PhD Thesis (Title and Abstract)

Modelling and Analysis of Efficient Transportation in Food Grain Supply Chain

Abstract

Food grain transportation is a significant component of post-harvest operations in developing countries (Zorya et al. 2011). In Indian context, food grain losses have been attributed to improper utilization of government infrastructure and resources, uncertainty associated with food grain supply, and untimely planning of rake allocation and scheduling. The efficient design of transportation network plays a major role in alleviating wastages and posits new avenues to focus on environmental sustainability. Therefore, this thesis attempts to develop and solve efficient food grain transportation models of single objective as well as multi objective nature. A two stage deterministic model is proposed in the first objective to facilitate efficient intra-state food grain movement by considering vehicle capacity constraints and k-parameter based constraint handling. The subsequent models are designed to facilitate inter-state food grain movement on a hub and spoke network while considering disruption, environmental and social concerns. The fourth objective attempts to quantify wastages at intermodal hubs and conducts multi-objective minimization of total supply network cost and GHG emissions. The mixed integer linear single objective problem is solved using CPLEX, whereas mixed integer non-linear problems are solved using self-tailored variants of Particle swarm optimization (PSO), such as Particle swarm optimization-composite particle (PSOCP), Self-Learning Particle Swarm Optimization (SLPSO), Particle Swarm Optimization with Differential Evolution (PSODE), Multi-Objective Particle Swarm Optimization with Differential Evolution (MOPSODE) algorithms.

The mathematical models hence elicited are validated on different size and configuration of problem instances. The outcomes of this research indicate that self-tailored particle swarm optimization algorithms were able to solve the proposed models within polynomial execution times. For the intra-state problem, results reveal that the overall vehicle utilization factor and minimum rake loading requirements are positively correlated. For the inter-state case, the results capture the increasing level of disruption on different cost components with specific factor level recommendations made to achieve individual and total costs. For the case of uncertain supply, it

was found that the percentage increase in transportation, hub location, environmental and total shipment cost was 30%, 0%, 40% and 50% respectively as compared to the deterministic case. The outcome of the final objective indicates that reducing the wastage threshold up to 50% causes reduction in supply network cost at the cost of increasing levels of GHG emissions. Further increasing the wastage threshold was found to cause damage to both supply network cost and GHG emissions levels.