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Multi-objective optimization for integrated sugarcane cultivation and harvesting planning.
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Summary: Sugarcane and its by-products make a relevant contribution to the world economy. In particular, the sugar-energy industry is affected by the timing of sugarcane cultivation and harvesting from which sucrose and bio-energy are produced. We address this issue by proposing a mixed-integer non-linear programming model to schedule planting and harvesting operations for different varieties of sugarcane. The decisions to be made include the choice of sugarcane varieties to be grown on a given set of plots, the periods for their cultivation, the subsequent harvesting periods, and the type of harvesting equipment. These decisions are subject to various constraints related to matching cultivation periods with harvesting periods according to the maturity cycles of the selected sugarcane varieties, the availability of harvesting machinery, the demand for sucrose and fiber, and further technical requirements. The tactical cultivation and harvesting plans to be determined account for three conflicting objectives, namely maximization of the total sucrose and fiber production, minimization of the total time devoted to harvesting, and minimization of the total cost of transporting the harvesting equipment. We develop a tailored exact method based on the augmented Chebyshev scalarization technique extended with a mechanism for identifying an initial feasible integer solution that greatly helps reduce the computational effort for obtaining Pareto-optimal solutions. Our computational study with instances that reflect the current cultivation and harvesting practices in Brazil demonstrate the effectiveness of the proposed methodology. In addition, a comparative analysis reveals the trade-offs achieved by alternative planting and harvesting schedules, thereby facilitating the decision-making process.

MSC:
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Keywords:
OR in agriculture; integrated cultivation and harvesting planning; multi-objective optimization; integer non-linear programming; sugar-energy industry

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JuMP

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References:
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