Indian Farming 76 (01): 33-36; January 2026

Towards sustainable production of sugarcane for higher income: Special focus on Uttar Pradesh

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Sugarcane is the largest commercial crop under cultivation in Uttar Pradesh. This is mainly due to the availability of sufficient water resources and assured price from the government and market availablity in the form of mills. The sugarcane cultivation in Uttar Pradesh is dominated by a single variety and excessive and imbalanced use of water, fertilisers and chemical pesticides. These practices led to depletion of water tables and degradation of soil. Higher application of fertiliser attracts more pests and diseases, affecting sugarcane yield and thereby the returns to farmers. The need for adoption of sustainable practices like drip irrigation, organic manure application, integrated pest management and intercropping system is necessary for the improved resource use efficiency of sugarcane in Uttar Pradesh.

Keywords: Drip irrigation, Intercropping, Pesticides, Synthetic fertilisers

ONE of the major cash crops cultivated in India is sugarcane, covering almost 4.89 mha in states like Uttar Pradesh, Maharashtra, Tamil Nadu and Karnataka. The sugarcane, being long duration crop, needs more nutrients and is cultivated under irrigation conditions. Over the period, the practices of imbalanced application of synthetic fertiliser and chemical pesticide have led to a high cost of cultivation. This influenced the production of sugarcane negatively in a set of environmentally sound, economically viable, and socially responsible farming methods. Sustainable sugarcane practices in Uttar Pradesh focus on optimising yields while efficiently using resources and minimising environmental impact. Sugarcane is a major cash crop in India, especially in Uttar Pradesh, which contributes significantly to national sugar production. However, traditional cultivation practices have led to soil degradation, excessive water use, pest outbreaks, and declining productivity. To ensure long-term productivity, profitability, and environment health, there is a growing need to shift towards sustainable sugarcane practices. To address these challenges, adoption of sustainable practices in sugarcane cultivation is the need of the hour. These practices aim to increase productivity and profitability, conserve natural resources, reduce input costs, and ensure long-term environmental sustainability.

Current sustainability issues in sugarcane

Environmental factors:

- **Inefficient water use, soil degradation, and residue burning:** Excessive reliance on flood irrigation leads to water wastage, groundwater depletion, and reduced water-use efficiency. Continuous tillage, removal of crop trash, and residue burning degrade soil structure, lower organic matter, and contribute to air pollution.
- **Loss of biodiversity and lack of climate-resilient practices:** Monocropping of sugarcane reduces agro-biodiversity and makes the ecosystem more vulnerable to pests and diseases. Limited adoption of drought-tolerant varieties, poor pest management, and inadequate adaptation measures increase susceptibility to climate shocks.

Economic factors:

- **High input costs, low price realisation, and weak market access:** Overdependence on costly chemical fertilisers, pesticides, and water-intensive practices reduces net profitability. Delayed payments, lack of value-chain integration, and poor market linkages limit farmer incomes and discourage investment in sustainable practices.
- **Low mechanisation and inefficient technology use:** Manual harvesting and outdated production methods increase labour costs and reduce operational efficiency.

Limited access to affordable mechanisation restricts the potential for higher yields at lower production costs.

Social factors:

- **Unstable livelihoods and income vulnerability:** Fluctuating cane prices, weather uncertainties, and delayed procurement payments create financial stress for farmers. Heavy debt burdens and lack of diversified income sources increase livelihood risks.
- **Health risks, unsafe working conditions, and inadequate training:** Exposure to chemical inputs without proper safety measures leads to health hazards for farmers and labourers. Limited access to skill development and training prevents adoption of safer, more efficient, and sustainable practices.

Sustainable production methods in sugarcane

***Nursery raising*:** Utilising single-budded chips in nurseries instead of sets reduces seed requirement up to 75% compared to traditional methods. This also minimises wastage of sugarcane and early growth of tillers.

***Adoption of wider spacing*:** Planting at wider spacing (e.g. 5 × 2 feet) allows for better sunlight penetration, air circulation, and easier intercultural operations. When sugarcane seedlings are transplanted at a spacing of around 150 cm between rows and 60 cm between plants, it allows each seedling adequate access to sunlight, air circulation, and root space. These spacing triggers robust tillering, producing 15–20 tillers/plant, compared to just 6–8 tillers under conventional dense planting.

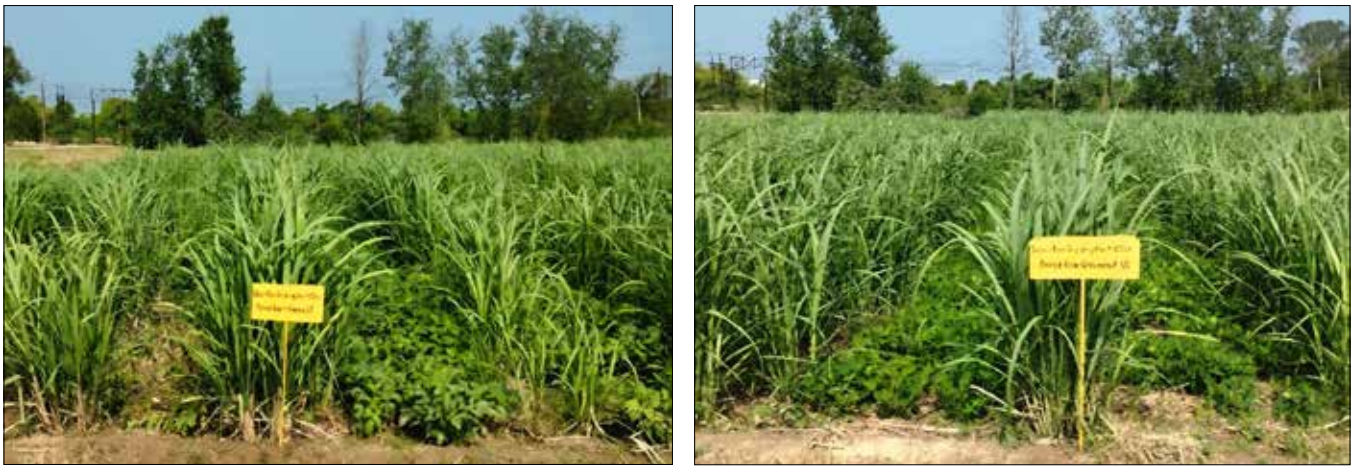
***Water management*:** Efficient irrigation methods like drip fertigation minimise water consumption and reduce fertiliser application. Irrigation is managed precisely to meet plant demand instead of flooding the field. After transplanting, timing or irrigation should be based on the critical water requirement, based on crop stage and soil type. Drip irrigation, especially sub-surface drip, is highly effective under high intensification, since wider spacing and single-bud seedlings enable placement of drip lines at 20–30 cm apart. This can cut water use by 40–50% compared to flood irrigation, while boosting yields by 20–40%. Fertigation through drips can double fertiliser efficiency from 30% under flood systems to 60%, and improve benefit:cost ratios.

Surface drip irrigation in sugarcane at ICAR-IIFSR, Modipuram

***Integrated pest and disease management*:** An integrated, sustainable strategy combining cultural methods, biological agents, moderate chemical usage, frequent monitoring, and resistant varieties is necessary for effective pest and disease management in sugarcane. This holistic strategy minimises dependency on chemical interventions, maximises yields, and preserves crop health.

- **Yellow sticky traps:** Yellow sticky traps are a simple cost-effective and eco-friendly tool for agriculture in monitoring insect-pests. These traps attract and trap winged insects like aphids. These cards are adhesive panels with a vibrant yellow colour that are used to catch flying bugs. The colour yellow takes advantage of a behavioural reaction of aphids, whiteflies, thrips and leaf miners.
- **Tricho card:** Tricho cards are small, typically rectangular cards embedded with parasitised eggs of *Trichogramma* species, tiny wasps that naturally prey on insect eggs. Each card contains approximately 1,800-2,000 parasitiod eggs. Most commonly used for early shoot borer, internode borer and top borer pests that often attack sugarcane. Protects crop output by getting rid of pests when they are at their weakest (egg stage) and limiting damage caused by larvae. Reduces reliance on insecticides, especially in dense crop canopies where chemical sprays are difficult in the later period.
- ***Trichoderma*:** *Trichoderma* is a multifunctional fungus that defends against diseases and also encourages plant growth. Through mycoparasitism, induced systemic resistance, competitive exclusion of pathogenic fungi and antibiosis, *Trichoderma* species inhibit pathogens. These are some species of *Trichoderma* used as biocontrol agents; *Trichoderma harzianum*, *T. viride*, *T. asperellum*, and *T. hamatum*.

***Nutrient management*:** Sugarcane is a heavy feeder and long-duration crop, prone to nutrient depletion due to persistent removal of macro- and micro-nutrients. Chemical fertilisers often creates imbalances, particularly deficiencies of Zn, S, B and degrades soil health over time. Integrated nutrient management (INM) is essential to restore and sustain soil fertility while maintaining productivity. Aiming for balanced nutrition, the right source, rate, timing, placement, guide both nutrient and water stewardship. Surface or subsurface drip fertigation helps deliver nutrients at optimal times and depths, reducing leaching, volatilisation losses, and improving nutrient-use efficiency. Encouraging organic nutrient management practices also reduces reliance on synthetic fertilisers.



Sugarcane intercropping with cowpea and groundnut at on-station trials of ICAR-IIFSR

Table 1. Major and important varieties of sugarcane and their characteristics

Varieties	Yield potential (t/ha)	Recommended region	Important characteristics	Area under cultivation
Co 0238 (Karan 4)	80–110	Haryana, Punjab, Western and Central Uttar Pradesh, Uttarakhand and Rajasthan	High sugar recovery (12–13%), drought-tolerant, erect growth	It accounted about 44.45% of the state's total sugarcane area (12.56 lakh ha)
Co 0118	85–100	Punjab, Haryana, Western and Central Uttar Pradesh and Uttarakhand	High yield, moderately resistant to red rot	Covered 22.14% (6.25 lakh ha)
CoLk 94184	70–76	Eastern U.P. and Bihar	Early maturity, good ratooning ability and high sugar yielding	
Co 238	80–100	Punjab, Haryana, UP, Uttarakhand and Rajasthan	High sugar recovery, early maturing	The remaining varieties-collectively made up between 0.05–9.37% each, but none individually exceeded that upper bound
Co 86032	120–150	Tamil Nadu, Karnataka and Maharashtra	Excellent ratooning, high yield and sugar	
Co 62175	100–150	Southern India (Karnataka) and some parts of southern Maharashtra	Juicy stalk, good sugar recovery, stable yield	
BO 91	85–100	Bihar and Eastern India	Moderate sugar, drought tolerance	
CoC 671	95–110	Tamil Nadu	Good ratooning, early maturity	
Co 740	120–140	Tamil Nadu	Pest-tolerant	
Co 13235	85–110	Subtropical zone (North India)	Medium thick, juicy, non-lodging, improved red rot resistance over Co 0238, erect, good ratooner	

Source: https://eng.ruralvoice.in/national/44-pc-of-up-sugarcane-area-planted-with-disease-prone-variety-india-sugar-production-falls-20-pc.html

Residue management and sugarcane mulch

Sugarcane trash left on the field after harvest can be used as a protective mulch. It improves microclimate conditions, inhibits weed growth, lowers erosion and increases soil moisture retention. Crop leftovers that are retained add nutrients and organic materials to the soil. Instead of burning, these residues act as a protective layer, enhancing crop health and sustainability. Sugarcane mulchers are also available in the market and may be hired by farmers. This helps in covering the soil's surface with chopped cane leaves, which remain as an organic covering.

Intercropping in sugarcane

Utilising wider spacing for intercropping can improve land use, increase income for farmers, and reduce weed growth. Intercropping is well-suited to sugarcane due to its wide row spacing, early slow growth, and long season. Short-duration crops like pulses, oilseeds, vegetables, and cereals can thrive in the early months between sugarcane rows without disrupting cane development. Intercropping with legumes also improves soil health by enhancing nitrogen, phosphorus, organic carbon levels, and microbial activity. Studies show increased available N, P, total N/K, organic matter, and enzyme activities along with greater microbial diversity. Peanut+sugarcane system, for instance, enriches soil enzymes and nitrogenase action, benefiting both crops. Diversity in cropping also offers weed suppression and pest

management benefits. Legumes and other intercrops form dense canopy cover that reduces weeds, while attracting beneficial insects or repelling pests, such as controlling early shoot borer (*Chilo infuscatellus*) when intercropped with soybean, green beans or coriander.

Adoption of other improved varieties

Farmers need to adopt the other sugarcane varieties that are improved for different characteristics, which enhance the yield. Currently, CO 0238 variety is dominant in Uttar Pradesh by over 44% area, leading to farmers' distress due to higher expenditure for managing pests and diseases. These improved varieties aim to reduce the cost of cultivation for farmers and have disease resistance to ensure healthier crops and higher yields.

SUMMARY

Commercial cultivation of sugarcane with a dominant single variety (CO 0238) has led to the severe agronomic and environmental challenges, affecting the economic returns through vulnerability to pest and disease incidence, and also high fertiliser and water application. The farmers' dependence on high levels of pesticides and fertiliser, resulted in better yield, however, intensive irrigation practices led to water table depletion. It has also contributed to soil health deterioration, and nutrient imbalance, threatening the long-term sustainability of sugarcane-based farming systems.

To address these issues, there is a pressing need to promote varietal diversification by encouraging farmers to adopt other available varieties, which are also high-yielding and techniques like drip irrigation and integrated nutrient and pest management practices. Moreover, awareness programmes should be initiated among farmers on benefits of intercropping, particularly leguminous crops. Promoting these sustainable practices can play a pivotal role in improving the economic viability, environmental sustainability, and resource-use efficiency of sugarcane cultivation in the region.

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