DUAL ROW PLANTING A STEP TO MECHANIZATION IN CANE CULTURE

BY

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ABSTRACT

Commercial cane cultivation in Pakistan mostly comprise planting cane in single rows at 75cm inter rows spaces. Though cane furrows are mostly made with tractor but latter use of farm machinery for complete weeding and hoeing is not common due to narrow inter row spaces. The studies reported in here were carried out to compare working efficiency of two planting methods, the single row planting at 75cm and the dual row spacing at 60 – 120 – 60cm row spaces. The experiment was conducted at grower's field in Chuhar Jamalia area of Sujawal District during October, 2006. The experiment was laid out on two planting methods with 12 replications. The observations were recorded on germination, tillering, cane formed shoots and cane yield. During 2012-13, Dual row planting technology was extended to commercial cultivation comparing the single row planting on grower's fields at 1048 acres. The data for both the sites shoe significant yield increase in dual row planting treatments. The dual row planting gave 25% and 23% higher yield of cane over single row treatment at Sujawal and Nawabshah, respectively. The yield increase in dual row planting was due to more tillering more cane formed shoots and higher per cane weight. Besides the economic gains, mechanical cultural operations showed most efficient, cheapest and time saving mechanism of inter-row hoeing and weeding. The techniques of better ratoon management and profitable inter cropping are also discussed.

INTRODUCTION

Following expansion in sugar industry, expansion in cane area has necessitated the use of tractors for various farm operations. But, their proper use is still questioned under Pakistan conditions. Besides the common use of tractors, growers mostly follow conventional planting at 75cm row spacing. For proper mechanized operation in the process of weed control and hoeing, 75cm row spacing is not enough especially with high yielding varieties. In cane cultivation, while row spacing control plant density, its proper configuration and spatial arrangement affect working efficiency of the farm machinery. Row spacing in sugarcane vary from country to country and is influenced by climate, varieties and farm equipment in use. The row spaces adopted in different countries are shown in **Table-1**

Cane yield is a manipulation of plant density and cane weight which are highly influenced by row spaces. Studies carried out in this direction show interesting features. In a comparison of Dual row planting at 50 – 110 – 50cm and single row at 100cm row spaces, the former system gave 18.53% higher cane yield over the latter. However sugar recovery was not affected; This increase in cane yield was significantly correlated with number of mill-able canes (Klomsa etal, 2007).

Amolo and Obayo (2003) made comprehensive study on the effect of paired row (50 cm in 200 cm centre) and standard row (150 cm) on cane yield of sugarcane. Under sub-humid conditions

paired row spacing gave higher cane yield and sugar recovery, while close spacing gave inferior quality and reduced cane yield. Under humid conditions closer spacing was recommended for minimal mechanical operations and only for seed production.

Table-1. Inter row spaces adopted in various cane growing countries

Country	Row space (m)	Country	Row space (m)
USA, Louisiana	1.6, 1.8	Brazil	1.6
Florida	1.6	Indonesia	1.2, 1.5
Argentina	1-6	Philippines	1.2, 1.5
Cuba	1.65	China	1.2, 1.5
South Africa	1.5, 1.8	India	0.9, 1.2, 1.5
Mauritius	1.5, 1.8 0.5 – 1.3 – 0.5	Pakistan	0.75, 1.2
Australia	1.6 1.8 0.5 – 1.3 – 0.5		

Hunsigi,1993, Black Burn, 1984.

Garside and Bell (2009) observed that cane varieties show different capacity to adopt wider and narrow row spacing. Some varieties are better adapted to single row of 180cm while others to dual row spacing of 50cm in 180cm center. It is due to propensity of tillers ability to compensate between stalk number, stalk weight and tendency to lodging. Water use efficiency was significantly higher in dual row spaced 1.8m apart than in single rows spaced 1.5m. There is clear yield advantage to planting cane in dual rows. The cane productivity was reported to be improved by 3 to 28% from dual row planting of 50 - 130 - 50cm against single row spaces of 160 cm. The variation was due to differential varietal response. In another study 1.2 m space gave higher yield of cane than planting at 1.0 m row distance (Yen metal, 2013). A comparison of 0.9, 1.2 and 1.8 m showed significant yield increase with 0.9 and 1.2m over 1.8 m (Richard etal, 1994).

In comparing row distance of 1.0m and 1.5m during autumn and spring sowing, wider row distance increased cane yield by 4.7 tha^{-1} with enhancing recovery by 0.87^{o} (Malik and Ali, 1990). Rehman etal (2013) compared yield and quality response of sugarcane to inter row spaces of 75, 90 and 120 cm. The highest yields were obtained from 120 cm spaces, however yields of 90 and 120 cm were at par. Similar observations were recorded by Chatha etal, (2007). The studies on row spaces of 0.75, 1.0, 1.25 and 1.5 m, recorded highest cane yield and sugar contents from 1.25 m row distance (Soomro etal, 2009). Significantly higher yield of cane obtained from wider row spaces of 120 cm over narrow spaces of 6o and 90cm was also confirmed by Mansif etal (2015).

MATERIAL AND METHODS

The studies were carried out to compare yield and quality performance of sugarcane planted under two methods the Single row planting (SRP) and Dual row planting (DRP). The trials were conduct at two locations; Dewan Sugar Mills area during 2006 and Habib Sugar Mills area during 2012.

1. Dewan Sugar Mills Area.

Planting methods

Single row planting-SRP= Single rows at 75cm inter row spaces, drawn with a conventional three row ridger.

Dual row planting-DRP= Two adjacent rows at 60cm space with 120cm wide strip 60 -120- 60cm, drawn with a specially designed ridger.

Plot size: Single row=12 rows each 75cm wide x 10 meter long; (9000 m^2)

Dual row= 10 rows in a set of 60 -120- 60cm strips wide x 10 meter long; (9000 m^2).

Replications: 12; 'T' test applied for comparison of means

Seed rate: 75,000 double budded setts per hectare.

The experiment was planted at a grower's field (Mian Asmatullah) in Chuhar Jamali area of Sujawal District in Sindh, during first week of October, 2006. Each planting system was laid out in alternate way. The data was recorded for germination, tillering, cane stalks per m^2 and cane yield tha^{-1}.

2. Habib Sugar Mills Area

The DRP and SRP technology was extended to 1048 acres of commercial plantation of four growers; the area details shown in **Table-2**. Both the planting systems were adopted by the growers at their forms. The planting was carried out under the supervision of sugar mills development staff. The data on cane area and cane yields were collected by the concerned sugar mills staff. The cane yields were worked out from the cane supplies record of the sugar mills for the corresponding area of the growers already earmarked. The juice quality of cane samples collected for the two planting method from grower's fields were also recorded.

Table-2. The cane area planted under single row (SRP) and Dual row (DRP) system at grower's field in Habib Sugar Mills, Nawab Shah

S.No	Name of grower	Area in acres		
		Total	Single row	Dual row
1	Bachal Jamali,	800	250	550
2	Abduj Ghafoor Koree	18	14	4
3	Fasihi Ahmad	180	140	40
4	Ali Raza Jamali	50	44	6
	Total	1048	448	600

RESULTS AND DISCUSSION

1. Dewan Sugar Mills Area

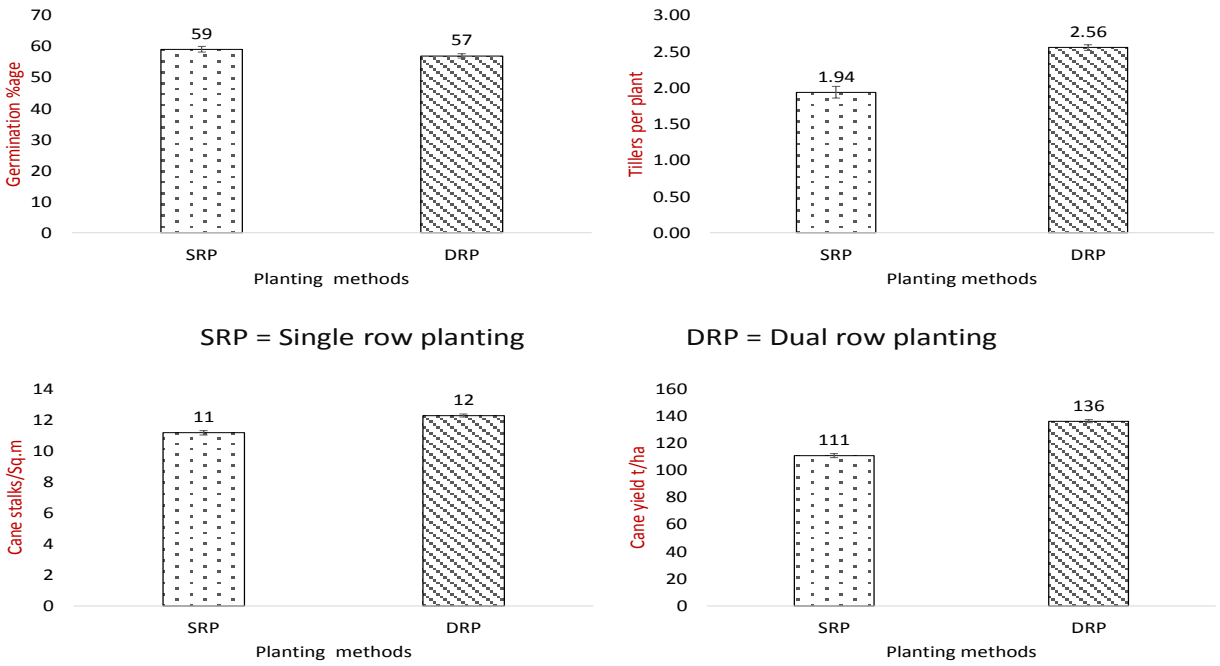
Plant Density:

The data on germination, tillering and cane formation is shown in **Table-3.** Both the planting systems have almost the same rate of germination around 57-59%. However plants in DRP have produced more tillers (2.56 tillers per plant) than the plants in SRP system (1.94). Similarly, numbers of cane stalks per square meters are also higher in DRP (12) than in SRP (11). More tillering and more cane stalks formation in DRP are due to their availing of more space and facing relatively lesser competition for light and nutrients.

Statistical comparison of means of various characters are also shown in figure below:

Table-3. Cane yield and yield contributing factors as affected by SRP and DRP

Factor	Stat. Sign	SRP	DRP
Germination	Mean	59	57
	SE	0.900	0.712
Tillering	Mean	1.94	2.56
	SE	0.089	0/039
Cane stalks per. M^2	Mean	11	12
	SE	0.133	0.100
Cane yield tha^2	Mean	110.18	136.80
	SE	1.406	1.800



Cane yield contributing characters as affected by planting methods

2. Habib Sugar Mills Area.

Cane Yield

The cane yield data given in **Table-4** indicate that out of 1048 acres, dual row plantings of 600 acres recorded a stripped cane yield of 930 maunds against 746 maunds obtained in single row planting. As such dual row planting gave 24.66% higher yield over single row planting. This yield improvement was noticed with all the growers in this tract. Similar results were reported by Malik and Ali(1990) and Yen (2013), where in 1.5m row spacing gave a yield increase of 5-tonnes per acre over 1m spacing. However this positive yield response was for September planting and not for spring planting.

Table-4. Cane yields obtained from single row (SRP) and Dual row planting (DRP) at grower's field in Habib Sugar Mills, Nawab Shah

S.No	Name of growers	Planted area acres			Cane yield maunds acre^{-1}			Percent variation
		Total	SRP	DRP	SRP	DRP	Difference	
1	Bachal Jamali,	800	250	550	749	936	187	24.97
2	Abduj Ghafoor Koree	18	14	4	561	775	214	38.15
3	Fasihi Ahmad	180	140	40	815	890	75	9.20
4	Ali Raza Jamali	50	44	6	570	735	165	28.94
	Total	1048	448	600	746	930	184	24.66

Cane juice quality

The data on the effect of row spacing on juice quality is shown in **Table-5**. It is interesting to note that cane planted in DRP at Bachal Jamali Farm recorded a recovery rise of o.53^{o} over SRP System. Sugar recovery improvement was also noticed at the farm of M. Abdul Ghafoor. In some earlier studies comparing row spacing's of 1m and 1.5m, the wider row planting (1.5m) has shown a recovery increase of 0.87^{o} (Malik, atal-1990). In closer row spaces cane leaves get over lapped and are not much exposed to light. While in wider row spaces leaves on 1.2m, space avail of more opportunity to light exposure, thus photo synthetic activities are enhanced for sugar synthesis.

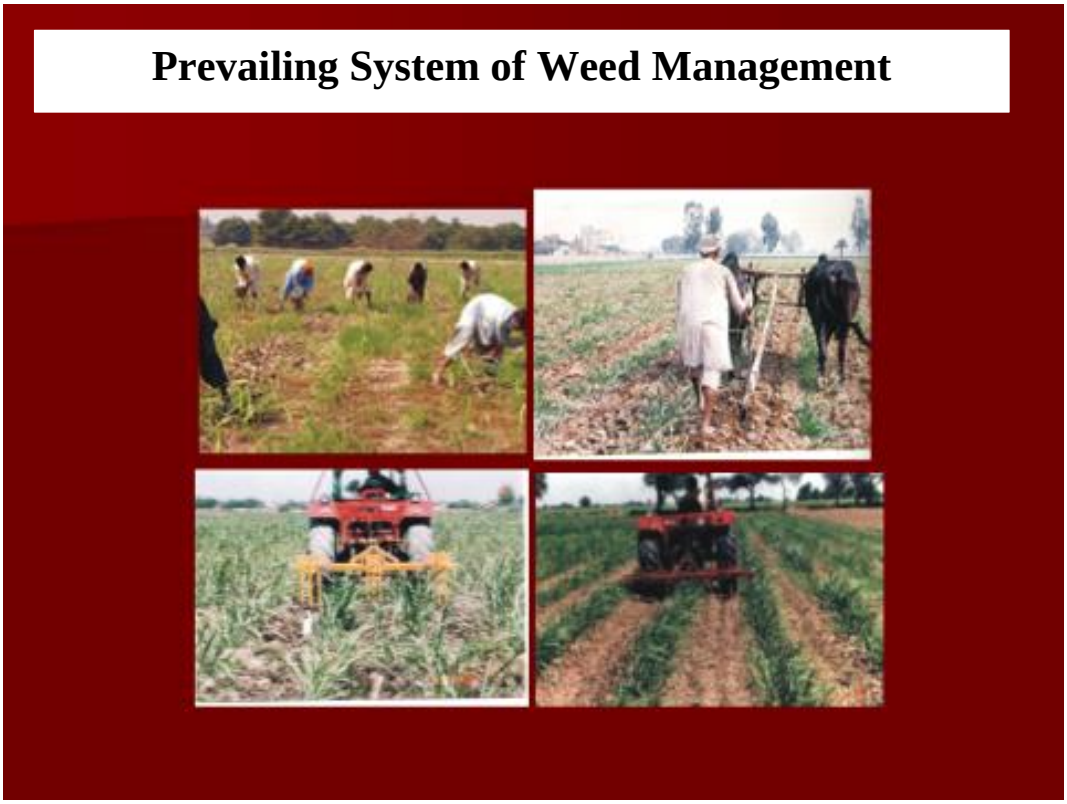
Table-5. Cane juice quality as affected by single row and dual row planting in Habib Sugar Mills.

Name of grower	Planting method	Cane variety	Brix	Pol	Purity	Sugar recovery	Degree increase
Bachal Jamali	SRP	SPF 234	20.95	17.72	84.58	10.82	-
"	DRP	SPF 234	22.35	18.67	83.53	11.35	+ 0.53
Abdul Ghafoor Koree	SRP	HS 12	22.55	18.06	80.08	10.76	-
"	DRP	HS 12	23.70	19.28	81.35	11.37	+ 0.61

The existing planting systems in Pakistan

Bullock cultivation:

The system is somewhat obsolete, very rare practice of planting cane with bullocks. However, bullocks are often used for inter-row hoeing with munnah hal or tarphali. This is even done in cane fields wherein planting has been done with tractor, and more so in ratoon crop. This is because in closer row spacing tractor operation is not convenient.



Weed control: In case of manual hoeing, 12 – 15 man days are required for hoeing one acre. You may imagine the extent of the labor needed for 100 or more acre, and above all time factor is important, soil moisture deplete soon after without which labor can't work.

In the case of hoeing with bullocks drawn implements, it hardly covers one acre a day, large plantation can't be managed in time. When the cane crop elongates in size growers are reluctant to work.

For inter row cultivation with tractor (as shown in figures above) this is the first and last hoeing. When the tillering completes tractor operation at 75 cm rows distance damage the cane shoots due to closer spacing. Hoeing is quite possible at 120 cm row distance but in this case plant density is low and the growers have not adopted this practice eagerly.

Tractor cultivation:

This should be dealt in with a little wider term extending to mechanization. In true sense it involves the use of farm machinery in inter - rows spaces for different field operations that include:

- Inter-row cultivation for weed control and hoeing,
- Plant protection: use of spray equipment for control of weeds, diseases and pests.
- Crop harvesting: manual, use of Cane Thumper, Sugarcane Chopper Harvester.

Sowing operation

Conventional planting: Single row ridger – three furrows each at 2.5 ft. row space. Method is of general use in Pakistan. Inter-row hoeing is possible only on completion of germination. At latter stages hoeing is done manually with hand tools; cane rows are too close for tractor operation.

Wider row planting: Ridger designed to make two deep trenches at 4 feet row distance
Plant population per unit area is much lesser than three row ridger, as such could not be popularized.

Dual row planting

The tractor makes two furrows each at 0.6m row space, leaving a 1.2 m wide strip in between, having row configuration of 60 – 120 – 60 cm. This system is the topic of the day, how it operates can be viewed from the pictures.

The position of seed sett placement can be viewed as under:

	No. of furrows	Seed sett placement
Conventional row space – 75cm single	88	1.72
Dual row ridger 60 – 120 – 60 cm	67	2.28
Single row ridger 120 cm	55	2.75

The images given above show configuration and layout of furrows, irrigation after sowing and the start of germination.

The figures showing different growth stages of cane crop provides most suitable time and space for inter row operation with tractor at any stage of crop growth till close in of cane shoots.

The figures also indicate that the dual row configuration offers very effective and efficient system of tractor operation for inter row cultivation, spray of herbicide / pesticide at different stages of germination and tillering. Earthing up is quite possible which also allow irrigation in furrows.

Different growth stages of cane crops




Inter row cultivation at different growth stages



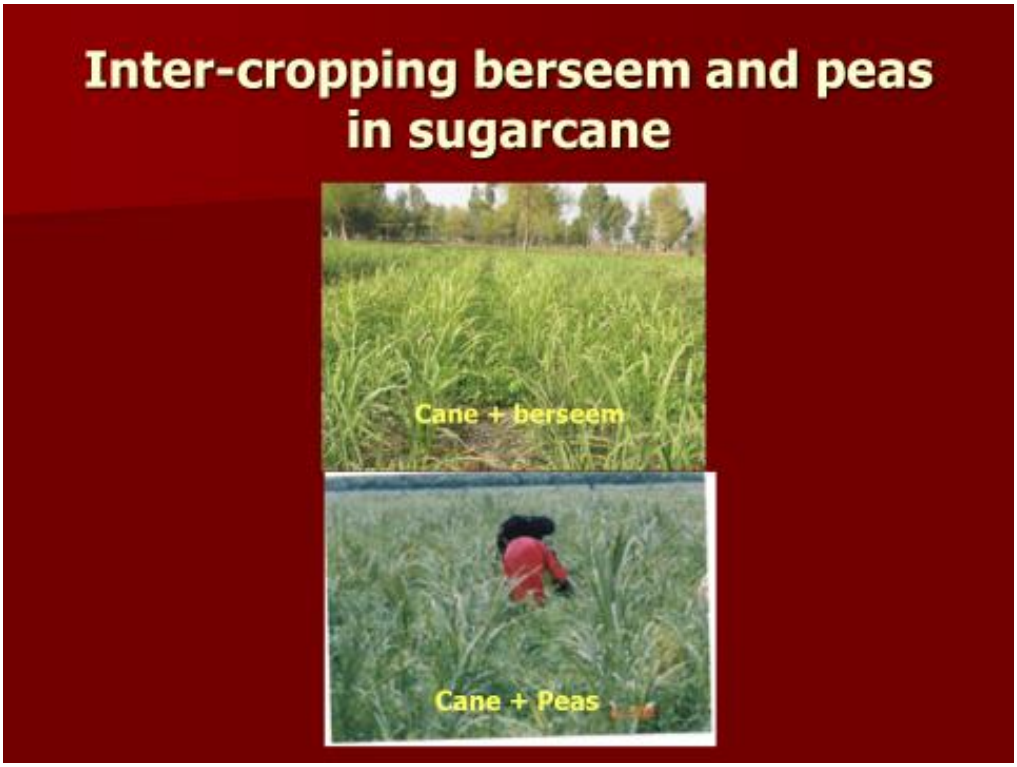

Inter-cropping:
To stabilize his economy, inter-cropping is a usual feature of small cane growers. Sometimes we need to convert vegetable growers to cane culture. For that matter we should have a more profitable system of inter-cropping or relay cropping. Wheat and sarson are the two most relished inter-crops of small growers of cane growing regions, but by so doing cane crop is mall nurished. Wheat and sarson are taken as the main crop while sugarcane is considered as subsidiary crop.

Philosophy in successful intercropping is providing enough space o crop plans that hey don' compete for light air and nutrients. Either of the crop should no suffer due to shading effect. the problem is well marked in 75 cm inter-row spaces of cane. The existing system of intercropping in 2.5 ft row spaces has much depressing effect on cane yield. Dual row cropping affords to grow other crops without detrimental effect on cane yields.

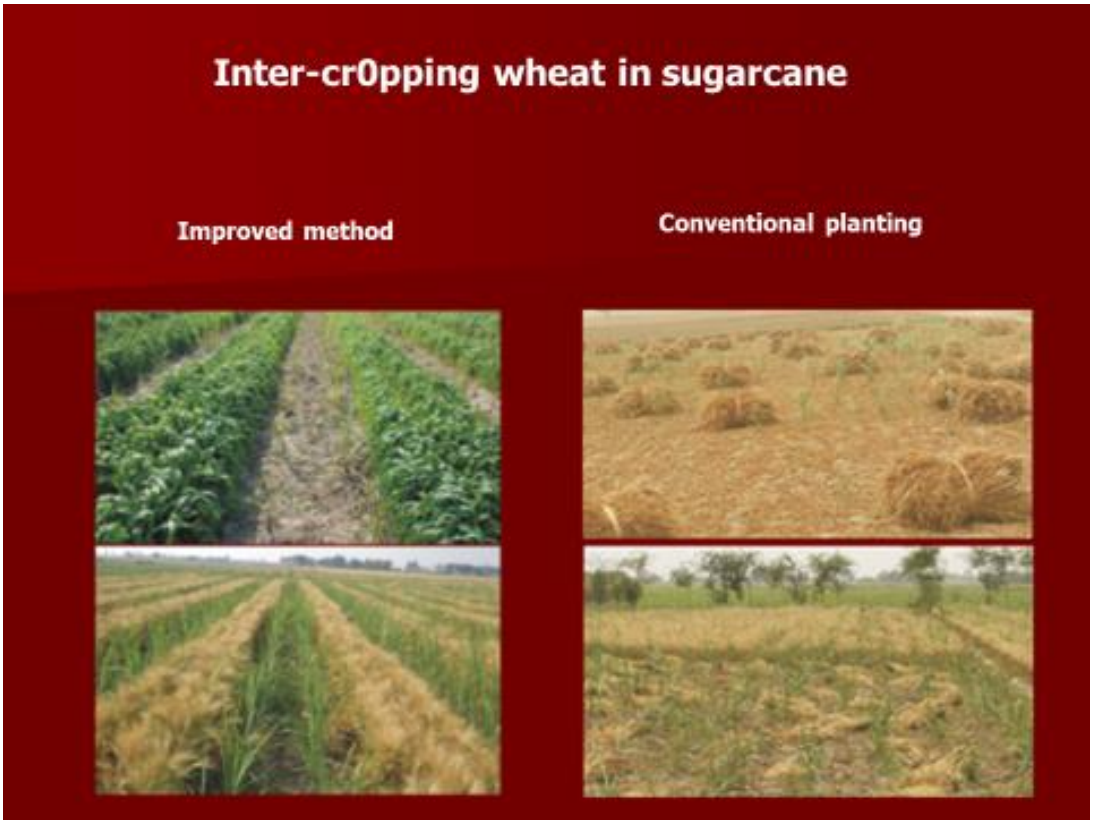
The image show he improved and conventional planting of inter-cropping wheat in cane at 75 cm inter row spaces of cane and dual row planting at 60 – 120 – 60cm spaces. The tillering and plant density of cane can well be compared in both the planting systems. By the harvest of wheat cane crop is fully established in dual row planting.

Inter-cropping sarson in sugarcane is equally good and give successful crop of both the inter-crops.

Dual row planting can also accommodate green manure crop partly as fodder and later to be incorporated as green manure; eg. Berseem, Frosh beans. Peas has also proved very good inter-crop as vegetable. Legumes and pulses help improve land productivity.




Inter-cropping sarson in sugarcane
Conventionl planting
Improved method
Improved method
Improved method


Inter-cr0pping wheat in sugarcane
Improved method
Conventional planting

Ratoon management: After harvesting of plant crop, ratoon crop needs proper inter row hoeing /cultivation operations. The DRP system can best manage the crop for weeding, hoeing, fertilization till the stubbles sprout to advance tillering stage. Narrow row spaces do not offer much scope for mechanized operations in cane fields.

Besides inter row hoeing in ratoon fields, a programme can be chalked for incorporation of trash as mulch and green manuring. This mechanized operation is possible only with wider row spacing.

Summery & Advantages

- This is a new planting technique and is a step towards mechanization.
- At both the experimental sites ie. Sajawal and Nawabshah, Dual Row Planting gave significantly higher yield of cane than single row planting, due to better tillering, higher plant density and higher per cane weight.
- The dual row space coincide perfectly with the wheel track of the tractor.
- The best benefit of the DRP is that it provides most suitable time and space for various mechanized operations in standing crop of sugarcane.
- It is a labor and time saving device. Practically it has been noticed that 12 - 15 persons are required to complete spade hoeing in one acre. As against this, tractor can accomplish hoeing of ten acres, in one day.
- Inter-row hoeing with tractor is quite efficient and more effective at early as well as later stage of crop growth.
- The system can control soil moisture quite well in time.
- Due to better aeration and light through wide strips crop attain good tillering and makes fast growth.
- Due to wider rows cane leaves are more exposed to light that induces higher rates of photosynthesis, hence higher sugar recovery.
- Can accommodate inter- crops with much profitable returns without any depressing effect on cane yields.
- Can accommodate some green manure and legume crops for improving land productivity.
- The DRP system is best for managing ensuing ratoon crop.

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