Consortia Platform on Conservation Agriculture: A Decade of Research in Sugarcane (2015–2024)

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ICAR–National Institute of Abiotic Stress Management

Baramati, Pune, Maharashtra 413 115

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Authors

GC Wakchaure
BJ Gawhale
AK Biswas
RL Choudhary
Kamlesh K Meena
Yogeshwar Singh
Kunal M Shinde
Aliza Pradhan
Amresh Chaudhary
Paritosh Kumar
K Sammi Reddy

राअस्ट्रैप्रसं
NIASM

भाकृअनुप–राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान
ICAR–National Institute of Abiotic Stress Management
Indian Council of Agricultural Research
बारामती, पुणे, महाराष्ट्र 413 115
Baramati, Pune, Maharashtra 413 115

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Design & Art

Mr. Pravin More, Senior Technical Assistant (Computer)

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भारतीय कृषि अनुसंधान परिषद
कक्ष क्र. 101, कृषि अनुसंधान भवन-II, नई दिल्ली-110 012, भारत
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
Room No. 101, Krishi Anusandhan Bhavan-II, Pusa, New Delhi-110012, India

डॉ. सुरेश कुमार चौधरी
उप महानिदेशक (प्राकृतिक संसाधन प्रबंधन)
Dr. Suresh Kumar Chaudhari
Deputy Director General (Natural Resources Management)

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Foreword

Conventional farming often relies on intensive tillage and the burning of crop residues, practices that significantly contribute to soil degradation, reduced agricultural productivity, and increased greenhouse gas (GHG) emissions. Further, land clearing, over-exploitation of natural resources, and biodiversity loss pose major challenges to global food security and environmental sustainability. Conservation agriculture (CA) is largely recognized as a potential strategy for resolving these obstacles and promoting sustainable agriculture. Modern CA enhances the natural resource base–soil, water, and air quality–while minimizing production costs through three interrelated principles: *minimal soil disturbance, permanent residue cover, and crop diversification*. In India, however, CA's full potential has not yet been realized, as it requires site-specific water, soil, and nutrient management practices, alongside knowledge-intensive applications of technologies. Over the past two decades, ICAR, SAUs, CIMMYT, and NGOs have progressed in scaling CA, but further efforts are needed. In response, ICAR launched the "*Consortia Research Platform on Conservation Agriculture*" in 2015–2016. As part of this broader initiative, a project was implemented at the ICAR–National Institute of Abiotic Stress Management (NIASM) in Baramati, Pune, Maharashtra, primarily focusing on the sugarcane cropping systems.

As the predominant industrial crop, sugarcane faces major constraints in India's sugar economy due to high input requirements, trash burning, and stagnant productivity. Excessive tillage, mono-cropping, and abiotic stresses further limit sugarcane production in tropical-subtropical semiarid regions. To address these issues, long-term CA experiments focusing on tillage, residue management, and intercropping along with good agronomic and engineering practices such as optimized planting geometry, micro-irrigation, and exogenous PGRs, were conducted from 2015–2024. Key findings and recommendations from these 10 years of research are summarized in the present bulletin "*Consortia Platform on Conservation Agriculture: A Decade of Research in Sugarcane*", providing strategies to improve soil health, resource-use efficiency, and profitability in sugarcane-based cropping systems. The bulletin also highlights the benefits of SORF (Stubble Saving, Off-Barring, Root Pruning, and Fertilizer Application) practice using a multifunctional drill (MRD) to manage the water-energy-carbon nexus in sugarcane. It is hoped that project outcomes, including HRD activities, linkages, infrastructure, technologies, and publications, will help raise awareness of CA among researchers, farmers, industrialists, and socio-economically disadvantaged groups. This bulletin is expected to serve as a comprehensive guide on CA, supporting the development of environmentally sustainable and profitable sugarcane production systems.

(S.K. Chaudhari)

PREFACE

Agriculture is crucial to India's economy, employing more than half of the population and supporting agro-based industries that promote equitable growth, raise rural incomes, and ensure food security. However, increasing urbanization and industrialization are forcing the conversion of limited land resources to non-agricultural uses. At the same time, the impacts of global warming and abiotic stresses pose serious threats to natural resources, agricultural productivity, and food security. These challenges are further exacerbated by conventional farming practices, such as intensive tillage, excessive use of agricultural inputs, crop residue burning, and mono-cropping, which reduce resource-use efficiency, leave soil vulnerable to erosion, contribute to biodiversity loss and cause environmental degradation through greenhouse gas (GHG) emissions. This underscores the basis for conserving natural resources to achieve the long-term sustainability of agricultural and natural ecosystems.

Conservation agriculture (CA) is an ecosystem approach to agricultural land management based on three interlinked principles: minimum mechanical soil disturbance, permanent residue cover, and crop diversification via rotation or intercropping. It comprises a set of farming practices tailored to specific crops in localized environments, which enhance biodiversity and natural soil biological processes, thereby improving soil health, water and nutrient use efficiency, and supporting sustained crop production. It also aims to overcome the problems associated with conventional farming practices by introducing resource-efficient, profitable, stress-tolerant, eco-friendly, and climate-smart production techniques and methodologies.

This summary bulletin provides an overview of the research outcomes and the state of CA practices standardized for the sugarcane cropping system, especially in the subtropical, semi-arid drought-prone regions of Peninsular India during 2015–2024. It is part of the larger Consortia Research Platform on Conservation Agriculture (CRPCA), launched by ICAR, New Delhi. The results of the experiments conducted under this project at ICAR–NIASM are discussed as Phase–I (2015–2020) and Phase–II (2021–2026 ongoing), with the aim of improving overall system productivity, managing water-carbon-energy footprints, and reducing greenhouse gas emissions (GHGs) in sugarcane systems by interlinking three CA principles. The bulletin details various CA practices such as reduced tillage, residue management, and intercropping alongside good agronomic and engineering technologies developed to enhance resource-use efficiency, environmental quality, and productivity of the sugarcane cropping system. The bulletin also includes highlights of HRD and capacity-building programs, DAPSC activities, relevant publications, and infrastructure developed under the research consortium.

We sincerely acknowledge the invaluable guidance and contributions of Dr. P.S. Minhas, Dr. N.P. Singh, Dr. H. Pathak, Former Directors of ICAR–NIASM, for initiating and facilitating research on CA in sugarcane. We extend our heartfelt thanks to the scientists, technical staff, and farmers involved in the program, as well as those who supported us during the research work. Our gratitude also goes to NRM Division of the Indian Council of Agricultural Research, New Delhi, for their continuous support and encouragement. We hope the insights and recommendations from the last 10 years of CA research in sugarcane presented in this bulletin, will be valuable for the researchers, farmers, students, and other stakeholders.

Authors

1. Introduction

Modern agriculture is grappling with series of interconnected challenges ranged from soil degradation, biodiversity loss, water scarcity, low profitability and food insecurity (Muluneh, 2021). These challenges are largely driven by unsustainable agricultural practices such as intensive tillage, excessive use of chemical inputs and mono-cropping, which pose serious threats to human wellbeing, ecosystem and environment. Additionally, climate change-induced abiotic stresses have a severe impact on natural resources, agricultural productivity, and food security globally. In this situation, feeding the world without destroying more nature will become increasingly difficult and eventually impossible under continuous population growth. Hence, a series of transformative changes and holistic approaches are required for addressing these multiple challenges simultaneously. The sustainable development goals (SDGs) adopted by all United Nation members' states provide a framework for integrative solutions, particularly emphasizing sustainable agricultural practices as essential for achieving food security and environmental sustainability (UN, 2015).

Conservation agriculture (CA) emerges as one of the viable solution and sustainable alternative that addresses these widespread challenges by promoting ecosystem health, enhancing resilience and supporting sustainable food production system (Friedrich et al., 2012). Adopting CA practices can help in mitigating soil erosion, enhancing nutrient availability and conservation of water resources, thereby contributing to multiple SDGs, including zero hunger (SDG2), clean water and sanitation (SDG6) and life on land (SDG15) (Farooq, 2023). According to the United Nation's Food and Agriculture Organization (FAO), CA is a farming system that promotes maintenance of a permanent soil cover, minimum soil disturbance, and diversification of plant species. It enhances biodiversity and natural biological processes both above and below the ground surface contributing to increased water and nutrient use efficiency, as well as improved and sustained crop production. Hence, CA technologies are crucial for the future of sustainable agriculture. The IPCC 2019 report on 'Climate Change and Land' lists CA as a way to adapt climate risks. It's three key principles–minimum soil disturbance (up to 20–25%), crop diversification (crop rotation and intercropping), and permanent soil cover (over 30% crop residue retention) not only protect the environment but also help lower greenhouse gas emissions (GHGs) and fight climate change through sustainable land management (Fig.1).

Conservation agriculture (CA) is practiced globally on approximately 180 million hectares (Mha) of cropland, constituting about 12.5% of global cropland area, evenly distributed between the Global North and Global South. Over the last two decades, the average annual rate of global expansion of CA cropland has been 10.5 Mha. The largest extents of adoption are in South and North America, followed by Australia and New Zealand, Asia, Russia and Ukraine, Europe and Africa. In particular, its adaptation in

Asia is a more recent development, with larger farms in Kazakhstan and China, and small farms in India and Pakistan. Specifically, wheat-rice cropping systems in the Indo-Gangetic Plains are being transformed into CA systems, referred to as –'double no-till' rice-wheat systems, and in some areas it has been possible to add a short season-legume crop such as mung bean in the cropping system (Kassam et al., 2020). CA offers potential advantages across different agro-ecoregions and farmer groups, ranging from the nano-level (improving soil properties) to the micro level (saving inputs, increasing farm income, reducing production costs), and the macro level (improving food security, reducing poverty and mitigating global warming). Despite its benefits, the adoption of CA has been relatively slow on smallholder farms in India. Recognizing its potential impact and importance, the Indian Council of Agricultural Research (ICAR) launched the project entitled "**Consortia Research Platform on Conservation Agriculture (CRP–CA)**" in 2015–16, with its headquarters at the ICAR–Indian Institute of Soil Science (IISS), Bhopal. Nearly a decade ago, this initiative adopted a farmer-participatory approach to refine and implement new CA–based crop production systems in India, including sugarcane.

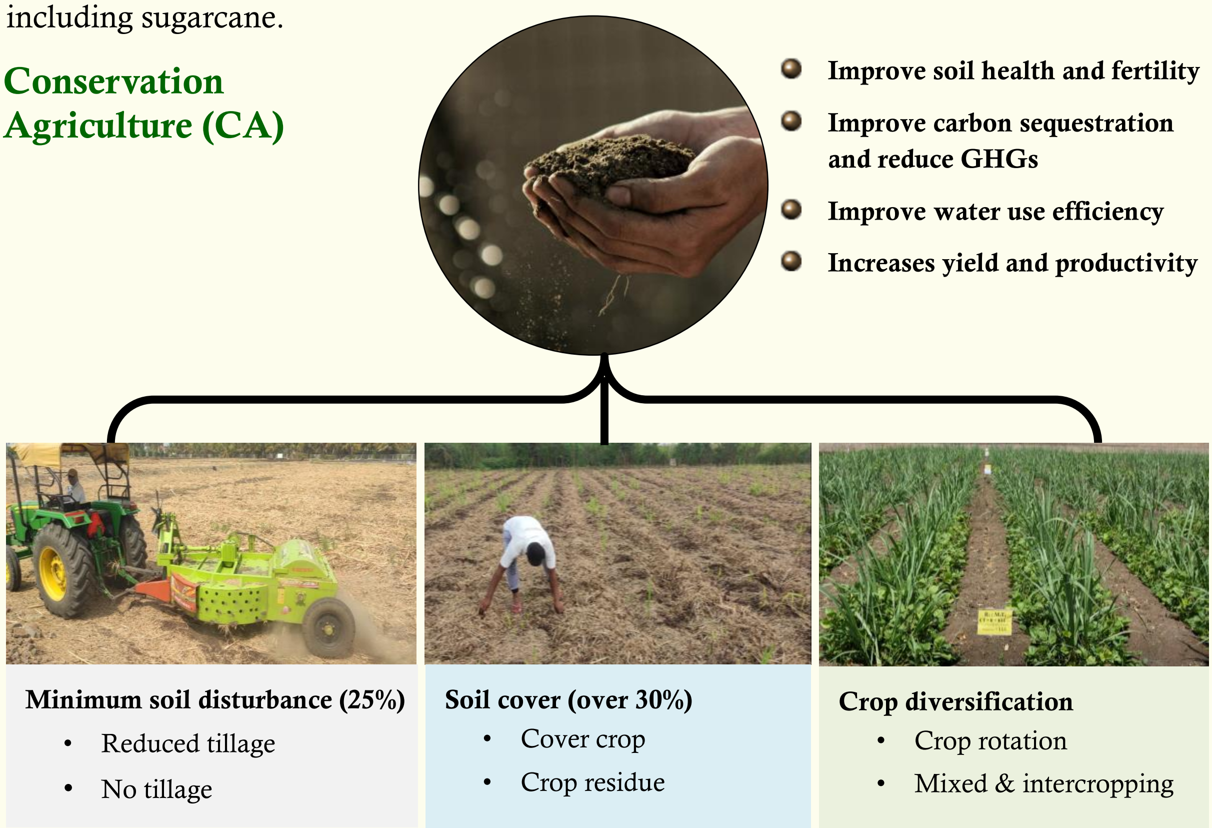


Fig.1. Three basic principles of conservation agriculture (CA).

2. Why CA in sugarcane cropping system?

Sugarcane is one of the most important perennial industrial crops, supplying about 80% global sugar demand and 40% biofuel needs. It is cultivated on over 26.1 million hectares (Mha), with an annual production of 1.9 billion tonnes (Bt), in tropical and subtropical climatic conditions of more than 115 countries located between latitudes of 36.7°N to 31.0°S (Wakchaure et al., 2022; FAO, 2023). In India, sugarcane is grown in diverse agro-climatic and soil conditions between latitudes 8°N and 33°N, excluding cold-hilly regions such as the Kashmir Valley, Himachal Pradesh, and Arunachal Pradesh. In northern subtropical states, the crop typically matures in one year, known as 'Eksali,' while in southern tropical states it takes 18 months to mature, referred to as 'Adsali.' Sugarcane is planted year-round in different parts of the country; for example, it is sown in September–October (autumn) and February–March (spring) in subtropical regions, while in tropical regions, it is planted in June–August (Adsali) and January–February and October–November (Eksali).

Fig.2. Excess use of water, high trash load and its burning causes loss of soil biology and environmental pollution in sugarcane.

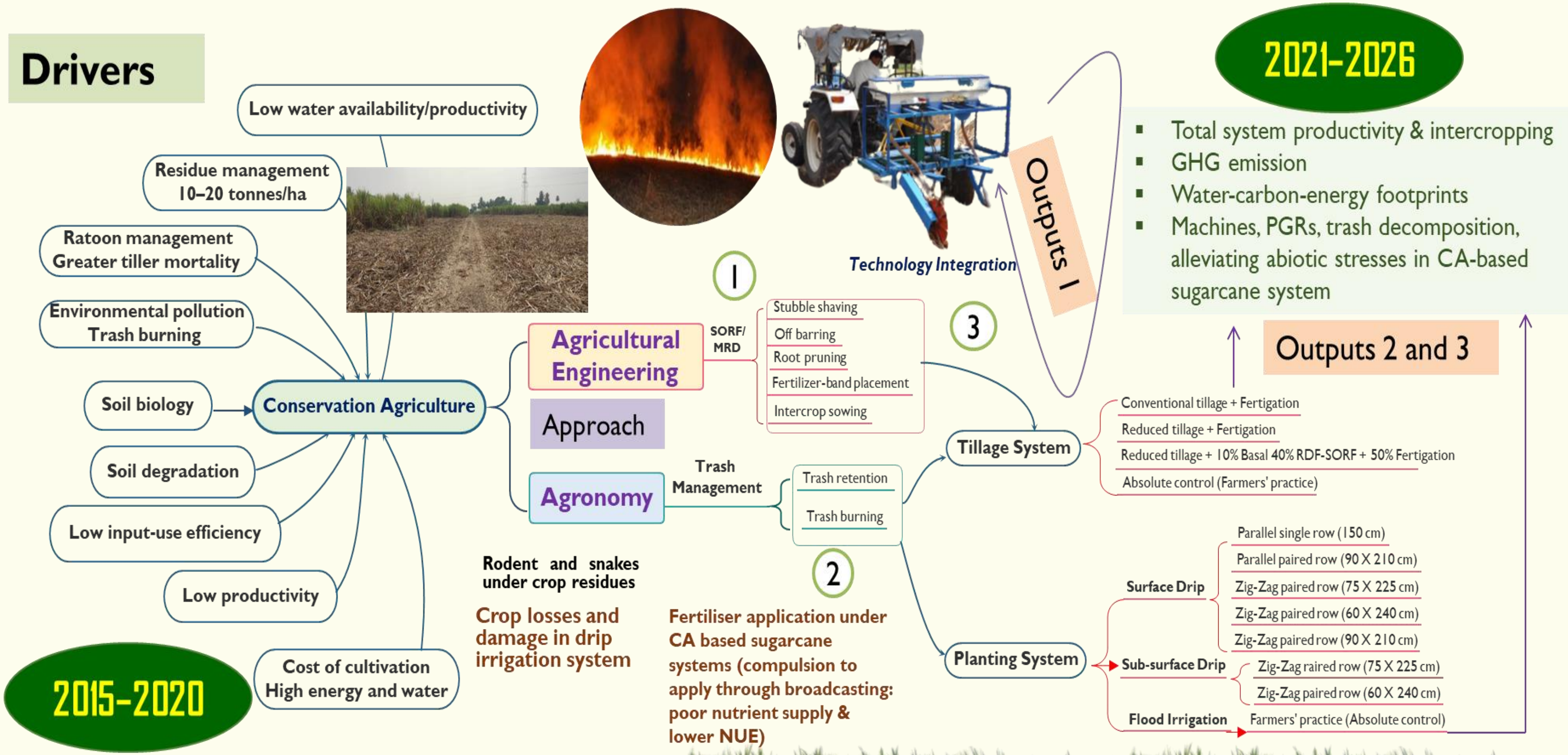
India ranks second globally in both sugarcane production (490.5 Mt) and acreage (5.1 Mha) contributing 25% of the world production next to Brazil. It supporting over six million cane farmers and their families, along with workforces and entrepreneurs of over 550 sugar mills, apart from a host of wholesalers and distributors spread across the country (Solomon 2020). However, intensive tillage and mono-cropping have been identified as major factors contributing to stagnating sugarcane productivity, posing significant challenges to India's sugar economy. In addition to high water-nutrient-energy consumption, crop is experiencing vagaries of weather at critical growth stages. Climate change, overexploitation of natural resources, and human activities exacerbate the effects of abiotic stresses on the sugarcane cropping system. In particular, ratoon crop is grown on half the sugarcane area yields 20–25% less than the plant crop. Here, the management of high load (10–15 t ha^{-1}) and tough nature of loose trash generated after sugarcane is major challenge (Fig.2). Additionally, hindrances in field operations, lower nutrient use efficiency (NUE), trash burning, and greenhouse gas (GHG) emissions, which lead to the loss of soil biology and environmental pollution, are major constraints to achieving higher cane yields (Choudhary et al., 2017). Overall, CA practices have the potential to reduce basic inputs, improve soil health and cane productivity as well as environmental pollution, and thus, it can be recommended for long-term sustainability of the sugarcane-based cropping systems (Singh et al., 2021).

3. Rationale of the project

Agriculture is vital to Indian economy, providing livelihoods to most of its population. Despite achieving food self-sufficiency, challenges like yield gaps, inefficient use of water and nutrients, declining farm profits, soil degradation and climate risks persist. Feeding a growing population with rising demand for resource-intensive foods is difficult, especially with limited farmland. To address this, sustainable strategies are needed to boost productivity, enhance farm income, protect natural resources, and reduce environmental impacts. Conservation agriculture (CA) offers a promising solution, especially in rainfed and fragile regions, by improving efficiency, reducing inputs like water and labour, minimizing pollution, enhancing soil health, and increasing resilience to climate risks. However, CA's full potential has not been realized, as it requires site-specific, knowledge-intensive applications of technologies like machinery, crop varieties, and pest management. Over the past two decades, organizations like ICAR, SAUs, CIMMYT, and NGOs have made progress in developing and scaling CA, but further efforts are needed. Hence, ICAR launched the "Consortia Research Platform on Conservation Agriculture" in 2015–2016, aiming to mainstream CA for the sustainable use and management of natural resources to improve productivity and ensure food security. As part of this initiative, a project was implemented at the ICAR–National Institute of Abiotic Stress Management (NIASM) in Baramati, Pune, Maharashtra, focusing on the sugarcane cropping system with the following specific objectives for the Phase–I (2015–2020).

1. Development and validation of location specific CA practices for enhancing productivity, profitability and resource-use efficiency.
2. Quantification of the impact of CA practices on soil health and carbon sequestration.
3. Development of suitable planting systems, micro-irrigation techniques and residue management practices.

The conceptual framework for the rationale behind conservation agriculture in sugarcane is summarized in Fig. 3.



Residue	CH_4 emission (1000 tone C equivalent)	N_2O emission (1000 tone C equivalent)	Total emission (1000 tone C equivalent)
Sugarcane	115.12	26.48	141.60

Fig.3. Conceptual framework for the rationale behind conservation agriculture in sugarcane cropping system.

The key drivers of low water productivity, inefficient input use, challenges in residue management and trash burning, environmental pollution, and higher cultivation costs underscore the need for CA in the sugarcane system. Two approaches—Agricultural Engineering and Agronomy—were employed to assess the long term effect of tillage, residue retention and other management practices (planting geometry, nutrient-irrigation management) and technologies such as SORF (Stubble Saving, Off-Barring, Root Pruning, and Fertilizer Application) across various sugarcane cropping systems. The results from the initial five-year (Phase–I, 2015–2020) experiment served as inputs for further studies aimed at improving overall system productivity, promoting intercropping, reducing greenhouse gases emissions (GHGs), managing water-carbon-energy footprints, and application of plant growth regulators (PGRs) to alleviate abiotic stresses in CA-based sugarcane systems during Phase II (2021–2026). Key findings from the past 10 years of experiments have been applied to improve soil health, enhance productivity and profitability, and increase resource-use efficiency in sugarcane-based cropping systems, especially in the context of a changing climate.

4. Experimental location, soil and climatic conditions

Fig.4. illustrates the major sugarcane growing states and experimental site, located at the research farm of ICAR–National Institute of Abiotic Stress Management (NIASM) in Malegaon Kh Village, Baramati Tehsil, Pune District, Maharashtra, India (18°09′N, 74°30′E and 560 MAMSL).

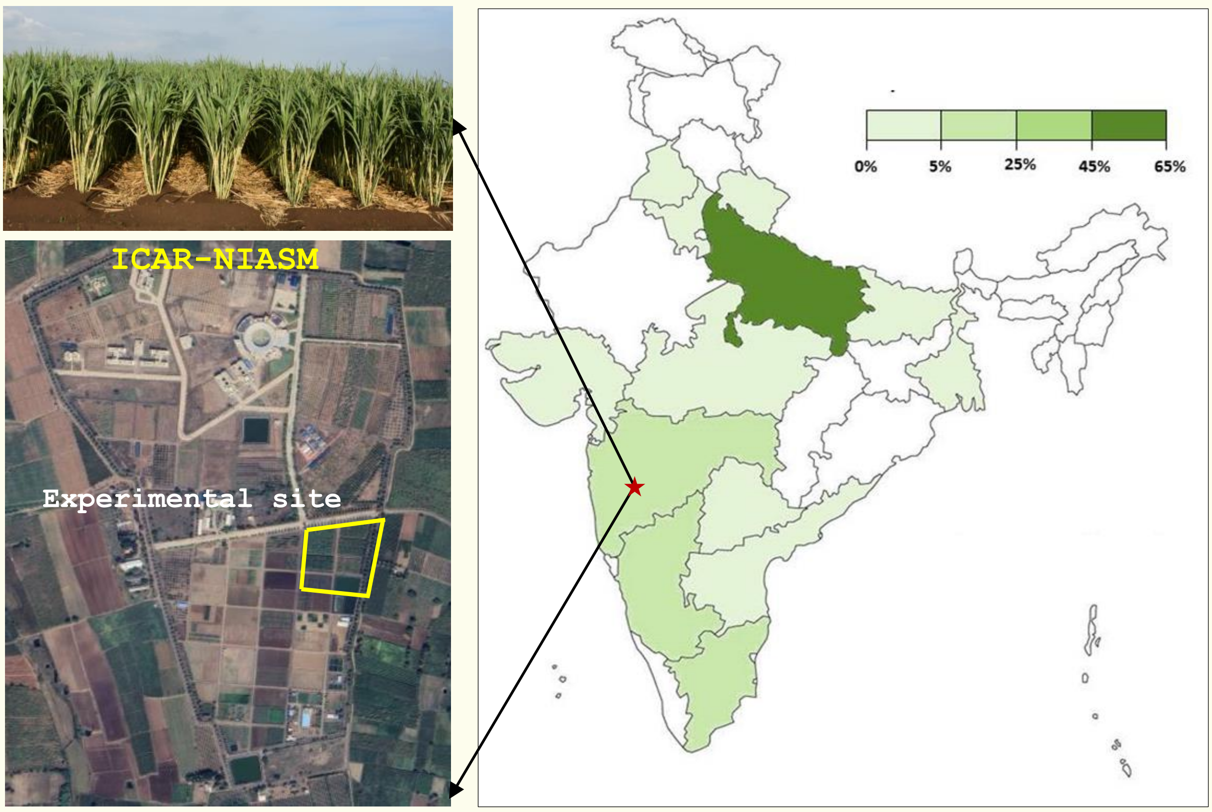


Fig.4. Location map of the experimental site under sugarcane system (ICAR–NIASM).

The black soil (≤ 40–60 cm depth) of the study site was sandy clay in texture, comprising 56.1% sand, 8.0% silt and 35.9% clay. The soil pH (1: 2.5 soil-to-water suspension) was 8.2; with an EC 0.26 dS m^{-1} and organic matter of 6.6 g kg^{-1}. The available N, P and K levels were 176, 25 and 148 kg ha^{-1}, respectively. The site was characterized by low, erratic rainfall and is susceptible to drought (Wakchaure et al., 2021). A major portion of the agricultural area is rainfed, except for about one-third of the Baramati region, which is irrigated by the Nira canal and supports sugarcane cultivation. The weather data from 1986–2019 show that the annual mean maximum temperature ranged from 27.8 ºC–34.4 ºC, with a long-term average of 33.0ºC, while the annual mean minimum temperature fluctuated between 17.3 ºC and 22.3 ºC, with a mean of around 19.5 ºC. The long-term average annual rainfall is only 576 mm, mainly distrusted across the monsoon (69%), pre-monsoon (10%) and post-monsoon (21%) seasons (Singh et al., 2020).The annual open-pan evaporation, as reported by the USWB, is 1965 mm (Minhas et al., 2015).

5. Phase–I: Salient achievements (2015–2020)

The key achievements of each experiment conducted during Phase–I (2015–2020) are briefly discussed in a pointwise manner.

5.1. Optimizing effect of planting geometry, micro-irrigation and residue management practices on sugarcane-mung bean cropping system

- Sub-surface drip irrigation (SSDI) with live or trash mulch significantly increased cane yields (*Var.* MS–10001) in both plant and ratoon cane. The highest cane yield (150.3 t ha^{-1}) was recorded with zigzag paired row planting (ZPR–225 cm × 75 cm) combined with SSDI and mulch, followed by ZPR–240 cm × 60 cm + SSDI (142.0 t ha^{-1}). In contrast, the lowest yields were observed in the farmer practice plots (125.3 t ha^{-1} with trash retention and 106.3 t ha^{-1} with burning). Mung bean live mulch and residue retention improved yields by 10.6%. Furthermore, mung bean as an intercrop produced seed yields of 3.8–7.9 q ha^{-1}, with parallel single-row planting at 150 cm spacing and surface drip irrigation (PSR–150 cm + SDI) yielding 39–84% more than other treatments (Fig.5).

Zigzag paired row planting   Mung bean as live mulch + SSDI   ZPR + Trash mulch + SSDI

Fig.5. Performance of zigzag paired row planting on mung bean-sugarcane system.

- Maximum water productivity (WP) of 0.90 Mg ha^{-1} cm^{-1} was achieved with ZPR–225 cm × 75 cm + SSDI with mulch, followed by 0.80 Mg ha^{-1} cm^{-1} in ZPR–240 cm × 60 cm + SSDI. The lowest WP was observed in farmer practice plots. Trash management and subsurface irrigation reduced water loss and improved WP by 8.9% over non–mulched SSDI, 10% over surface drip irrigation (SDI) and 31.03% over surface irrigation (SI).

- The treatment combining ZPR–225 cm × 75 cm planting geometry with subsurface drip irrigation (SSDI) and surface residues retention (mung bean live mulch and trash) showed the highest dehydrogenase activity (260.00 µg TPE g $soil^{-1}day^{-1}$) and soil biomass carbon (385 µg g $soil^{-1}$). This result is likely due to improved soil moisture availability, which enhanced microbial activity compared to other treatments.

- ZPR–225 cm × 75 cm planting geometry along with SSDI and surface residues retention exhibited maximum organic carbon, OC (0.75%), available N (180 kg ha^{-1}), P (18.46 kg ha^{-1}) and K (530 kg ha^{-1}) status of soil after harvest of crop. It may be happened due to continuous mulching of crop residue with minimum volatilization losses.

5.2. Effect of tillage, crop residues and nutrient management practices in sugarcane cropping system

- The plant crop (Var. MS–10001) results (2016–2017) revealed that reduced tillage (RT) excluding deep tillage and applying 10% of RDF (300: 115: 115; N: P: K; kg ha^{-1}) as basal and 90% through fertigation (M_2), can be adopted without compromising cane yields (162.2 t ha^{-1}) compared to conventional tillage (CT, 157.1 t ha^{-1}), which follows the same fertilizer application method (M_1) in laser land levelled (LLL) field plots. Furthermore, RT with the application of 40% of RDF through band placement using SORF and 50% of RDF through fertigation (M_3) improved the cane yield (170.0 t ha^{-1}) over the application of 10% RDF basal+90% RDF through fertigation.


Laser land levelling (LLL)


Live mulch of mung bean


Fertiliser placement–SORF

Fig.6. Plant sugarcane crop with mung bean live mulching and fertiliser placement.

- The yields improvement with M_3 over M_1, M_2 and conventional farmers' practices (M_4) treatments were 5.7, 10.5 and 26.4%, respectively. Further, LLL and drip irrigation practices not only saved the irrigation water (48%) but also improved the cane yield up to the tune of 10–15%. The residue management practices also significantly affected cane yield and recorded 5.3–12.7% yield improvement over trash burning (Fig.6).

- Pooled results from a two-year ratoon sugarcane field trail (2018–2020) indicated that the highest ratoon yield (153.5 t ha^{-1}) was achieved with reduced tillage (M_3), trash retention (S_1) and placement of 50% of RDF as basal by using SORF, with the remaining 50% applied through fertigation (N_2). This was followed by a yield of 149.8 t ha^{-1} with 75% of RDF as basal using SORF and remaining 25% by fertigation ($M_3S_1N_3$). The N_2 reported 10% yield improvement over N_1 where 25% of RDF was applied as basal by using SORF and remaining 75% through fertigation. Trash residue management improved cane yield by 13.4% compared to trash burning (S_2) treatments.

- Reduced tillage with trash-retention and nutrient management ($M_3S_1N_3$) practices exhibited in the highest levels of available nitrogen (180.7 kg ha^{-1}), phosphorus (18.6 kg ha^{-1}) and potassium (530.1 kg ha^{-1}) in the soil after crop harvest. In this treatment, soil organic carbon (SOC) reported as 9.7, 7.9 and 4.8 Mg ha^{-1} year^{-1} at soil depth of 0–5, 5–15 and 15–30 cm soil depth, respectively (Fig.7).

Trash treatments — Initial fertiliser placement — Grand growth stage

Fig.7. Optimising tillage, trash management and nutrient management practices in ratoon sugarcane.

5.3. Engineering interventions for CA in sugarcane system

- Two prototypes of the SORF drill were developed to perform various intercultural operations, intercropping, and in-situ trash retention by integrating the three principles of conservation agriculture (CA). These innovations aim to enhance the productivity, resource-use efficiency, and environmental quality of the ratoon sugarcane system (Fig.8).

- Both Prototype–I (NIASM) and Prototype–II (developed in collaboration with IISR, Lucknow) are tractor-operated (approximately 65 hp) with PTO-driven threepoint hitch linkages. They consist of three main components: (i) a power transmission unit, (ii) a central horizontal rotating disc attachment with fixed peripheral blades for stubble shaving, and (iii) two vertical discs/shovels for off-barring, equipped with root pruning and fertilizer placement mechanisms.

- The spacing between the two high-carbon steel root pruners mounted on the main frame is adjustable to accommodate different row spacing's used in sugarcane planting. The adjustable vertical off-bar discs/shovels cut the raised bed (0.10–0.20 m soil depth) from the outer sides and spread the lifted soil over the chopped trash. These discs also act as root pruners, trimming older roots. Fertilizer can be placed simultaneously through a fertilizer box using a fluted roller-star wheel metering drill mechanism, depending on the adjusted fertilizer rate, beneath the surface.
- In addition to drilling fertilizers (0.10–0.20 m) soil depth, depending on raised bed height, these machines are suitable for a variety of operations in a single pass, such as trash chopping, stubble shaving, covering trash with loose soil, off-barring, and root pruning for ratoon sugarcane crops.

Prototype–I: Trash chopper–offbar–root pruner–fertilizer drill (ICAR–NIASM)

Prototype–II: SORF(Stubble shaving, off baring, root pruning and fertilizer placement)

Fig.8. Prototypes of SORF for implementing CA in ratoon sugarcane cropping system.

6. Phase–II: Salient achievements (2021–2026 ongoing)

As discussed in Section 3, the initial outputs from Phase–I (2015–2020) were utilized to design the objectives and establish new conservation agriculture (CA) experiments for Phase–II (2021–2026). The objectives of Phase–II are as follows:

1. To quantify the impact of conservation agriculture on GHGs emission in sugarcane-based cropping system
2. To improve the water productivity through restructured planting technique, sub-surface drip irrigation systems and CA practices
3. To develop intercropping systems for sustainable soil and environmental health through conservation agriculture
4. To develop suitable machine and microbial technology for sugarcane trash decomposition and nutrient management

The key achievements of the long-term CA experiments, (i) initiated during Phase I and concluded in Phase–II, and (ii) initiated in Phase–II, are briefly presented below.

6.1. Effect of residue retention and nutrient management on carbon sequestration, soil biology and yield in multi-ratoon sugarcane

- The field experiment was conducted in the split-plot design, with residue burning (RB) and residue retention (RR) as the main plot treatments, and three nutrient management practices as subplot treatments: 25% of the recommended dose of fertilizers (RDF, i.e., 300: 150: 150 kg of N, P_2O_5, and K_2O kg ha^{-1}, respectively) applied as basal + 75% through fertigation (N_1); 50% of RDF as basal + 50% through fertigation (N_2); and 75% of RDF as basal + 25% through fertigation (N_3). These treatments were applied to four ratoon sugarcane crops (2018–2022) grown after the plant crop (2016–2018).
- Residue retention (RR) resulted 21% increase in total soil organic carbon (SOC), with 42%, 47%, 17%, and 13% higher very labile, labile, less labile, and non-labile C pools, respectively, than residue burn (RB) plots. RR plots also showed significantly higher dehydrogenase activity (DHA) (86%), alkaline phosphatase activity (APA) (16%), and ß-glucosidase activity (BGA) (22%) than RB. Among nutrient management practices, the order of effectiveness was $N_2 > N_3 > N_1$.
- Residue retention practices also demonstrated higher carbon sequestration (0.68 Mg C ha^{-1} yr^{-1}), carbon retention efficiency (37%), and yield improvement (38%), with the potential to reduce GHG emissions by 2.72 Mg CO_2 ha^{-1} yr^{-1} compared to traditional practices. Residue retention practices reported higher C sequestration (0.68 Mg C ha^{-1} yr^{-1}), carbon retention efficiency (37%), and yield (38%) with a

potential to reduce GHG emissions by 2.72 Mg CO_2 ha^{-1} yr^{-1} as compared to traditional practices.

- Residue retention combined with 50–75% RDF as basal is recommended for enhanced soil carbon retention and soil biology, promoting sustained sugarcane productivity.

6.2. Reduced tillage, surface trash retention and fertigation strategies for managing water-energy-carbon nexus in drip irrigated sugarcane

- A six-year field experiment (2016–2022) was conducted to evaluate the impact of tillage, surface trash retention, and nutrient management combined with the SORF (stubble saving, off-baring, root pruning, and fertilizer band placement) practice, using a multifunctional ratoon drill (MRD) in a drip-irrigated sugarcane system. The initial experiment for the plant crop included six treatment combinations: main plots consisted of three tillage practices (CT: conventional tillage + 10% RDF basal and 90% fertigation; RT_1: reduced tillage (RT) + 10% RDF basal and 90% fertigation; and RT_2: RT+10% RDF basal, 40% band placement, and 50% fertigation), and subplots included soil surface trash retention practices (M: mulching; NM: non-mulching). Additionally, three nutrient levels (N_1: 25% RDF basal without SORF and 75% fertigation; N_2: SORF with 50% RDF basal and 50% fertigation; N_3: SORF with 75% RDF basal and 25% fertigation were applied in sub-subplots to subsequent ratoon crops.

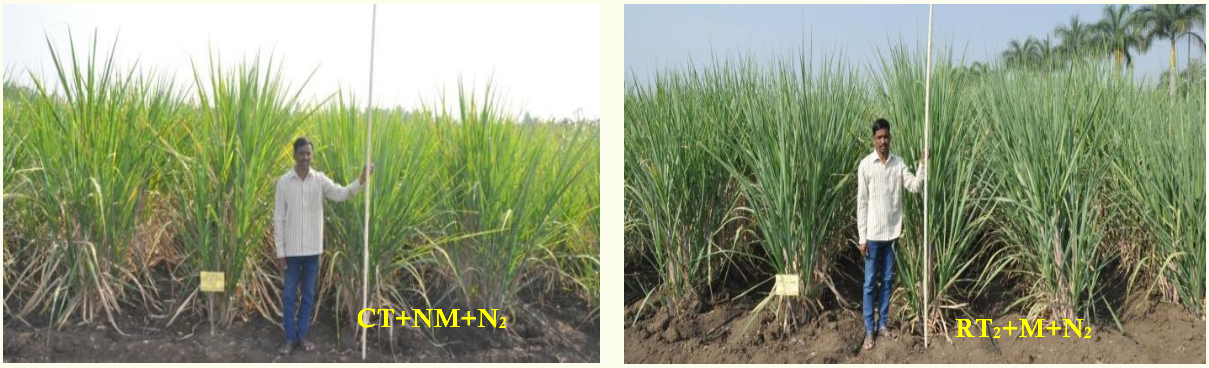


Fig.9. Performance of reduced tillage (RT_2) and surface trash retention (M) with 50% RDF basal using SORF and remaining (50%) through fertigation over farmers practice.

- Integrating reduced tillage, trash retention, and optimal nutrient management with SORF (RT_2+M+N_2) in CA systems effectively managed the water-energy-carbon nexus in sugarcane, improving soil health, cane growth, and ratoon yield by 45.4%, while reducing the yield gap between plant and ratoon crops by 8% over farmers (CT+NM+N_1) practice (Fig.9). This system also demonstrated efficient water savings (11.5–24.8%) and reduced the water footprint by 60%. Energy use efficiency was enhanced (38.7–56.3%), while energy consumption and GHG emissions were reduced by 20% and up to 12.9%, respectively. Additionally, carbon sequestration increased by 65.5–73.1%, lowering the carbon footprint by 72–88% in semi-arid regions.

6.3. Optimizing planting geometry and residue management in sugarcane-groundnut intercropping under subsurface drip irrigation practices

- The experiment, initiated in 2021, aimed to optimize the effects of zigzag paired row planting, subsurface drip irrigation (SSDI), and intercropping with groundnut to enhance the productivity of the sugarcane (Co–86032) cropping system. The main plot treatments included; M_1: Zigzag paired row (ZPR) with 60 cm plant spacing and 150 cm row spacing + SSDI; M_2: ZPR (75 cm, 150 cm) + SSDI; M_3: ZPR (60 cm, 210 cm) + SSDI; M_4: ZPR (75 cm, 210 cm) + SSDI; M_5: ZPR (60 cm, 225 cm) + SSDI; M_6: ZPR (75 cm, 225 cm) + SSDI; M_7: ZPR (60 cm, 180 cm) + SSDI; and M_8: ZPR (75 cm, 180 cm) + SSDI. Two soil surface retention treatments, S_1: groundnut residue + sugarcane trash, and S_2: without residue, were applied in sub-plots. Additionally, a control treatment with surface irrigation management practices was maintained for comparison.
- In the plant crop (2021–2022), the M_6S_1 treatment, i.e., ZPR 75 cm × 225 cm + SSDI with residue retention, resulted in the highest cane yields (154.7 t ha^{-1}), which was 37% higher than the M_1S_2 i.e. commonly recommended for farmers' practices. A similar trend was observed for groundnut pod yield, where M_6S_1 (ZPR 75 cm × 225 cm + SSDI) recorded the highest yield of 24.1 q ha^{-1}, followed by M_5S_1 (ZPR 60 cm × 225 cm + SSDI) with 23.3 q ha^{-1}. Furthermore, residue retention improved ratoon cane yield by 13.7–29.9% compared to residue-burning practices (Fig.10).

Fig.10. Effect of zigzag planting geometry and residue management in plant sugarcane-groundnut intercropping system under subsurface drip irrigation practice.

- In the ratoon crop, a two-year pooled analysis (2022–23 and 2023–24) revealed that the highest cane yield was reported for M_6S_1 (135.2 t ha^{-1}), followed by M_5S_1 (131.8 t ha^{-1}). M_6S_1 also recorded the maximum groundnut pod yield (9.8 q ha^{-1}), while M_1S_1 had the lowest yield (3.9 q ha^{-1}). Surface trash retention and groundnut residues improved ratoon cane yield by 17.9–40.9% over the farmers' standard practices (Fig.11).

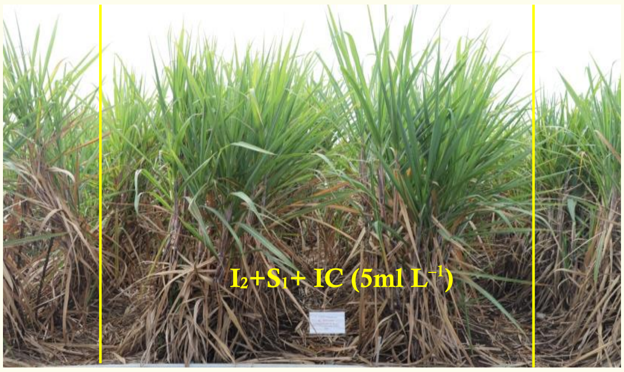
Fig.11. Effect of zigzag planting geometry and residue management in ratoon sugarcane-groundnut growth under a subsurface drip irrigation system.

- It can be concluded that groundnut–sugarcane intercropping is successful in the plant crop. However, a significant reduction groundnut pod yield in the ratoon crop (up to 83.8%) suggests that it may not be economically viable. Overall, the synergy of planting geometry, intercropping, and surface residue retention demonstrates the potential to boost the productivity of the sugarcane cropping system.

6.4. Interactive effect of chickpea genotypes, deficit irrigation and plant growth regulators in CA based sugarcane cropping system

- Initiatives have been taken to study the interaction between genotypes (G), management (M), and environmental factors (E) under a reduced-tillage practice in sugarcane cropping system. Accordingly, a field experiment was initiated to examine the interaction effects of chickpea genotypes (G), plant growth regulators (M), and water stress environments (E) in sugarcane (Variety: Co–86032) during 2022. The main treatments included three deficit irrigation levels, viz., I_1: 50% ETc; I_2: 75% ETc; and I_3: 100% ETc (full irrigation), which were maintained using as subsurface drip irrigation system. Two soil surface residue management practices, S_1: intercrop (with eight chickpea cultivars: Pusa–1003, BG–276, Pusa Green–112, ICCV–92944, IPC–06–11, JG–16, Vijay, and Phule Vikram) residue cover, and S_2: no residue cover, were used in the subplots. Four plant growth regulators (PGRs), namely thiourea (TU, 1800 ppm), irradiated chitosan (IC, 5 ml L^{-1}), nano-urea (NU, 4 ml L^{-1}), and salicylic acid (SA, 25 µM), along with a control (no PGRs), were applied exogenously at two-month intervals after crop establishment (60 DAT) as sub-subplot treatments. Preliminary results showed that in the plant crop, the highest cane yield of 157.1 t ha^{-1} was obtained with I_2+S_1+IC, i.e., 75% ETc with intercrop residues and the exogenous application of irradiated chitosan (5 ml L^{-1}). Crop residue retention (S_1) increased plant cane yields by 8.1%, 17.2%, and 23.1% under full (100% ETc), 75% ETc, and 50% ETc, respectively, over the control (S_2). PGRs improved plant crop cane yields by 4.0–7.2%, 8.3–18.7%, and 11.7–22.4% under full (100% ETc), 75% ETc, and 50% ETc water deficit conditions, respectively. Overall, PGRs like IC and the chickpea cultivar Phule Vikram appear promising for enhancing the growth and productivity of the sugarcane system (Fig.12). However, due to the severity of rust infection in chickpea and the complexity of the experiment, genotype interaction factor was eliminated from the ratoon crop trial.

Sugarcane-chickpea intercropping



DI (75% ETc) +crop residue + IC (5 ml L^{-1})

Fig.12. Effect of deficit irrigation, crop residue surface mulch and irradiated chitosan on plant sugarcane.

- The highest ratoon cane yield of 140 t ha^{-1} was obtained with I_1+IC+S_1, i.e., when irrigated at 75% ETc with irradiated chitosan (5 ml L^{-1}) in trash-retained (S_1) plots under reduced tillage practices (Fig.13). Surface trash retention (S_1) increased ratoon cane yields by 9.4%, 21.0%, and 36.4% under full (100% ETc), 75% ETc, and 50% ETc irrigation levels, respectively, compared to the control (S_2). PGRs improved ratoon cane yields by 5.0–12.0%, 9.9–25.4%, and 15.9–35.4% under full (100% ETc), 75% ETc, and 50% ETc water deficit conditions, respectively.
- Compared to results from the plant crop (2022–23), the combined practice of 75% ETc, IC (5 ml L^{-1}), and surface trash retention reduced the yield gap between plant

and ratoon crops by up to 10.9%, along with 25% water saving over traditional farmer practices.

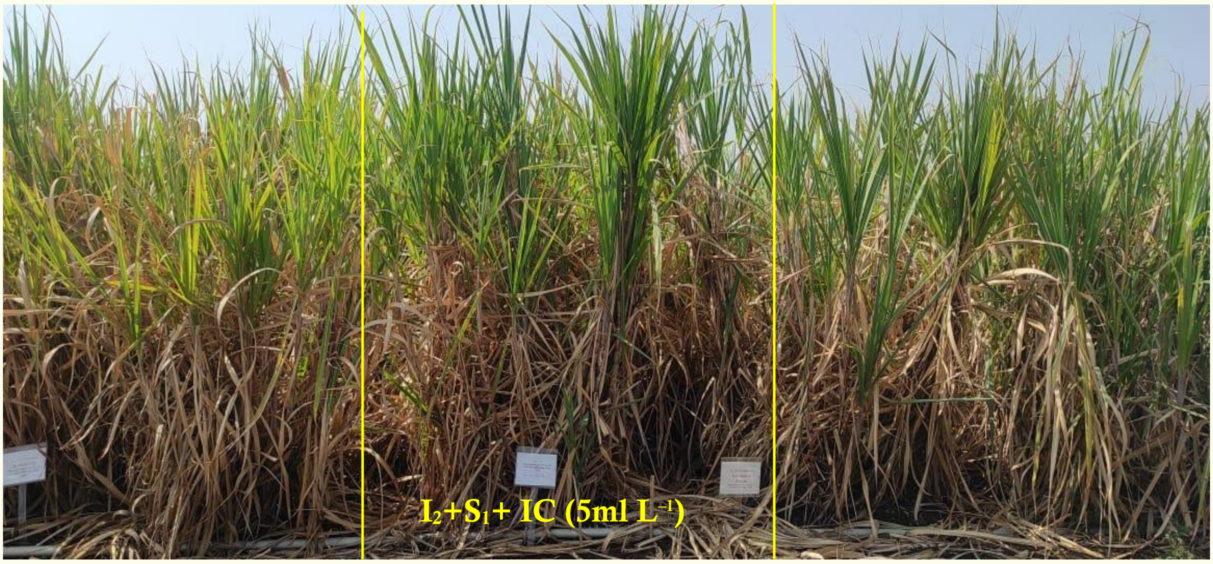


Fig.13. Ratoon crop responses to deficit irrigation, irradiated chitosan and surface trash.

6.5. Design and development of multi-functional ratoon drill (MRD) for enhancing productivity and resource conservation in sugarcane

Background: Ratoon crop cultivated on half of the sugarcane area (2.5 Mha) yields 20–25% less than the plant crop. The challenge lies in the high load (10–15 t ha^{-1}) and tough nature of loose trash after harvest, posing obstacles to conservation agriculture (CA) practices and intercropping. Additionally, lower nutrients use efficiency and burning (GHGs) are the major constraints. Therefore, two prototypes of SORF (Prototype–I and Prototype–II) were developed during Phase–I, though they require further refinement, including the additional mechanism for sowing intercrop seeds in trash retained field. Consequently, two additional prototypes (Prototype–III and Prototype–IV) of a multi-functional ratoon drill (MRD) were developed to enhance productivity and resource conservation in ratoon sugarcane cropping systems on shallow basaltic soils (Fig.14).

Key operations: Recently developed prototype MRD performs following five operations in single go in a trash retained fields.

1. Stubble shaving: Uniform stubbles cutting left after harvest with stubble shaver
2. Off-baring: Adjustable off-baring shovels partially cut and spread soil over chopped trash to expedite decomposition
3. Root pruning: Pruning older lateral roots in ratoon sugarcane and stimulates fresh root growth
4. Placement of fertilisers: Placing fertilisers in bands in trash retained ratoon field
5. Sowing: Simultaneous sowing of intercrop (chickpea, sesbania and summer maize) in ratoon sugarcane crop

MRD drill–Prototype (III)

MRD drill–Prototype (IV)

Demonstration of MRD drill

Sowing of summer maize

Fig.14. Field testing and demonstration of multifunctional ratoon drill (MRD).

Benefits and salient features: MRD is beneficial for timely ratoon management operations, offering the following key benefits and features

- Ratoon cane yield improved by 10–38%
- Healthier with more number of malleable canes and least tiller mortality rate
- Saving 6–21% irrigation water and 20–25% fertilizers
- Band placement of fertilisers and sowing of green manuring and intercrops (chickpea, maize, sesbania) with ease
- Significant improvement in NUE (13%)
- Field capacity of 0.60 ha h^{-1}using 35-50 hp tractor at 3.2 km h^{-1} operational speed with 95% efficiency
- B: C ratio for MRD in ratoon sugarcane is 1.5–1.8, surpassing conventional practices
- Net profit increased up to INR 50000 per hectare

Guidelines for use of MRD:

1. Checking field conditions: Stubble shaving, off -barring/pruning, fertiliser cum seed application operations with MRD are best accomplished in well chopped trash retained fields with medium soil moisture. It does not work well in fields where moisture levels are too high. In this such situations care must be taken to prevent blockage of seed and fertilizer tube under black soil conditions.
2. Removal of drip system: Removal of the drip lateral pipes before performing MRD operation from trash retained ratoon cane fields is essential.
3. Calibration: Calibrate the fertiliser/seed rate of MRD machine depending upon recommended basal dose of fertilisers to be applied and quantity seeds of selected intercrop in ratoon sugarcane.
4. Spacing and depth control: Adjust the spacing between off-bar cum root pruners and depth of shovel/ tines for seeding cum fertiliser application with help of adjustment screw before performing operation using tractor.
5. Irrigation: Apply the drip/furrow irrigation immediately after completion of MRD machine operations.

Precautions: The MRD requires skilled tractor operator during transportation and field operations for obtaining high field efficiency in trash retained ratoon sugar cane fields. The machine has to be operating in well trash chopped fields only.

Cost and spread of MRD: The maximum cost of MRD machine is up to ₹ 85 thousands with all accessories. Net profit increased up to ₹ 50 thousand per hectare. The keeping in mind 2.5 million ha area of sugarcane under ratoon crop, it is estimated that approximately ₹ 6.75–12.50 thousand crores per annum could be earned as an additional net profit by the farmers. The MRD is disseminating through field demonstrations, KVKs, state departments and institute visits to more 3000 sugarcane farmers, sugarcane factories employees and entrepreneurs engaged in manufacturing of farm equipment.

7. Recommendations

- The planting geometry of zigzag paired rows (ZPR–225 cm × 75 cm) combined with subsurface drip irrigation (SSDI) and surface residue retention (using mung bean live mulch and trash) demonstrated significant improvements in cane yield (16.3%), water productivity (0.90 Mg ha^{-1} cm^{-1}), and soil health (including enzyme activity, SOC, and NPK levels) compared to conventional farming practices. Additionally, sugarcane-mung bean intercropping has proven to be economical for both plant and ratoon crop. Therefore, this approach can be recommended as a potential substitute for conventional practices in canal-based shallow basaltic soils of the Deccan Plateau.

- In plant crop, Laser Land Leveller (LLL)+ Reduced tillage (RT) + Application of 40% RDF as band placement in standing crop and remaining 50% RDF through fertigation improved the cane yields by 5.7, 10.5 and 26.4% over LLL + conventional tillage (CT) + 90% fertigation, LLL+RT+90% fertigation and farmer practices, respectively. LLL and drip irrigation practices saved the irrigation water up to 48%. In ratoon crop, the same treatment reported significant improvement in cane yield, SOC and NPK levels. The synergies of micro-irrigation and mulching (trash/ live mulch) enhanced the cane yield by around 5.3–13.4% compared to trash burned treatments.

- A field experiment on residue retention and nutrient management in multi-ratoon sugarcane (1 plant crop + 4 ratoons) demonstrated that residue retention (RR) significantly improved SOC (21%), carbon sequestration (0.68 Mg C ha^{-1} yr^{-1}), ratoon cane yields (38%), and potentially reduced GHG emissions (2.72 Mg CO_2 ha^{-1} yr^{-1}) compared to residue burning (RB) over six years. Overall, RR combined with 50–75% RDF (300:150:150 kg of N, P_2O_5, and K_2O ha^{-1}) as a basal application is recommended for enhancing soil biology and promoting sustained sugarcane productivity.

- CA by integrating reduced tillage (RT) + trash retention (M) and optimal nutrients (N_2) i.e. 50% RDF basal with SORF practice and 50% fertigation sustainably manages water-energy-carbon nexus in sugarcane cropping system. This practice improved soil health, cane growth and ratoon yield productivity by 45.4% and narrated yield gap between plant and ratoon crop by 8%. RT_2+ M+ N_2 efficiently saved irrigation water by 11.5–24.8%, enhanced energy use efficiency by 38.7–56.3%, and reduced GHGs emission by up to 12.9%.

- In sugarcane-groundnut intercropping, the planting geometry of ZPR (75 cm × 225 cm) combined with subsurface drip irrigation (SSDI) and residue retention recorded the highest cane yield in the plant crop (154.7 t ha^{-1}) and groundnut pod yield (24.1 q ha^{-1}), compared to farmers' practices (60 cm × 150 cm). In ratoons, the corresponding yields were lower for both sugarcane (135.2 t ha^{-1}) and groundnut (3.9–9.8 q ha^{-1}). It can be concluded that while groundnut-sugarcane intercropping is successful in the plant crop, the significant reduction in groundnut pod yield in the ratoon crop (up to 83.8%) suggests that it may not be economically viable for ratooning.

- Sugarcane responses to deficit irrigation, exogenous plant growth regulators (PGRs) and surface trash retention were studied. The highest plant (157.1 t ha^{-1}) and ratoon (140 t ha^{-1}) cane yields were obtained with irrigation at 75% ETc, combined with irradiated chitosan (5 ml L^{-1}) in trash-retained plots under reduced tillage practices. In both crops, surface trash retention improved average cane yields by 8.1–9.4%, 17.2–21.0% and 23.1–36.4% in full (100% ETc), 75% ETc and 50% ETc irrigation levels compared to the control. Similarly, PGRs increased cane yields by 4.0–12.0%, 8.3–25.4% and 11.7–35.4% under full (100% ETc), 75% ETc and 50% ETc, water deficit levels, respectively. Overall, the combined practice of 75% ETc, IC (5 ml L^{-1}), and surface trash retention reduced the yield gap between plant and ratoon crops by up to 10.9%, while achieving a 25% water savings compared to traditional farmer practices.

- The development of a multi-functional ratoon drill (MRD) for stubble shaving, off-barring, root pruning, band placement of fertilizers, and intercropping under soil-surface retained trash/residue conditions has opened new avenues for successfully integrating the three principles of conservation agriculture (CA) to enhance productivity and resource conservation in sugarcane-based cropping systems.
- Overall, shifting from conventional farmers' practices to an integrated approach of reduced tillage with in-situ trash and nutrient management via SORF practice using an MRD drill could help in improving soil health, resource-use efficiency, crop productivity, and environmental quality in the sugarcane cropping system.

8. Human resource development and capacity building activities

Some of the major human resource development and capacity-building programs organized during the years 2015–2024 are listed below:

8.1. Workshops organized

1. Two-day Workshop on "Challenges and Opportunities in Sugarcane Cultivation under Changing Climatic Scenario" held during July 10–11, 2017, at ICAR–NIASM, Baramati, Pune, Maharashtra. More than 350 progressive farmers from Maharashtra were participated.
2. One-day Awareness Workshop on "Scope and Prospects of Organic Farming in Sugarcane Cultivation" held on June 26, 2018 at ICAR–NIASM, Baramati, Pune, Maharashtra. More than 150 progressive farmers were participated.
3. One-day Workshop on "Climate Smart Technology for Cultivation of Sugarcane" held on July 27, 2019 at ICAR–NIASM, Baramati, Pune, Maharashtra. More than 320 progressive farmers were participated.
4. One-day Workshop on "Conservation Agriculture and Farmers' Awareness Campaign on Efficient and Balanced Use of Fertilizers (including Nano-fertilizers)" held on June 21, 2022 at ICAR–NIASM, Baramati, Pune, Maharashtra: More than 200 farmers, women, youths and SCSP beneficiaries were benefited.



8.2. Trainings organized

1. Model Training Course (MTC) on "Climate Smart Agriculture for Enhancing Crop and Water Productivity under Abiotic Stress Conditions" held during December 16–23, 2017 at ICAR–NIASM, Baramati, Pune, Maharashtra. More than 20 extension functionaries of state development departments/ KVK/ICAR/SAUs across India were participated.
2. Collaborative Training on "Climate Smart Agriculture and Abiotic Stress Management Technologies for Enhancing Farmers Income" with MANAGE (Hyderabad) held during December 16–20, 2019 at ICAR–NIASM, Baramati, Pune, Maharashtra. Total 26 extension functionaries of state development departments/KVK/ICAR/ SAUs across India were participated.
3. Model Training Course (MTC) on "Climate Change and Abiotic Stress Management Strategies for Enhancing Crop Productivity and Farmers Income" held during January 4–11, 2020 at ICAR–NIASM, Baramati, Pune, Maharashtra. Total 23 extension functionaries of state development departments/KVK/ICAR/SAUs from India were participated.
4. Short Term Course on "Abiotic Stresses in Agriculture: An introduction and Hands-on Training for Skill Development" held during June 01 to July 10, 2022, at ICAR–NIASM, Baramati, Pune, Maharashtra. Total 52 Graduate, Masters and PhD students and young researchers from SAUs and ICAR were participated.


SHORT TERM COURSE
ON
ABIOTIC STRESSES IN
AGRICULTURE:
An introduction and
Hands-on Training for
Skill Development
JUNE 01 - JULY 10, 2022
ICAR-National Institute of
Abiotic Stress Management
Baramati, Pune, Maharashtra - 413 11
ICAR

5. Short Term Training Course on “Conservation Agriculture for Improving Water Productivity and Post-Harvest Quality of Field Crops under Abiotic Stress Conditions” held during September 12 to October 3, 2022, at ICAR–NIASM, Baramati, Pune, Maharashtra. Total 22 Masters and PhD Students from SAUs were participated.

6. Inplant Training Course on “An Overview and Hands-on Instrumentation for Abiotic Stresses in Agriculture” held during November 1–30, 2023 at ICAR–NIASM, Baramati, Pune, Maharashtra. Total 20 B. Tech (Agricultural Engineering) students from private colleges and SAUs were participated.

7. Winter School on “Climate Change and Abiotic Stresses Management Solutions for Enhancing Water Productivity, Production Quality and Doubling Farmers Income in Scarcity Zones” held during January 5–25, 2023 at ICAR–NIASM, Baramati, Pune, Maharashtra. More than 28 Scientists/Professors/SMS/Teaching faculties from SAUs/ICAR/KVKs were participated.

8. Inplant Training Course on “Abiotic Stresses in Agriculture, Mitigation Strategies and Engineering Interventions” held during September 04 to October 3, 2023 at ICAR–NIASM, Baramati, Pune, Maharashtra. Total 22 B. Tech (Agricultural Engineering)/Masters Students from SAUs/private colleges were participated.

8.3. Demonstrations, VIP visits and linkages with SAUs/media groups for organizing extension and research activities

1. Conducted more than 300 field trials/frontline demonstrations of SORF and MRD drill during 2015–2024 at Institute, farmers’ fields, exhibitions by KVK/SAUs and Kishan Melas etc. More than 3000 farmers, SMS/state government officials, entrepreneurs and students were benefited.

2. Organized field visits and demonstrations of conservation agriculture experiments for QRT, RAC, IRC, CRPCA-LP, SAUs, NABARD and ICAR officials during 2015–2024.

3. Established linkages with SAUs, KVKs and Vasantdada Sugar Institute conducting research and training to faculty and students in association with ICAR–NIASM, Baramati.

4. Developed linkages with Sakal media groups (Pune) for creating publicity of conservation awareness programme.

अॅग्रोवन

संवर्धित शेतीची सूत्रे

डॉ. गोरक्ष वाकचौरे,
प्रशांत भोसले

जमिनीची उत्पादकता प्रामुख्याने अजैविक कारणामुळे कमी होत आहे. याची प्रमुख कारणे म्हणजे जमिनीचा अधिक वापर, सेंद्रिय खतांचा अभाव, रासायनिक खतांचा असंतुलित वापर. यासाठी संवर्धित शेती पद्धतीचा अवलंब फायदेशीर ठरणार आहे.

संवर्धित शेतीमध्ये आंतरपीक पद्धतीचा अवलंब फायदेशीर दिसून आला आहे.

टेक्नोवन

१०
बुधवार, १८ मे २०२२
सकाळ अॅग्रोवन

डॉ. गोरक्ष वाकचौरे, प्रशांत भोसले

संवर्धित शेतीसाठी बहूकार्यान्वित ऊस खोडवा ड्रील यंत्र

बहू-कार्यान्वित खोडवा ड्रील यंत्र मातीत खते देणे, बियाणे पेरणीसाठी उपयुक्त आहे. याचबरोबरीने मुळांचा जारवा तोडणे, पाचटावर माती टाकणे आणि ऊस बुडक्यांची छाटणी करण्यासही फायदेशीर ठरणारे आहे.

खोडवा पिकामध्ये संवर्धित शेतीमध्ये पाचट आच्छादन केले जाते. परंतु अजूनही शेतकरी पाचट जाळतात. यामुळे मातीचे जीवशास्त्र विस्कळीत होते, नैसर्गिक भू-चक्र बिघडते, सुपीकता कमी होते आणि पर्यावरणीय प्रदूषणाला हातभार लागतो. ऊसतोडणीनंतर पाचट आच्छादनामुळे काही वेळा आंतरमशागतीय क्रियांमध्ये अडथळा येतो. नवीन पिकाच्या तुलनेत खोडवा उसाचे उत्पादन २५ ते ३० टक्के कमी होते. या समस्यांचे निराकरण करण्यासाठी राष्ट्रीय अजैविक ताण व्यवस्थापन संस्थेने बहू-कार्यान्वित खोडवा ड्रील यंत्र विकसित केले आहे.

बहू-कार्यान्वित खोडवा ड्रील यंत्र

- यंत्र पीटीओ ट्रॅक्टरचलित (३५ ते ६५ अश्वशक्ती) आहे.
- यंत्र मातीत खते (१५ ते २० सेंमी खोली) आणि बियाणे (५ ते ७ सेंमी) सोडण्याव्यतिरिक्त इतर विविध कामे करते उदा. मुळांची छाटणी म्हणजेच जारवा तोडणे, पाचटावर माती टाकणे आणि ऊस बुडक्यांची छाटणी करणे.

बहू-कार्यान्वित खोडवा ड्रीलयंत्र

यंत्राद्वारे होणारी कामे

बहू-कार्यान्वित खोडवा ड्रील यंत्र पाचटकुट्टी करून राखलेल्या खोडवा उसात एकाच वेळी पाच प्रमुख कामे करण्यासाठी योग्य आहेत.

- **बुडखा छाटणी :** उसाची हाताने कापणी केल्यानंतर शेतात उरलेले असमान बुडखे, पृष्ठभागाजवळ एकसमान उंचीवर खूप वेगाने कापले जातात.
- **माती ढकलणे :** उभे ऑफ-सेटिंग डिस्कस/फावडे वाफ्याला बाहेरील बाजूंनी अर्धवट कापतात. कापलेल्या मातीला कुट्टी केलेल्या पाचटावर पसरवतात, जेणेकरून त्याचे विघटन वेगवान होईल.
- **मुळांची छाटणी :** नव्या मुळांच्या वाढीस चालना देण्यासाठी खोडवा उसाच्या बाजूच्या जुन्या मुळांची छाटणी केली जाते. नव्याने विकसित झालेली मुळे उसाच्या सुरुवातीच्या वाढीस चालना देतात. यामुळे पाणी आणि पोषक तत्त्वांच्या शोषणास प्रोत्साहन मिळते.

9. DAPSC (SCSP) activities

1. In 2022 and 2023, two awareness training programs on conservation agriculture (CA) and the efficient and balanced use of fertilizers (including nano-fertilizers) were organized for SCSP beneficiaries, particularly those engaged in sugarcane farming. The farmers were informed about the judicious use of fertilizers, crop residue management, and machinery for in-situ trash conservation in ratoon sugarcane cropping systems. About 172 SCSP beneficiary farmers participated.

2. During 2021–2024, seven frontline demonstrations on basic conservation agriculture (CA) principles, MRD drills, and drip irrigation systems for efficient nutrient and water use, as well as in situ trash management in ratoon sugarcane, were conducted. A total of 168 SCSP farmers, including women and youth beneficiaries, participated.

3. Basic agricultural inputs such as drip irrigation systems, milk cans, and storage tanks were provided to SCSP beneficiaries involved in agricultural activities. Sieving machines, flour mills, and household items such as utensil kits were distributed to landless and farm labourer SCSP beneficiaries. A total of 106 SCSP beneficiaries from more than 10 villages in the Ahmednagar and Pune districts benefited from the scheme under CRPCA, ICAR–NIASM.

कारखेलमध्ये ठिबक सिंचन, पीठ गिरणींचे वाटप

लोकमत

राष्ट्रीय अजैविक तान व्यवस्थापन संस्थानच्या वतीने पाणी साठवण टाक्यांचे वाटप करण्यात आले.

ग्रामीण भागात गरजूंना पाणी टाक्यांचे वाटप

राष्ट्रीय अजैविक ताण व्यवस्थापन संस्थानचा उपक्रम

लोकमत

राष्ट्रीय अजैविक तान प्रबंधन संस्थेच्या वतीने महिलांना गृहोपयोगी साहित्य वाटप करण्यात आले.

महिलांना गृहोपयोगी साहित्य वाटप

लोकमत न्यूज नेटवर्क

10. Infrastructure, equipment & facilities procured/developed

The following infrastructure, equipment, and other facilities have been developed at the ICAR–NIASM Centre to support scheduled CA research activities.

1. Developed three prototypes of multifunctional ratoon drills for ratoon sugarcane management and a prototype of bud detectors with cutters for preparing nursery seedlings.
2. Established drip irrigation facilities for CA research (over 1 hectare).
3. Procured a precision laboratory and field weighing balances
4. Procured a plant canopy analyzer cum canopy interception meter
5. Procured a green-seeker (portable NDVI meter)
6. Procured portable refractometer
7. Procured computer, accessories, and other misc. equipment

Multifunctional ratoon drill (MRD)

Drip irrigation facilities

Plant canopy analyzer cum canopy interception meter

Field weighing balances

Bud detector

Refractometer

Green-seeker (NDVI)

11. Technologies, publications and conference abstracts

11.1. Technologies developed (Approved by ICAR, New Delhi)

1. Multi–Functional Ratoon Drill (MRD) for Enhancing Productivity and Resource Conservation in Ratoon Sugarcane Cropping System.
2. Trash and Fertiliser Management in Ratoon Sugarcane.

11.2. Research papers

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11.5. Popular articles

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ICAR–NATIONAL INSTITUTE OF ABIOTIC STRESS MANAGEMENT
(Deemed to be University)
(Indian Council of Agricultural Research)
मालेगांव, बारामती, पुणे – 413 115, महाराष्ट्र, भारत
Malegaon, Baramati, Pune – 413 115, Maharashtra, India
Phone: 02112 – 254057, Fax: 02112– 254056
Web: https://niasm.icar.gov.in/