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ORIGINAL ARTICLE

Fuzzy Multi-fractional Programming for Land Use Planning in Agricultural Production System

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Abstract In this paper, we present a multi-objective linear fractional programming (MOLFP) approach for multi-objective linear fuzzy goal programming (MOLFGP) problem. Here, we consider a problem in which a set of pair of goals are optimized in ratio rather than optimizing them individually. In particular, we consider the optimization of profit to cash expenditure and crop production in various seasons to land utilization as a fractional objectives and used remaining goals in its original form. Further, the goals set in agricultural production planning are conflicting in nature; thus we use the concept of conflict and nonconflict between goals for computation of appropriate aspiration level. The method is illustrated on a problem of agricultural production system for comparison with Biswas and Pal [1] method to show its suitability.

Keywords MOLFP · MOLFGP · Linear programming (LP) · Conflict and nonconflict in goals · Land-use planning

1. Introduction

Fractional programming with optimization a function is defined as ratio of two functions. In modeling of many physical and/or economical systems, one is encountered

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the problem of optimizing efficiency of system such as cost/volume, profit/manufacturing cost etc. In such multi-objective optimization problems, we often find situations where goals are conflicting and non-commensurable.

Thus optimal solution to one objective function is not necessarily optimal for other functions and hence one need a solution as the best compromise solution. Mathematical programming with linear fractional objective function was first studied by Charnes and Cooper [2] and was further enriched by Craven [3] and Schiable [4, 5]. Goal programming with linear fractional criteria and multi-objective linear fractional programming was studied by Kornbluth and Steuer [6, 7]. In management science, the need of methods for multi-objective programming in planning was systematically described by Cohon [8]. As Zimmermann [9] studied the fuzzy programming and linear programming with several objective functions, Luhandjula [10] developed a fuzzy approach for MOLFP.

Further, Nykowski and Zolkiewski [11] presented a compromise procedure for MOLFP problems. If interested, various methods used in the solution of fractional programming problems can be viewed in Craven [3] and the methods for fuzzy multiple objective decision making can be obtained in Lai and Hwang [12].

Dutta et al. [13] gave a fuzzy set theoretic approach for MOLFP, where as Lara and Minasian [14] used fractional programming as a tool for the assessment of sustainability. Ohta [15] considered the fuzzy solution to multi-objective programming problem by goal programming approach. Mohanty and Vijayaraghawan [16] used the concept of conflict and non-conflict between goals given by Cohon [8] to compute appropriate aspiration level. Chakraborty and Gupta [17] studied fuzzy mathematical programming for MOLFP and Minasian and Pop [18] gave a fuzzy set approach to solve an MOLFP problem. Pal et al. [19] studied a goal programming procedure for fuzzy multi-objective linear fractional programming (FMOLFP) problem.

Further, Toksari [20] gave a Taylor series approach for multi-objective fractional programming problem and a goal programming approach for such problem has been given by Chang [21]. Recently, Stanojevic and Minasian [22] studied a problem of fully fuzzified linear fractional programming and Mehrjerdi [23] also gave a procedure for solving fractional programming problem through fuzzy goal setting and approximation.

But in most of studies of fuzzy goal programming approach, the application area are mathematical or financial or industrial problems, However. Biswas and Pal [1] used fuzzy goal programming approach to land use planning in agricultural system. Recently, Zeng et al. [24] considered an application of fuzzy multi-objective linear programming to crop area planning. The motivation of the present study is to show the suitability of fuzzy goal programming approach to multi-objective fractional programming problem in a real life situation of agricultural production system in which the goals are conflicting in nature and the information available are generally imprecise and vague mainly due to field data. Such problems of agricultural production fall in the category of multi-objective fractional programming problems, where objectives are in fraction forms. For example, maximization of overall profit (profit/ expenditure), maximization of productivity (production/ area), minimization of cost of cultivation etc. The present work is organized in the following sections. Sec-