Abstract

The Indian government runs the most extensive food program in the world to ensure food security for its people by distributing highly subsidized food grains. This thesis focuses on important issues prevalent in the food grains supply chain such as, highly skewed procurement pattern, inefficient management of the peak stock, ensuring uninterrupted food grains supply in the deficit states, and an increasing operational cost. Due to the skewed nature of public procurement, the farmers of only a few Indian states get the benefit of the price support program. Inefficient management of the peak stock coupled with limited storage facilities lead to a significant amount of loss and quality deterioration of the food grains. Though the use of ICT has improved the public distribution system but an uninterrupted supply of food grains needs to be ensured at the deficit states. Moreover, the ever increasing food subsidy remains a concern, which has gone up by almost fifty times from 1991-92 to 2017-18.

The thesis presents a state of the art of the Indian food program by focusing on critical areas of the food grains supply chain namely, procurement, storage, transportation, and distribution. Thereafter, a multi-objective model is developed for obtaining a trade-off between the balanced price support across Indian states and operational cost reduction capturing the unique aspects of the Indian food program. A recently developed Grasshopper Optimization Algorithm is used to solve the MINLP model and is compared with NSGA-II. Increasing private procurement and moving towards self-sufficiency across the states are found to be the most impactful scenarios. For uninterrupted distribution, especially in the deficit state, a model is developed for the maximization of overall distribution by introducing a small equity deviation in the presence of capacity constraint. The effect of the lower equity deviation and the upper equity deviation is analyzed. Further, overall distribution effectiveness is maximized by augmenting capacity under a budget constraint based on a non-uniform unit cost of capacity addition.

To manage the peak stock of food grains, a simulation model is developed and the applicable strategies of peak management are evaluated. The controlling factors are optimized and are used for estimation of peak reduction along with likely financial savings. Practical implications and possible ways of strategy implementation are discussed. A game-theoretical model is developed considering the central agency, a surplus state, and a deficit state to address the increasing procurement incidentals due to high statutory charges in surplus states and its impact on the operation. It is found that an incentive to the deficit state by the central agency would reduce the relevant operational cost and

also lead to more balanced procurement between the states. Procurement in the deficit state remains important for the central agency for operational cost reduction.

Keywords: Indian food program, supply chain efficiency improvement, price support, operational cost reduction, equitable distribution, peak management, differential taxation