

Autumn sugarcane-based intercropping

—A viable, profitable and sustainable production system

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Sugarcane crop holds an important place amongst the major arable crops worldwide and it is known to provide sugar to more than half of the global population. In South-East Asian countries, average size of land holding is decreasing day by day owing to constant increase in human population. Therefore, to meet the demand of food viz. cereals, pulses, oilseeds, vegetables, sugar, etc. for the ever increasing population, production of these crops needs to be raised and this is one of the very important amongst the 17 sustainable development goals prescribed by FAO, 2015 to end poverty and hunger and achieve sustainable development in all three dimensions (social, economic and environmental) over the next 10 years (2021-2030). Since increasing the area under these crops is not possible due to limited availability of agricultural land, the only option is to increase the crop productivity of the available land. The productivity of land could be enhanced substantially by growing intercrops in the space left between wide-row sown crops eg. sugarcane crop in this case. Intercropping has the potential to raise a farmer's economic returns per acre per annum. In sugarcane crop, farmer can grow wheat, rapeseed-mustard or gram as an intercrop in autumn sugarcane which gives higher land equivalent ratio and net returns over sole sugarcane crop.

Keywords: Autumn sugarcane, Economic returns, Intercropping, Sustainability

INTERCROPPING means the growing of two or more crops on the same field with the planting of the second crop after the first crop has completed its development. The rationale behind intercropping is that different crops planted are unlikely to share the same insect pests and disease-causing pathogens and to conserve the soil. Today intercropping can go a long way if properly managed and looked after, to solve the problems of low productivity per unit area and inefficient use of natural resources. Autumn-planted sugarcane occupies the land for more than one year and the farmers do not want to sacrifice winter (*rabi*) crop at the cost of autumn cane in spite of approximately 20% higher yield and 0.5 unit more sugar recovery than spring planted sugarcane. The only way to harvest another crop during

this period is to grow intercrops in it. The productivity of land could be enhanced substantially by growing intercrops in the space left between sugarcane rows. Autumn-planted sugarcane is very suitable for intercropping because of the delayed germination and slow growth rate during November to February due to prevalence of low temperature. This period can safely be utilized for raising suitable *rabi* crops like potato, wheat, *raya*, *toria*, *gobhi sarson*, peas,

cabbage, etc. in between the inter row spaces of sugarcane by which farmers can get extra profit.

The highest gross monetary returns were obtained when sugarcane was intercropped with potato. However, the highest net monetary returns were recorded in sugarcane + wheat system (44,128 ₹/ha) and benefit:cost ratio (2.23:1) was maximum by intercropping with mustard and wheat than other crops used as intercrop (Table 1).

Table 1. Effect of intercropping systems on economic returns of sugarcane intercropping systems (Pooled mean of 2 years)

Treatment	Gross monetary returns (×10 ³ ₹/ha)	Net monetary returns (×10 ³ ₹/ha)	B:C ratio
Sugarcane+Potato	85,032	41,418	1.90:1
Sugarcane+Wheat	79,151	44,128	2.23:1
Sugarcane+Mustard	70,784	37,833	2.23:1
Sugarcane+Cowpea	73,522	38,157	2.14:1
Sole sugarcane	62,150	35,467	2.16:1

Source: Suryawanshi *et al.* (2010)



Sugarcane + Mustard



Sugarcane + Wheat

Similarly, profitability of intercropping with sugarcane was further investigated by researchers and they found that yield of sole sugarcane was 48.16 t/ha whereas for different crop combination with sugarcane as sugarcane + potato, sugarcane + onion, sugarcane + mustard and sugarcane + lentil, the adjusted sugarcane yield was 105.23, 98.86, 82.78 and 81.13 t/ha, respectively. One per cent change in total cost of sugarcane with intercrops would increase the gross return by 1.13, 1.19, 1.22 and 1.27 in case of sugarcane with potato, onion, mustard and lentil, respectively. It may be attributed to lesser competition for light and space and moreover, deep hoeing of the field due to ridge planting, earthing up and digging of potato tubers which caused proper soil aeration and weeds free condition to the cane plants. It was noted that the productivity of sugarcane+*gobhi sarson* system may be improved, if sugarcane and *gobhi sarson* are planted in 1:2 row ratio. Sugarcane+*gobhi sarson* 'GSL 2' (1:1) recorded the highest cane equivalent yield of 87.95

t/ha and it was 22% higher than that of sole sugarcane. The economic analysis also indicated that sugarcane+*gobhi sarson* 'GSL 2' (1:1) recorded the highest net profit of ₹ 80,894/ha, followed by intercropping of sugarcane + *gobhi sarson* 'GSC 5' (1:2) + sugarcane + *gobhi sarson* 'GSC 6' (1:2) with 26.9% and 22.2% higher net returns over sole crop of sugarcane, respectively (Table 2).

Further, it was observed that sugarcane + oilseed rape and sugarcane + Indian mustard intercropping systems produced cane yield (73.6–88.6 t/ha) similar to sole sugarcane (78.4–85.3t/ha). When grown as intercrops with sugarcane + oilseed rape produced seed yield of 1.47–1.59 t/ha while Indian mustard produced 2.51-2.95 t/ha. Sugarcane + oilseed rape and sugarcane + Indian mustard systems increased the net returns by 1.3 and 1.7 fold as compared to sole sugarcane (USD 1674 /ha). Indian mustard exhibited higher weed suppression than oilseed rape and sole sugarcane, which may be associated with greater production of secondary branches and planting

arrangement of Indian mustard (2 rows) as compared to oilseed rape (1 row).

In another study conducted on intercropping of pulses, highest cane yield (125.6 t/ha) was obtained when sugarcane was intercropped with gram followed by intercropping with lentil (123.8 t/ha) and sole cane (120.8 t/ha). The economic analysis demarcates autumn sugarcane + gram as most profitable intercropping system that gave the highest net returns (₹ 178,042.5/ ha) and the highest BC ratio (1.84) as compared to autumn sugarcane + lentil and sole cane.

Keeping in mind the above discussed benefits from growing intercrops in autumn sugarcane, our farmers must adopt the following good agricultural practices for successful raising of the main crop i.e. autumn sugarcane. The detail of the agronomic practices for successful cultivation of different *rabi* intercrops in autumn planted sugarcane is given in Table 3.

Wheat: Any recommended variety can be sown from last week of October to 15 November using seed

Table 2. Productivity and economics of different intercropping treatments in autumn-sugarcane (Pooled mean of 3 years)

Treatment	Cane yield (t/ha)	Yield of intercrop (t/ha)	Cane equivalent yield (t/ha)	Gross returns (×10 ³ ₹/ha)	Net returns (×10 ³ ₹/ha)	% increase/decrease in net returns over sole crop
Sole sugarcane	72.09	-	72.09	116.0	61.4	-
Sugarcane+ <i>gobhi sarson</i> 'GSC 5' (1:1)	70.86	0.97	82.03	131.8	71.3	16.2
Sugarcane+ <i>gobhi sarson</i> 'GSC 5' (1:2)	69.03	1.25	86.36	139.4	77.9	26.9
Sugarcane+ <i>gobhi sarson</i> 'GSC 6' (1:1)	69.52	0.89	79.64	128.1	67.6	10.1
Sugarcane+ <i>gobhi sarson</i> 'GSC 6' (1:2)	68.59	1.20	84.69	136.5	75.0	22.2
Sugarcane+ <i>gobhi sarson</i> 'GSL 2' (1:1)	69.52	1.52	87.95	141.4	80.9	31.8

Source: Kumar *et al.* (2012)

Table 3. Agronomic practices for cultivation of *rabi* intercrops in autumn

Particular	Detail
Crop cultivars	Co Pb 92, Co 118, CoJ 85 or CoJ 64
Time of planting	20 th September to 20 th October
Seed rate/ha	3 budded sets-50000, 4 budded-37500 and 5 budded-30000
Spacing and method of planting	Preferably use paired row trench planting method. Make trenches 3 ft apart with tractor drawn PAU designed trencher. Plant two rows of sugarcane in 30 cm broad and 20-25 cm deep trenches. Place the cane sets at the bottom of the trenches and cover with the soil left in between two rows. In case of flat planting also, distance between two rows should be 90 cm.
Fertilizer application	Apply 225 kg nitrogen per ha in three equal splits i.e. at planting, at the end of March and by the end of April. Phosphorus and potassium should be applied on soil test basis. Some dose of fertilizers for intercrops should be applied additionally as and when recommended to its pure crop.
Chemical weed control	Different chemicals are recommended for weed control according to the intercrop which are given below: Wheat: Post-emergence application of Axial 5 EC (pinoxaden) @ 1000 ml/ha or Leader/SF-10/ Safal/Marksulfo 75 WG (sulfosulfuron) @ 32.5 g/ha after 30-35 days of sowing to control <i>gullidanda</i> . Apply Algrip 20 WP (metsulfuron) @ 25 g/ha after 30-35 days of sowing or Affinity 40 DF (carfentrazone ethyl) @ 50g/ha 25-30 days after sowing to control broadleaf weeds or apply Total 75 WG @ 40g/ha or Atlantis 3.6 WDG @ 400 g/ha 30-35 days after sowing in to control both grass and broadleaf weeds. Raya: Application of Isoproturon @ 1000 g/ha after 25-30 days of sowing. Garlic: Pre-emergence application of Stomp 30 EC (pendimethalin) @ 2.5 litre/ha within two days of planting or Goal 23.5 EC (oxyfluorfen) @ 1000 ml/ha in 500 litres of water within one week of planting garlic and before the emergence of sugarcane.
Irrigation	Irrigate the field according to the inter-crop sown.

@40 kg/ha. Two rows of wheat should be sown between two rows of sugarcane with 20 cm spacing between rows of wheat. Apply 65.5 kg N, 30 kg P₂O₅ and 30 kg K₂O/ha.

Gobhi sarson: Varieties GSL-1 and GSL-2 are recommended for sowing as intercrop from 10 to 31 October using 2.5 kg seed /ha. Sow one row of gobhi, sarson between two rows of sugarcane. Apply 25 kg N and 15 kg P₂O₅/ha.

Raya: All recommended varieties can be sown during whole of October using 2.5 kg/ha seed. Two rows of raya at 30 cm row spacing can be sown between two rows of sugarcane. 50 kg N and 20 kg P₂O₅ should be applied /ha.

Toria: All recommended varieties can be sown from 20 to end of September using 2.5 kg seed /ha. Two rows of toria at 30 cm row spacing can be sown between two rows of sugarcane. Apply additional doses of fertilizers i.e 37. kg N and 12.5 kg P₂O₅ /ha. Wheat can be sown after toria harvesting.

Gram: Any recommended variety can be sown from 25 October to 10 November using seed rate of 30 kg/ha. Two rows of gram with 30 cm row spacing can be sown as intercrop in sugarcane. Apply additional doses of fertilizers i.e 15kg N and 20 kg P₂O₅/ha.

Potato: Chandermukhi or any other variety can be sown from 20 September to 15 October by using 20 q seed/ ha. Plant one row of potato between two rows of sugarcane. Additional doses of fertilizers should be applied to potato intercrop i.e 87.5 kg N, 40 kg P₂O₅ and 87.5 kg K₂O /ha. Wheat and onion can be sown after harvesting of potato in end December.

Peas: Two rows of recommended variety at 30 cm row spacing can be sown in October with seed rate of 55kg/ha. 35 kg N and 40 kg P₂O₅ /ha should be applied additionally.

Garlic: PG-17 and PG-18 varieties can be sown from 4 week of September to 1 week of October using 280-313 kg seed/ha. Three rows of garlic at 15 cm row spacing can be sown between two rows of sugarcane. Apply 25 ton FYM, 62.5 kg N and 30 kg P₂O₅ /ha additionally. If sugarcane is planted with paired row trench planting method, then reduce the seed rate to 213-238 kg /ha and apply 18.75 ton FYM, 47.5 kg N and 22.5 kg P₂O₅/ha.

Cabbage: Transplant one row of 4-5 weeks old seedlings of any recommended variety in between two rows of sugarcane from last week of Oct to Nov. Apply 62.5 kg N, 31.5 kg P₂O₅ and 31.5 kg K₂O/ha additionally.

Radish: Sow two rows of any recommended variety at 30 cm spacing in October using 10-12.5 kg seed /ha as intercrop in sugarcane. Apply additional doses of fertilizers i.e. 62.5 kg N and 30 kg P₂O₅ /ha.

SUMMARY

It is, therefore, evident that intercropping of winter crops *viz.*, wheat, mustard, pulses and potato with autumn planted cane produced more profits by efficient utilization of resources compared to sole cane crop. Thus, important crops of the respective regions taken as intercrops with sugarcane, not only increased the productivity per unit area and time, but also provided mid-season income which eased the burden on the already depleted income of the farmers and provided them with an option for better input management for remaining part of the sugarcane growing season. Therefore, by adopting such good agricultural practices farmers can play an important role in achieving the sustainable development goals by reducing poverty and hunger to some extent.

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