

RESEARCH ARTICLE

Adoption of variety Co 0238 and sugar recovery improvement in Haryana, India

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(Received 04 July 2020; accepted 01 December 2021)

Abstract

Many varieties are introduced by ICAR-Sugarcane Breeding Institute and other sugarcane research stations for yield and sugar recovery improvement. However, the yield and sugar recovery were stagnated at about 60 t/ha and less than 10% in sugar recovery up to 2012 in sub tropical India. The cost of production of sugar and profitability of the sugar industry besides many other factors depends primarily on the availability of good quality sugarcane during the crushing season. The main reason behind low productivity and sugar production was lack of promising high sugar sugarcane varieties. The farm productivity and sugar recovery from this part of the country remained much lower than the national average till few years back. However, the variety Co 0238 has turned around the situation with significant improvement in sugar recovery and cane yield to withstand the adversities of the unfavourable climatic factors in Haryana state of India. The data collected from different sugar mills have revealed that the sugar recovery significantly improved due to cultivation of variety Co 0238. The sugar recovery has improved 1.5 to 2 % and yield about 10-12 t/ha depending upon the agro climatic conditions of Haryana. Improved sugar recovery has increased sugar production and has immensely benefitted sugarcane farmers and sugar mills.

Keywords: Variety Co 0238; Early maturing; Sugar recovery improvement; Yield enhancement; Farmers income; Haryana.

Introduction

Sugarcane Cultivation in sub-tropical India is done since olden times. Initially old local varieties were used for sugarcane farming in rather unscientific manner which resulted in lower yields of sugarcane. The production of this region, initially known as United Province was much lower in cane yield which was around 18 t/ha (Co-op sugar 1971). After independence, many varieties were introduced by Sugarcane Breeding Institute and other stations for yield and sugar recovery improvement. However, the yield and sugar recovery were stagnated of about 60 t/ha and of less than 10 % in sugar recovery up to 2012 in the sub tropical region. The requirement of sugarcane for the mills and sugar for the zone was

unable to be accomplished. The cost of production of sugar and profitability of the sugar industry besides many other factors depends primarily on the availability of sufficient quantity of good quality sugarcane during the crushing season. The main reason behind low productivity and sugar production had been lack of promising high sugar recovery varieties in this zone.

Sugar recovery from sugarcane is one of the most important issues with respect to sugar industry. One of the main reasons for stagnant sugar recovery (9.5–10 %) in subtropics is cultivating proportionally less area of early maturing varieties (<25 %). The area has not been increased up to the desirable extent. There is much potential to increase the sugar recovery of this region by giving

preference for the cultivation of early maturing, high sugar varieties which tend to mature fast and accumulates higher sucrose % and purity in less time. Higher sugar recovery favours the revenue of sugar mills. According to Babu and Varma (2012), in India, all sugarcane growing States have a sugar recovery ranging from 8.96% to 11.35%. Among the sugarcane growing countries, Australia has registered a highest recovery of 14% while other important cane growing countries such as Brazil, U. S. A., South Africa, Cuba, Mauritius and Pakistan have obtained sugar recovery from 9% to 11% (Kennedy et.al 2020).

Sugarcane is cultivated traditionally in Haryana state and area of sugarcane cultivation is fluctuating over the period of time. Cultivation of sugarcane in Haryana which was in 2 lakh ha in 1999-2000 had reduced to 0.75 lakh ha in 2009-2010 due to significant reduction in cane yield and sugar recovery. The area and sugar recovery of the Haryana since 1990 is given below.

Sugarcane area in Haryana

Year	Area (‘000 ha)
1990-91	118
1991-92	120
1992-93	127
1993-94	128
1994-95	155
1995-96	162
1996-97	166
1997-98	165
1998-99	196
1999-00	201
2000-01	143
2001-02	161
2002-03	189
2003-04	160
2004-05	130
2005-06	127
2006-07	140

2007-08	140
2008-09	90
2009-10	74
2010-11	85
2011-12	95
2012-13	101
2013-14	102
2014-15	97
2015-16	93
2016-17	102
2017-18	114

It is quite visible that sugarcane cultivation is showing downward fluctuation along with yield and sugar recovery. ICAR-SBI, RC, Karnal has developed a number of high yielding and high recovery varieties such as Co 0118, Co 0119, Co 0238 and Co 0239 during this period (Ram et al 2010 and Ram and Nair, V. 2009). Among all these varieties, Co 0238, popular in the North West Zone of India was adopted in Haryana during 2013. Since adoption of the variety, sugar recovery has improved significantly depending on percentage of adoption in different sugar mills in the State (Ram 2018). Sandhu et al (2009).

Variety Co 0238 had also showed more improvement in cane yield with potato and onion intercropping (Singh 2011). Autumn planting of sugarcane variety Co 0238 with intercrops. i.e., lentil, rajma, potato, cabbage and cauliflower showed improvements in net profit of farmers as compared to autumn planted sole crop of Co 0238 cane variety. By adopting intercropping, farmers could enhance their economic status and easily meeting expenses of sugarcane cultivation but also fulfil the house hold requirements (Singh 2010). Further, Singh et.al (2010) had reported that large scale demonstrations conducted in command area of Jai Shree Sugar Mills Limited, Majhaulia, West Champaran, Bihar, clearly indicated that Co 0238, a new high yielding variety showed very good performance in the farmer fields. Average cane yield of 100 t/ha to 187.5 t/ha was reported during

study period (Singh 2012). However, there has been no study on sugar recovery improvement in Haryana by the variety Co 0238.

Haryana has ten cooperative sugar mills one private sugar mill that render service to about 40,000 sugarcane growers' families out of total 6 lakh farming families in the state. At present, 10 cooperative sugar mills are in operation in Haryana affiliated to Sugar Federation, another Co-operative sugar mill at Assandh (2500 TCD) is being operated by the HAFED. Totally 12 sugar mills and in operator in haryana.

To ascertain the sugar recovery improvement, a study was undertaken in the state of Haryana. So far, available studies were done with sample data which was not true reflection of sugar recovery improvement in Region/State. Hence, in the present study, all major sugar mills in the Haryana were studied for comprehensive results and conclusion. The study aimed policy implications for improvement in sugar recovery, yield improvement and increase in cane area in the state of Haryana.

Materials and Methods

The study was conducted by collecting primary, secondary data and expert level discussion held with cane professionals such as Cane officers, Manager (Cane) and Managing Director of the sugar mills. The basic as well as secondary data on area, production, yield, sugar recovery and other parameters of the state were collected from published sources. An interview schedule was prepared to collect the basic information on the different sugar mills in the state. Data on varieties which are being adopted in the farmers' field, method of cultivation and revenue were collected from farmers through personal interviews.

Out of 10 cooperative sugar mills, six sugar mills including one private sugar mill were selected for the intended objectives. The state wise data on cane area registration, plant and ratoon area, yield,

sugar recovery, sugar and molasses production were collected from the sugar mills which are located in different parts of State. The collected data were tabulated and simple analytical tools such as graphical analysis and correlation were done to interpret the results.

For identifying the major factors influencing the sugar recovery of the State, an expert level discussion was conducted. Consultants (sugar plant experts) and executives from the sugar mills actively participated in the discussion to bring out meaningful results and conclusion.

Analytical methods

The sugar recovery improvement was estimated with actual data obtained from respective sugar mills in the study area. The correlation coefficient is a statistical measure of the strength of the relationship between the relative movements of two variables. It measures the degree to which changes to the value of one variable predict change to the value of another. Positively correlated variables, the value increases or decreases in tandem. Here correlation analysis was done to find out adoption of the variety Co 0238 and sugar recovery improvement in the state.

Results and Discussion

Adoption of the variety Co 0238 was estimated since 2012-13 and it is depicted in Table.1.

Table 1. Area of adoption of variety Co 0238 in Haryana

Year	Total cane area cultivation in the State (ha)	% Area cultivated by variety Co 0238 in the State
2012-13	1,01,000	3.7
2013-14	1,02,000	14.8
2014-15	97,000	19
2015-16	93,000	29
2016-17	1,02,000	39.5

2017-18	1,14,000	54.2
2018-19	94,000	60.5
2019-20	1,18,000	60.2

The adoption of the variety has steadily increased from 3.7 % in 2012-13 to 60.5 % in 2019-20 in Haryana. The cane area cultivation which was fluctuating during 2013-15 was stabilised due to adoption of this variety. Normally, adoption of the variety would take place in phased manner due to length of the cultivation period. However, the variety Co 0238 was adopted at much a faster rate with more than 50 % of the area in the state within a span of five years that has revealed the potential of the variety. Data collected from six sugar mills located in the state are depicted here.

Saraswati Sugar Mill, Yamuna Nagar

The Saraswati Sugar Mill was established in 1933 at Yamunanagar in Haryana, India. It has a cane crushing capacity of 1,20,000 quintals of cane. It is one of the largest sugar mill and yearly intakes sugarcane from more than 50,000 farmers every year.

Saraswathi sugar mill has adopted the variety Co 0238 since 2011 (Fig.1). The figure shows that

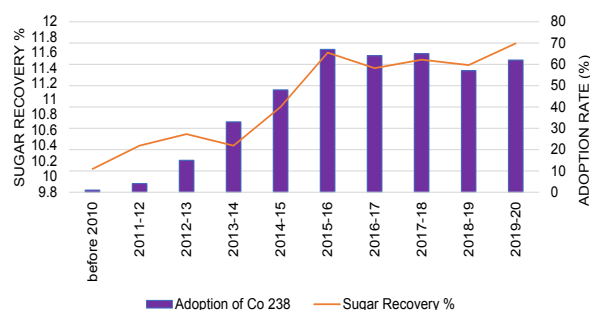


Figure 1. Adoption of variety Co 0238 and sugar recovery in Saraswati sugar mill - Yamuna Nagar, Haryana

sugar recovery was about 10 % during initial stage of adoption of the variety Co 0238.

The adoption of the variety has reached maximum area of 67 % of the total cane area in the sugar mill during 2015-16. Correspondingly, the sugar mill has attained highest ever sugar recovery of 11.7 % since the sugar mill was established. The variety has significantly improved more than 17 % sugar recovery in the sugar mill. It has immensely benefitted the sugar mill by additional sugar production since adoption of the variety. The optimum level of adoption of Co 0238 could be helpful to attain high % sugar recovery in the coming years which will be helpful to maximise the profitability of the farmers and sugar mill.

Table.2. Variety wise sugarcane area in Panipat sugar mill (acre)

No	Variety	2013-14	2015-16	2016-17	2017-18	2018-19
1	Co 0238	84	206	1295	4464	7649
2	Co 0239	17	297	71	31	10
3	Co 0118	4	111	182	87	39
4	Co 89003	8589	10391	12306	12360	7579
5	CoH 160	0	193	1039	2419	2368
6	CoS 8436	5317	1980	1105	354	87
7	CoH119 (mid)	3317	1420	1832	1687	868
8	CoS 767 (late)	2125	1276	206	141	57
Total		19676	16026	18132	21630	18702

Panipat sugar mills

The cooperative sugar mill, Panipat in Haryana was established in the year 1956. The plant has a capacity of 1800 TCD (Tonnes of Crushing per Day). The capacity of rectified spirit (RS) is 30 KLPD and capacity of ethanol is 45 KLPD. (Kilo limte per day) It is one of the oldest cooperative sugar mills established in the state. The farmers in the sugar mill zone are cultivating basket of cane varieties which was developed by various research institutes. Among the varieties Co 89003 (early), CoS 8436, CoH 119 (mid) and CoS 767 (late) were the prominent varieties cultivated more than 98 % of the total cane area in (Table. 2).

Variety Co 0238 which was cultivated about 84 acres in 2013-14 had spread fast and reached about 7,649 acres in 2018-19. The adoption rate is shown in Fig.2. During 2013-14, variety Co 0238 was adopted in just about 0.4 % and consequently it was adopted about 40 % in 2018-19. The sugar recovery improvement was phenomenal in the sugar mill due to adoption of the variety Co 238 as shown in Fig.3.

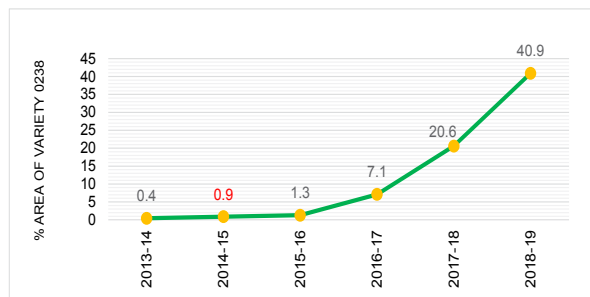


Figure 2. Adoption of the variety Co 0238 in the Panipat sugar mill – Panipat

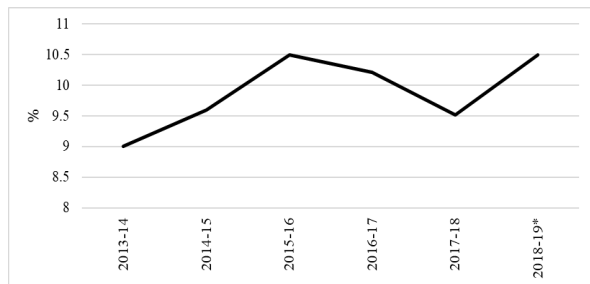


Figure 3. Adoption of variety Co 0238 and sugar recovery in the Panipat sugar mill- Panipat

The sugar recovery had jumped to 10.6 % with adoption of the variety about 40 % area in the sugar mill zone during 2018-19. The sugar mill had earned additional profit of Rs 17.3 crores during 2018-19 in comparison with 2013-14. The additional profit was primarily due to better sugar recovery by variety Co 0238. The higher adoption of Co 0238 in the sugar mill would be helpful to attain more sugar recovery which is helpful to realise the optimum profits to the sugar mill and sugarcane growers.

Rohtak Sugar Mills

The Haryana Cooperative Sugar Mills Ltd., Rohtak was established in 1956 with installed capacity of 1750 TCD. The plant was upgraded to a capacity of 3500 TCD in the year 2009. The Rohtak sugar mill also has co-generation power plant of 16 megawatt (M). The mill promote cultivating mid late and late varieties in about 83 % in Rothak district, when Co 0238 was introduced. The adoption of this variety had reached more than 75 % during 2018-19 from just 2.2 % in 2013-14 as shown in Table 3.

Table. 3 has illustrated the yield and sugar recovery recorded in the Rohtak sugar mill. The sugar recovery was recorded of 8.70 % during 2012-13 and improved significantly in correlation with adoption of the variety. The variety has improved more than 1 % and 1.8 % sugar recovery with the adoption rate of about 45 % and 75 % respectively in the sugar mill. This variety had it immensely benefitted the sugar mills to produce more sugar per unit of sugarcane.

Palwal Coop. Sugar Mill, Palwal

The Palwal cooperative sugar mill society was commissioned in 1984-85 in order to boost up the cooperative movement in India. This is a primary type of society directly linked with common people/farmer of the area.

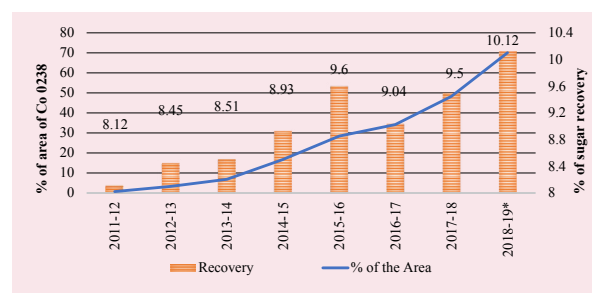
Though the sugar mill was performing well during nineties and early twenty first century, the sugar

Table 3. Total cane area, percentage of Co 0238 and sugar recovery-Rohtak Coop sugar mill, Rohtak

Season	Area (acre)	% of Co 0238	Recovery (%)	Yield (t/ha)
2012-13	16,277	0.9	8.70	38.0
2013-14	12,382	2.2	8.39	54.1
2014-15	13,654	9.2	8.50	51.4
2015-16	15,660	20.5	9.15	49.6
2016-17	17,194	45.9	9.27	49.4
2017-18	17,579	63.8	9.75	43.2
2018-19	13,077	75.3	10.50	55.6

recovery had deteriorated with cultivation of the old varieties. The sugar recovery had touched its lowest of 8.12 % during 2011-12. The sugar mill realised the poor sugar recovery trend and has introduced high yielding and high sugar recovery variety of Co 0238 in the mill zone. The variety was tested in the own mill farm and found much superior than existing varieties in the mill zone. It was introduced in 2011-12, soon, it was adopted about 50 % area in 2015-16, Consequently, the adoption of the variety had touched about 70 % at 2018-19 (Fig.4).

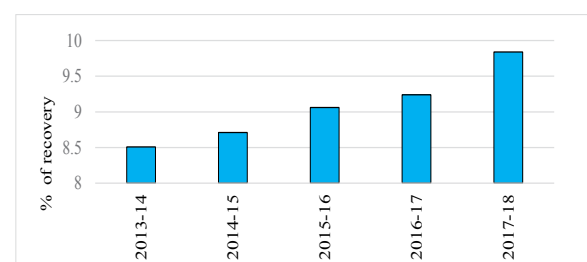
The performance of sugar mill has improved in terms of sugar recovery vis-a-vis with adoption of the variety Co 0238. The sugar recovery has reached to 9.04 % during 2015-16 and has attained 10.12 % during 2018-19 which was about 12 % sugar recovery improvement in the span of six years in comparison with just before introduction

**Figure 4.** Adoption of Co 0238 and sugar recovery in Palwal co-op sugar mill

of the variety Co 0238 in the Palwal sugar mill (Fig. 4). The sugar mill has earned additional profit of Rs 22.3 crores during 2018-19 in comparison with 2011-12. The additional profit earned by the sugar mill can be mainly attributed to better sugar recovery by the variety Co 0238.

Meham sugar mill- Rohtak

The cooperative sugar mill, Meham was established in the year 1991 in the Rohtak district of Haryana. The plant has capacity of 2500 TCD. The sugar mill is cultivating a number of varieties comprising early, mid and late maturing varieties, However, mid and late varieties was cultivated predominantly before introduction of the early maturing variety Co 0238. The variety was introduced during 2013-14 in the sugar mill zone and corresponding sugar recovery was recorded 8.5 % (Fig.5).

**Figure 5.** Sugar recovery improvement at Meham sugar mills, Rohtak Dist

After introduction of the variety, the sugar recovery has improved aligning with adoption rate of the variety. The sugar recovery of about 9.85 % in 2017-18 is due to adoption of the variety Co 0238. The additional sugar production was about 5714 tonnes due to improved sugar recovery. The sugar mill has earned an additional profit of Rs 19.99 crores during 2017-18 in comparison with 2013-14. The variety has immensely benefitted the sugar mill in terms of recovery and farmers are being benefited with early harvesting and incentive price offered by the State government through State advised price (SAP).

Karnal Co-op sugar mill, Karnal

The Karnal cooperative sugar mill is located in Karnal, was established in the year 1977. The plant has a capacity of 2200 TCD. The sugar mill serves the cane farmers of Karnal and neighbouring districts.

Sugarcane is one of the major crops in the district being cultivated in about 16,000 acres on yearly basis. The mill is promoting cultivation of varieties such as Co 89003, C₀J 64, C‘O’J 85, C₀S 96268, C₀ 0238 and C‘O’ 0118 in the early maturing category and C₀S 8436, C₀H 119 in the mid late and C₀P 84212 in late category during 2011-12. However, the yield and sugar recovery were low and cane area had decreased in the district. In this juncture, ICAR- SBI, RC, Karnal has released variety Co 0238 which was well adopted in the

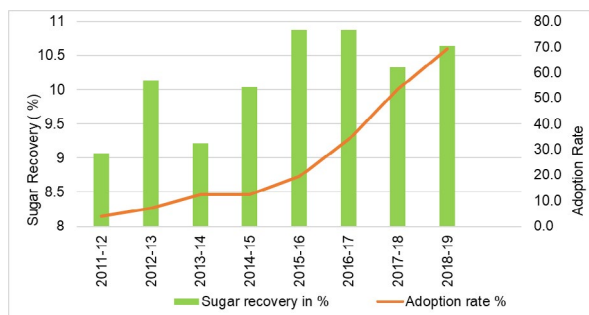


Figure 6. Adoption of Variety Co 0238 and sugar recovery improvement in Karnal Coop. sugar mill

sugar mill in the span of 10 years. The variety was cultivated in about 3.9 % area during 2011-12 and has been adopted in about 74 % during 2019-2020. (Fig.6).

The high yielding, high sugar recovery with early maturity had high acceptance among all category’s farmers including *Gur* and *khandsari* making units. The sugar recovery was about 9.07 % in 2011-12 and has touched 10.87 % during 2016-17 and Karnal sugar mill had won awards for high sugar recovery.

State level sugar recovery

The sugar recovery at micro level (sugar mill as a unit) and state level data (macro level) were collected to study the varietal impact on sugar recovery zone wise as well as aggregate level. The sugar recovery at state level since 2010 is depicted in the fig.7. to study the impact of the variety pre- and post-adoption level.

The figure has shown that the sugar recovery was about 9.4 % before adoption of the variety. After introduction of the variety, the sugar recovery has shown increasing trend and recovery has crossed the 10 % level when the adoption of the variety was about 50 % in the state. The sugar recovery has reached 10.56 % during 2015-16 and recovery is marginally reduced due to agro climatic conditions such as excess rainfall, introduction of low sugar recovery varieties and salinity. But

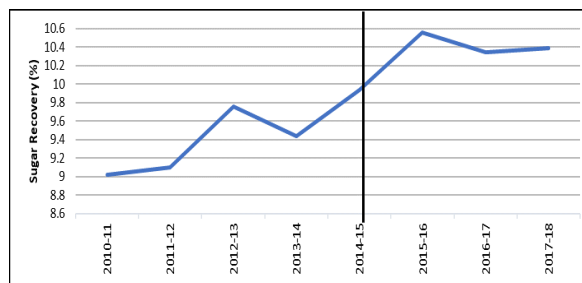


Figure 7. Adoption of Co 0238 and average sugar recovery percentage in Haryana

it was a short-term phenomenon and recovery has shown improvement in 2017-18.

The correlation analysis was done by using adoption percentage of variety Co 0238 and sugar recovery in the State. The correlation coefficient between the parameters is depicted in Table. 4.

Table. 4. Correlation analysis of adoption and sugar recovery improvement

Parameters	Adoption of Co 0238	Sugar Recovery (%)
Adoption of Co 0238	1	
Sugar Recovery %	0.8938361	1

The correlation coefficient has revealed that, adoption of the variety is mainly responsible for high sugar recovery in the state. The value of the coefficient (0.89) indicates that there is a high correlation between adoption of variety Co 0238 and sugar recovery improvement in various sugar mills as well as overall sugar recovery improvement was rewarded in the state.

Impact on sugar mills, farm productivity and income

Variety Co 0238 has benefitted the sugar mills in term additional sugar recovery in comparison with existing and old varieties cultivated in the respective sugar mills and state. The additional benefits by cultivating the variety Co 0238 are summarised and impact are given in the Table.5.

Table.5. Additional benefit to farmers and sugar mills (2014-15 to 2018-19)

S. No	Particulars	Values
1	Additional cane produced (lakh tonnes)	26.30
2	Additional benefit to farmers (in crores)	891

3	Additional sugar produced (lakh tonnes)	3.13
4	Value of additional sugar (in crores)	939

It has shown that about 26.3 lakh tonnes additional sugarcane produced which value about Rs. 891 Crores. It is an additional income earned by the sugarcane farmers in the span of five years in the State. Similarly, 3.13 lakh tonnes additional sugar was produced which has benefitted the sugar mills to earn additional profit of Rs. 939 Crores during 2014-15 to 2018-19. It has revealed that the variety has benefitted the farmers and sugar mills through additional yield and sugar recovery.

Conclusion

The variety Co 0238 has significantly improved sugar recovery with high level adoption in the study area as well as in the state of Haryana. The results show that the early varieties should be preferentially planted over the mid-late and late varieties for increasing sugar recovery in subtropical India. (Sugarcane as a raw material account for about 65-70% of the total cost of sugar production.) The results conclude that adoption of a variety Co 0238 an early maturing variety against mid-late and late maturing varieties was good for most of the sugar mills in the region to safeguard the interest of both millers and cane growers. However, the adoption of the variety may be precisely fixed keeping in view the behaviour of variety in the particular area, tolerance to diseases and pests and other local conditions to maximise the yield as well as sugar recovery and optimize the profits of the sugarcane growers and millers in the state of Haryana.

Acknowledgement

The researchers gratefully acknowledge the cooperation of the management and cane development personnel for their support during

the study. cave decades and express our gratitude to the Director, ICAR-Sugarcane Breeding Institute, Coimbatore for providing the necessary support to carry out the research work.

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