Indian Farming **68**(01): 65–68; January 2018

Vegetables intercropping with autumn planted sugarcane:

a step towards doubling farmers' income in Indian sub-tropics

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Intercropping refers to growing of two or more crops simultaneously on the same piece of land with adefinite row-planting pattern to obtain higher productivity per unit area and time. Rapidly increasing population, increased demand for food, limited scope for extension of cultivation to new areas, diversified needs of small farmers for food and cash etc. have necessitated the adoption of intercropping systems. In long duration crops like sugarcane, intercropping holds much promise. Due to slow establishment of sugarcane during the first 90-120 days, the greatest scope for complementary effect lies in the addition of annual intercrops to the temporal system to improve resource use efficiency in the early crop growth. Intercropping offers an opportunity for profitable utilization of available space. Sugarcane growers take advantage of this and grow various short duration crops like cereals, pulses, vegetables and spices as intercrops to obtain interim return.

Key words: Autumn, Farmer, Income, Intercropping, Sugarcane, Vegetables

SUGARCANE being the most important commercial crop after cotton is the efficient converters of solar energy into sugars and other renewable forms of energy. India is the second largest producer of sugar after Brazil with a global share of 17% (2014-15). Over five million farmers are involved in the cultivation of sugarcane in tropical and sub-tropical India, the two distinct agro-climatic regions of the crop in the country. Sugarcane in India is cultivated broadly under two distinct agro-climatic conditions commonly referred to as tropical and sub-tropical belts. The tropical belt comprising Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh, Gujarat, Chhattisgarh, Odisha and Kerala accounts for 42.9% of the total area under sugarcane cultivation in the country. The sub-tropical sugarcane region constitutes around 57.1% of total cane area in the country. The Uttar Pradesh, Bihar, Punjab, Haryana, Uttarakhand, parts of Madhya Pradesh, Rajasthan, West Bengal, Jharkhand, Asom, and other north and north-eastern states fall in sub-tropical belt. Among states, Uttar Pradesh is the main cane growing state in the country allocating about 2.2 million ha area (43.7%) for cane cultivation followed by Maharashtra with about 981 thousand ha (19.6%) of cane area. Karnataka and Tamil Nadu are other major cane growing states in tropical region accounting for 6 to 8.7% of the cane area followed by Andhra Pradesh and Gujarat, 3 to 4% respectively.

Small sugarcane growers need not wait until the harvest of the sole crop to obtain financial returns. Intercropping of economically important short duration crops with sugarcane through utilization of the present limited land resources would help to sustain sugarcane cultivation and provide interim return to marginal and small farmers, besides meeting the ever-increasing demand for vegetables and pulses. Great potential exists in India for increasing crop production and productivity through wider use of multiple cropping in cereals, millets, oilseeds, legumes and fibre crops. Legume intercrops in cropping systems enhance soil fertility through the excretion of amino acids into the rhizosphere. The nitrogen-fixed by the legume intercrop may be available to the associated sugarcane in the current season itself, as sugarcane remains in the field for over nine months after the harvest of the legumes.

A further possibility of soil fertility improvement is through addition of crop residues, which on decomposition adds to the fertility of the soil. Since considerable addition of nutrient occurs through intercrops, there is a possibility of reducing N application through fertilizer. The

Fig. 1. Intercropping of vegetables in autumn planted sugarcane

intercrops and cultivars selected should be of dwarf type with compact canopy and short duration. In general, the optimum row spacing recommended for autumn planted sugarcane is 90 cm which is widely followed in sub-tropical India, although there is a possibility to adopt wider row spacing. Such wider row spacing permits intercropping without adversely affecting the cane yield and thus increases the overall productivity and profitability of the system. Wider row spacing now becomes an important agronomic consideration to adopt mechanization on account of non-availability of labourers in sugarcane cultivation.

In the sub-tropical region, sugarcane is normally planted in autumn (September- October), *i.e.* before the onset of winter or after the cessation of winter. This planting of sugarcane invariably yields 15 to 20% higher sugarcane as also 0.5 unit more sugar recovery than spring planted cane. The cane planted in the autumn season germinates before the onset of winter and remains in the field without much growth until the spring sets in. During this period, the cane does not make much demand for the growth resources. This facilitates raising of any *rabi* crop as intercrop with autumn planted sugarcane. Several studies demonstrated that the total productivity of crops in sugarcane + *rabi* crops intercropping system is substantially higher than the total productivity of sole *rabi* crop in winter followed by sole sugarcane planted in spring season. Dwarf type crops with compact canopy including legumes, oilseeds, cereals, spices and vegetables are suitable as intercrops in autumn planted sugarcane. Potato has been reported to be a promising intercrop in autumn planted sugarcane in sub-tropical India. Therefore, cultivation of short duration spices and vegetables as intercrops in sugarcane can be a successful package as it provides the needed income during the early stages and increases the total productivity without affecting the cane yield in the system. There is a higher demand for vegetables in the market now-a-days since the consumption of vegetables is increasing at faster rate in modern time as these are supplementary items in human diet.

Recently, Hon'ble Union Minister of Agriculture and Farmers Welfare, while addressing a seminar on 'Hundred Year of Sugarcane Varieties', said that the government has set a target of doubling farmers' income by 2022 and is taking various steps to achieve this objective. The

Minister stressed that the sugarcane farmers should be encouraged to adopt intercropping to boost their income. For this, the Minister called upon the farmers to go for intercropping and grow pulses, oilseeds or vegetables along with sugarcane. Moreover, progressive farmers in certain areas of Punjab have improved their earnings three times what they did earlier after they started intercropping their cane with garlic, potato and turmeric. In intercropping, cane rows are sown three to four feet apart and this space is used for the other crops. According to estimates of the cane department of Government of Punjab, around 40 to 50% of the farmers are already growing autumn cane with suitable intercrops. At few places, up to 80% farmers have gone for intercropping with autumn planted sugarcane. In autumn planting seed requirement is reduced and yet gives a high yield, besides bringing in an additional income from intercrops. Along with vegetables and spices, the under mentioned *rabi* crops can be grown successfully as intercrop with autumn planted sugarcane in Indian subtropics for enhanced yields and net returns.

Category	Crops
Cereals	Wheat
Legumes	Pea, French bean, Chickpea, Lentil
Oilseeds	Mustard, *Toria*, Linseed, Sunflower, Sesame
Flowers	Gladiolus, Marigold
Spices	Chillies, Onion, Garlic, Coriander, Fennel, Cumin, Fenugreek, Nigella, Turmeric
Vegetables	Potato, Tomato, Carrot, Turnip, Cauliflower, Cabbage, Knoll Kohl, Lettuce, Radish, Lady's Finger, Cucurbits
Medicinal and aromatics	Mentha, Ginger

Package of practices for vegetables intercropping with autumn planted sugarcane

Vegetable crops *viz*., cauliflower, cabbage, knoll-khol, turnip, carrot, raddish and potato are suitable for intercropping with autumn planted sugarcane. Agronomic practices adopted for raising different intercrops are given in Table 1. Sugarcane is planted in furrows 90 cm apart keeping one-three budded setts @ 30 cm row length in the first fortnight of October. Sugarcane is fertilized with 150 kg N/ha (1/3 at planting as basal dressing + 2/3 in two equal split doses as top dressing after harvesting of intercrops at proper moisture) while, intercrops are given one-third of the total N + full doses of P_2O_5 and K_2O at their respective sowing times and remaining half of N is top dressed after 30 days of sowing, Table 1.

Field results of vegetables intercropping with autumn planted sugarcane

Data on-farm results presented in Table 2 further indicated that significantly higher numbers of tillers were recorded under the treatment of cane + potato when compared with other vegetables but, it was statistically at par with cane alone. The reduction in number of tillers was lower under cane + cauliflower, cane + cabbage, cane + knoll-khol and cane + turnip treatments (statistically at per among themselves) while maximum reduction was noticed due to intercropping of carrot and radish than that of sole crop of cane. The reduction in number of tillers may be due to dense canopy formed by the above intercrops. The numbers of millabe canes were significantly higher under cane + potato as compared to other systems. The number of tillers and millable canes were relatively higher under the intercropping of cauliflower, cabbage, knoll-khol and turnip when compared with carrot and radish. It was due to ample spaced planting and sparse population under sole crops resulted to lesser shading effect on sugarcane plants.

Data presented in Table 2 clearly indicated that the intercropping of potato with autumn planted sugarcane increased the cane yield significantly as compared to rest of the intercropping systems including sole cane. The potato as intercrops with autumn cane improved the cane yield by 8.25% while cane + cauliflower, cane + cabbage, cane + knoll khol and cane + turnip reduced the cane yield to the tune of 4.03% , 3.49%, 4.42% and 4.75%, respectively than that of sole cane. Such reduction in the yield of cane due to intercrops may be attributed

Table 1. Details of variety, row arrangement, date of sowing/harvesting, seed rate and fertilizer application for different intercrops

Intercropped vegetables	Variety	No. of intercrop rows in between two cane rows	Sowing duration (First fortnight of)	Harvesting duration (First fortnight of)	Plant to plant distance (cm)	Seed rate (kg/ha)	Application of fertlizer (kg/ha)		
							N	P	K
Cauliflower (*Brassica oleracea* var.botrvtis L.)	PSB-16	Two	November	November	45	0.350 (for nursery)	80	40	40
Cabbage (*Brassica oleracea* var. capitata F.alba)	Pride of India	Two	November	November	45	0.400 (for nursery)	80	40	40
Knol-khol (*Brassica oleracea* var.*caulopra* O.C. Linn.)	King of North	Three	November	November	20	0.450 (for nursery)	60	30	30
Turnip (*Brassica rapa* L.)	PTWG	Three	November	November	20	0.800	40	20	20
Carrot (*Daucus carota* L.)	Pusa Keshar	Three	November	November	10	3.50	60	30	30
Radish (*Raphanus sativus* L.)	Janupuri	Three	November	November	10	7.00	40	20	20
Potato (*Solanum tuberosum* L.)	C-3797	Two	November	Second fortnight of February	20	2,200	160	80	80

Table 2. Effect of vegetables intercropping on sugarcane growth, yield potentials and economic returns

Treatments	No. of tillers ('000/ha)	No. of millable canes ('000/ha)	Yield of intercrops (q/ha)	Yield of cane (tonne/ha)	CCS (%) cane	Cane equivalent yield (tonne/ha)	% decrease in cane yield over sole cane	% increase in cane equivalent over sole cane	Cost of cultivation (₹/ha)	Net returns (₹/ha)	B:C ratio
Autumn cane sole	315	134	-	94.50	10.20	94.50	-	-	121,715	133,395	1.10
Cane + cauliflower	253	129	201.20	90.69	10.14	137.10	4.03	45.08	143,623	226,547	1.58
Cane+cabbage	254	126	225.40	91.20	10.12	141.15	3.49	49.37	143,715	237,525	1.65
Cane+knol-khol	257	122	245.20	90.50	10.31	139.54	4.42	47.66	143,709	232,941	1.62
Cane+turnip	248	121	280.00	90.01	10.41	129.78	4.75	37.33	145,634	204,826	1.41
Cane+carrot	215	111	182.50	85.15	10.60	123.81	9.89	3.50	145,579	188,681	1.30
Cane+radish	229	113	305.00	83.60	10.44	113.06	11.53	19.64	143,810	161,560	1.12
Cane+potato	341	139	245.05	102.30	10.29	179.44	(+)8.25	89.88	163,098	321,282	1.97

CCS: Commercial Cane Sugar, Cost of cultivation given is as per economics calculated in 2014-15,B:C – Benefit Cost ratio

to the competition for space and light between cane plants and the plants of these intercrops. Higher cane yield reduction due to intercropping of carrot and radish may be due to taller plants accompanied with dense canopy formed under these intercrops resulting in severe smothering of cane plants. Similarly, the lower cane yield reductions under the intercropping of sole crops may be due to relatively lower plant height, ample spaced canopy and symbiotic association with cane plants. Contrary to this, the growing of potato as intercrops as intercrops with autumn cane increased the yield of cane to the tune of 8.25% than sole cane.

It may be attributed to the lesser competition for light and space and moreover, deep hoeing of the field due to ridge planting, earthling up and digging of potato tubers which caused for proper soil aeration and weeds free condition to the cane plants. Apart from this, potato as intercrops was given 160 kg N/ha and perhaps did not utilize the applied fertilizer form deeper soil layers because of sparse and shallow rooting. Later on, the residual N thus left must have utilized by sugarcane crop which enjoys extensive deep root systems. The economics of different treatments presented in Table 2 shows that all the intercropping systems exhibited higher net returns as compared to sole cane. The system of cane + potato produced highest B:C ratio and more net returns of 1.97 and 58.48% followed by cane + cabbage (1.65 and 42.73%), cane + knoll-khol (1.62 and 43.84%), cane + cauliflower (1.58 and 41.12%), cane + turnip (1.41 and 41.12%), cane + carrot (1.30 and 34.87%) and cane + radish (1.12 and 17.43%) when compared with B:C ratio (1.10) and net returns of ₹ 133,395/ha obtained under sole cane (Fig. 1).

SUMMARY

It is evident that the intercropping of winter vegetables *viz*., potato, cauliflower, knoll-khol, cabbage, turnip, carrot and radish with autumn planted cane produced, and respectively more net returns and showed effective utilization of resources as compared to sole crop of cane and is, therefore, worth adopting by sugarcane growers specially small and marginal ones where the farming is generally done by their own family members.

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