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ORIGINAL ARTICLE

## Agricultural Optimal Cropping Pattern Determination Based on Fuzzy System

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**Abstract** Fuzzy Systems provide a framework for integrating database management systems and fuzzy logic in order to improve the decision-making process. In this study, fuzzy system was used for achieving the best cropping pattern in Agriculture. It is crucial to Integrate ecological principles with economic principles to determine optimum models. Four main objectives defined: maximization of net income of farmers, minimizing the amount of water used in agriculture, minimizing the use of chemical fertilizers and chemical pesticides. Different scenarios were defined: single-objective scenarios, double-objective scenarios, triple-objective scenarios and quadruple-objective scenarios. Finally, four proposed cropping patterns in agricultural and horticultural sectors are evaluated. The results clearly demonstrated that the current cropping pattern needed to be changed, the proposed cropping patterns has put ecological and economic principles both in a maximum optimized level together which is due to the use of the fuzzy system.

**Keywords** Fuzzy system · Ecologic and economic principles · Optimal cropping pattern

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## 1. Introduction

The 21st century faces multiple challenges like climate change, population growth, food shortage, poverty, hunger, accelerated land cover change and environmental degradation [16, 1, 5]. The World is now filled with more than 7 billion people and the count is increasing at an alarming rate of 1.2 percent per annum and by 2050, the world population is projected to reach 9.6 billion [15]. Due to the inadequate food supply, about 1 billion people stay hungry every day in the world and the figure will increase to 2 billion by 2050. This scenario enforces the increasing momentum in agricultural production with more than 70 percent increase for the developing countries of Asia and Africa in coming decades [2]. In this regard, better management practices are essential to enhance productivity.

Cropping pattern is one of the crucial causes that reduces the quantity and degrades the quality of the agricultural products. Hence some high-tech and practical technology, such as fuzzy logic, for achieving to an optimal cropping pattern is needed. Determination of suitability areas for some crops in Mashhad plain with used of both geographical information system and remote sensing technique was done [11]. Fuzzy set theory is an extension of the conventional set theory that deals with the concept of partial truth [18]. Fuzzy logic aims to model the vagueness and ambiguity in complex systems [19]. Fuzzy set theory and fuzzy logic provide powerful tools to represent and process human knowledge in the form of fuzzy IF-THEN rules. Fuzzy logic has emerged as an important branch of the Expert system which has proved to provide a solution to real life problems that had remained unsolvable otherwise. It has found a wide range of applications in diversified areas [13]. Over the past few decades, fuzzy logic has been used in a wide range of problem domains. The areas of applications are very wide: process control, management and decision making, operations research, economics and pattern recognition and classification [7]. Fuzzy systems are similar to expert systems in their use of linguistic relationships, they can be applied to decision support systems [14]. In the lack of precise mathematical model which will describe the behavior of the system, Fuzzy Logic is a good weapon to solve the problem: it allows using logic if-then rules to describe the systems behavior. [3] Demonstrate a Fuzzy Decision Support System to improve the irrigation, given the information on the crop and site characteristics. [9] Demonstrated that Fuzzy sets and spatial suitability analysis can be used effectively to enhance decision making in agricultural planning and management. The best technique is used for the final prediction, and the predicted soil moisture content is utilized for generating appropriate notifications using fuzzy logic based weather model [10]. Soil and fertility management by fuzzy logic are the main issues concerning sustainability in viticulture [6]. Mashhad plain is considered as one of the best plains in Khorasan Razavi province because it includes a wide variety of agricultural duties and high volume of agricultural productions; moreover, it is an important center for processing agricultural products. Recently, according to the decrease of annual precipitation especially rainfall, increase of agricultural activities and land consumption trend in the plain.

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