Hybrid Differential Evolution and Particle Swarm Optimization Algorithm for the Sugarcane Cultivation Scheduling Problem

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ABSTRACT

This paper focuses on optimizing scheduling solutions for the flexible flow shop problem, with tooling constraints and machine eligibility, to minimize makespan for cultivating sugarcane. Normally, preparing the soil for planting sugarcane requires six steps: 1) 7 power harrow and rototiller, 2) rotary mini combine, 3) 22/24 disc harrow, 4) rotary mini combine, 5) sugarcane plantation, and 6) sugarcane sprayer. Each of these steps requires a variety of tools. With limited availability of tools and equipment, resource allocation is important. The objective of this research was to minimize the makespan. For optimal convergence, meta-heuristics, such as a Differential Evolution algorithm, a Particle Swarm optimization algorithm, and a Hybrid DEPSO algorithm were developed to solve the problem. Experimental results showed that all three methods efficiently solved flexible flow shop problems.

Keywords: Scheduling, Tool limitations, Tooling constraints, Tool change, Differential evolution, Particle swarm optimization, Sugarcane

INTRODUCTION

Sugarcane is an important crop in Thailand, the second largest sugar exporter in the world (Office of the Cane and Sugar Board, 2016). Increasing demand for cultivating sugarcane in Thailand has outstripped resources, especially for small farmers who do not own their own agricultural machinery. Preparing the fields for planting requires hiring large and expensive operators (Prasara and Gheewala, 2016). Thus, better allocation of resources is important to reduce the cost of producing sugarcane (Sugar Research Australia, 2017).

Preparing the soil for sugarcane production involves six steps, denoted here by the principal tool required: 1) 7 power harrow and rototiller, 2) rotary mini combine, 3) 22/24 disc harrow, 4) rotary mini combine, 5) sugarcane plantation, and 6) sugarcane sprayer. Steps 1, 4, 5, and 6 require small tractors and Steps 2 and 3 require medium- to large-sized tractors (see Figure 1). This study attempts to find solutions to the scheduling challenges inherent in