a vertical position in such a way that the eyes are facing upwards, after that 2-3 cm layer of soil is laid over it and a light irrigation is given. Spraying of water 2-3 times at an interval of 5-6 days in poly bag nursery. In

Bud-chip Sowing Technique

Sugarcane Seed Multiplication by Poly bag method

three to four weeks, a good set is achieved, and 3-4 leaves are produced, which are about 6 inches in length. The upper leaves of the plants should be cut by 2-3 cm before transplanting. By doing this, the loss of water by the plants is reduced. In the prepared field in which these plants are to be transplanted, a furrow is made by the ridge at a distance of 90 cm and plants should be transplanted at a distance of 45 cm in these furrows. Thus, about 23,500 plants are planted in one hectare. Irrigation should be done immediately after transplanting. After 8-10 days after transplanting, inspect the field, if the plants have dried up or died at any place, then new plants should be transplanted again at that place (Singh and Prasad, 2007).

3. Conclusion

In India's agrarian economy, sugarcane plays a significant role and provides support to one of the biggest agro-processing sectors in the nation. In addition, the sugar sector employs over 500,000 skilled and semi-skilled employees, most of whom come from rural areas. India will need close to 33 million tonnes of white sugar by the year 2030 just for domestic use. It is clear that improving crop productivity and quality will be essential to achieving the future sugarcane output objective. The development and promotion of technologies that increase farm revenue and provide employment prospects therefore require a research and development focus. In India, the mechanisation of sugarcane farming has not yet been fully utilised.

For sugarcane cultivation, traditional tools and equipment are still widely used. One of the causes of the low level of mechanisation is holding size. Without a doubt, mechanisation will increase sugarcane production's profitability while also lowering labor-intensive tasks that humans must perform. To increase the use of equipment based on sugarcane cultivation, various organisations, including the sugar industry, state agricultural universities, research organisations, cane departments, etc., must coordinate their efforts (Singh and Sharma 2010).

The next phase of revolution in Indian agriculture is bound to come through the use of improved cultivation practices suiting to local conditions. Concerted efforts are required to formulate a strategy for improved cultivation techniques and mechanising sugarcane production in India with the sole aim of increasing production and productivity per unit time, area and input at reduced cost of unit operation. This is must if we have to survive in the highly competitive international sugar market.

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