

Sustainability of sugarcane production evaluated based on N₂ fixation and organic matter cycle

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Objectives

In Northeast Thailand, infertile sandy soil with limited ability to supply and retain nutrients is distributed over large areas. Crops with the ability to fix atmospheric nitrogen endophytically could contribute toward the establishment of sustainable agriculture in these areas, and taking this into consideration, analyses on N₂ fixation in sugarcane and the organic matter cycle of sugarcane production were conducted to evaluate their sustainability.

Results

Possible N input by N₂ fixation in sugarcane planted in the research fields was estimated by the natural ¹⁵N abundance ($\delta^{15}\text{N}$) method using cassava as a presumed non-N₂-fixing reference plant. All seven varieties of sugarcane planted in the fields of the research centers showed clearly lower $\delta^{15}\text{N}$ values than those of cassava. Average of N input by N₂ fixation in the seven sugarcane varieties was 29% (Fig. 1).

Possible N input by N₂ fixation in field-grown sugarcane was also estimated by the natural ¹⁵N abundance ($\delta^{15}\text{N}$) method using neighboring weeds growing inside the sugarcane fields as presumed non-N₂-fixing reference plants. Of the total of 54 sugarcane samples, $\delta^{15}\text{N}$ values of 19 samples were markedly lower than those of all neighboring plants. Average contribution of N₂ fixation to total plant N of these 19 sugarcane samples was estimated to be 32% (Table 1).

In order to determine the organic matter cycle of sugarcane production, only the stems were removed from the field and most of the other parts remained as residues. Thus, most of the nutrients contained in the residues were returned to the field. In the process of sugar refining at sugar mills, bagasse, filter cake and molasses are discharged as by-products. The main element of the sugar, bagasse and molasses taken out of this organic matter cycle is carbon, on the other hand, filter cake contains large amounts of nutrients. In order to maintain a sustainable cycle of nutrients, the leaves of sugarcane should not be burned during harvesting and filter cake should be properly returned to the field (Fig. 2).

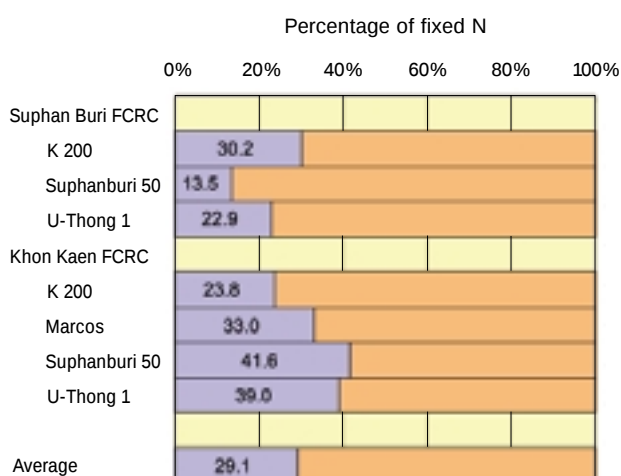


Fig. 1. Estimation of N_2 fixation in different varieties of sugarcane planted in research fields based on the natural ^{15}N abundance method.

Table 1. Estimation of N_2 fixation in field-grown sugarcane in Thailand.

Regions	No. of samples	No. of positive samples ^a	%Ndfa ^b of positive
Northeast	21	7	28
Central	33	11	35
Total	54	19	32

^aNumber of samples with $\delta^{15}N$ values lower than those of all neighboring plants.

^bEstimated % nitrogen derived from N_2 fixation.

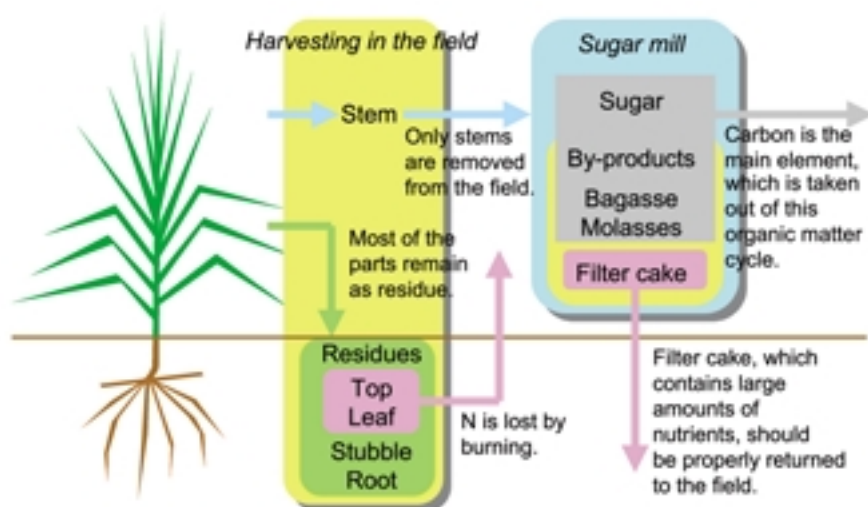


Fig. 2. Organic matter cycle of sugarcane production.

Reference

S. Ando, S. Meunchang, S. Thippayarugs, P. Prasertsak, N. Matsumoto and T. Yoneyama (2002) : Sustainability of sugarcane production evaluated based on organic matter cycle and nitrogen fixation. Proceedings of the 17th World Congress of Soil Science, Paper No. 1948, 1-8.

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