THE IMPROVEMENT OF STRATEGIC CROPS PRODUCTION VIA A GOAL PROGRAMMING MODEL WITH NOVEL MULTI-INTERVAL WEIGHTS

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Abstrak

Pada masa kini, keperluan untuk meningkatkan pengeluaran pertanian telah menjadi satu tugas yang mencabar bagi kebanyakan negara. Secara umumnya, terdapat banyak faktor-faktor sumber yang mempengaruhi kemerosotan tahap pengeluaran seperti paras air yang rendah, penggurunan, kemasinan tanah, kekurangan modal, kekurangan peralatan, impak eksport dan import tanaman, kekurangan baja, racun perosak dan peranan perkhidmatan pengembangan pertanian yang tidak berkesan dalam sektor ini. Objektif utama kajian ini adalah untuk membangunkan model matematik pengaturcaraan gol kabur (FGP) untuk memaksimumkan pengeluaran tanaman pertanian yang membawa kepada peningkatan manfaat pertanian (lebih tan hasil setiap ekar) berdasarkan peminimuman sumber utama untuk menentukan pemberat dalam fungsi objektif (air, baja dan racun perosak) tertakluk kepada kekangan yang berbeza (kawasan tanah, pengairan, buruh, baja, racun perosak, peralatan dan benih). GP dan FGP telah digunakan untuk menyelesaikan pembuatan keputusan pelbagai objektif (MODM). Daripada keputusan, kajian ini telah berjaya memperkenalkan kaedah alternatif baru yang menggunakan pemberat pelbagai selang dalam menyelesaikan masalah model multi-objektif FGP dan GP secara kabur, dalam persekitaran membuat keputusan yang tidak menentu bagi sektor pertanian. Di samping itu, analisis data (APD) telah digunakan untuk menilai kecekapan teknikal, alam sekitar dan ekonomi untuk zon pertanian dalam pengeluaran tanaman strategik bagi tahun yang berbeza. Kepentingan kajian ini terletak pada hakikat bahawa sebahagian daripada zon pertanian mempunyai had-had sumber manakala yang lain memberi kesan buruk kepada alam sekitar mereka disebabkan salah guna sumber. Akhir sekali, model ini digunakan untuk menentukan kecekapan setiap zon pertanian berbanding yang lain dari segi penggunaan sumber.

Kata kunci: Pemaksimuman Pengeluaran Pertanian, Pengaturcaraan gol kabur, Pengatuarcaraan gol, Pemberat multi-selang, Analisis Penyampulan Data

Abstract

Nowadays, the need to increase agricultural production has becomes a challenging task for most of the countries. Generally, there are many resource factors which affect the deterioration of production level, such as low water level, desertification, soil salinity, low on capital, lack of equipment, impact of export and import of crops, lack of fertilizers, pesticide, and the ineffective role of agricultural extension services which are significant in this sector. The main objective of this research is to develop fuzzy goal programming (FGP) model to improve agricultural crop production, leading to increased agricultural benefits (more tons of produce per acre) based on the minimization of the main resources (water, fertilizer and pesticide) to determine the weight in the objectives function subject to different constraints (land area, irrigation, labour, fertilizer, pesticide, equipment and seed). FGP and GP were utilized to solve multi-objective decision making problems (MODM). From the results, this research has successfully presented a new alternative method which introduced multi-interval weights in solving a multi-objective FGP and GP model problem in a fuzzy manner, in the current uncertain decision making environment for the agricultural sector. The significance of this research lies in the fact that some of the farming zones have resource limitations while others adversely impact their environment due to misuse of resources. Finally, the model was used to determine the efficiency of each farming zone over the others in terms of resource utilization.

Keywords: Agricultural Production Maximization, Fuzzy Goal Programming, Goal Programming, Multi-interval Weights.

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Table of Contents

List of Tables

List of Figures

GLOSSARY OF TERMS

AHP	Analytic Hierarchy Process
DM	Decision Maker
DV	Decision Variable
FGP	Fuzzy Goal Programming
FLP	Fuzzy Linear Programming
FMOLP	Fuzzy Multi-Objective Linear Programming
GDP	Gross Domestic Product
GP	Goal Programming
IP	Integer Programming
IW	Interval Weight
LGP	Lexicographic Goal Programming
LP	Linear Programming
MADM	Multiple Attribute Decision Making
Max	Maximum
MCDM	Multi-Criteria Decision Making
Min	Minimum
MIP	Mixed Integer Programming
MIW	Multi-Interval Weight
MIWFGP	Multi-Interval Weight Fuzzy Goal Programming
MIWGP	Multi-Interval Weight Goal Programming
MOP	Multi-Objective Programming
NLP	Nonlinear Programming
OR	Operations Research
SIW	Single Interval Weight
SIWFGP	Single Interval Weight Fuzzy Goal Programming
SIWGP	Single Interval Weight Goal Programming
SFA	Stochastic Frontier Analysis

CHAPTER ONE
INTRODUCTION

In the history of mankind, agriculture is considered the pioneering profession. The practice of agriculture in its truest sense entails the domestication of both plants and animals, which can be traced back to at least 10,000 years ago. But, people started altering plant and animal communities to benefit from them through farming since the beginning of time (Zeder, 2011). As a human practice, agriculture aims to provide the humankind with the necessary food and sustenance to overcome the life's challenges. As such, a country that attempts to eliminate poverty will raise the productivity of the agricultural sector.

1.1 Agricultural Environment

Agricultural activities are normally associated with improved productivity due to changes in the agricultural process, such as the shift from the traditional human labour usage to advanced synthetic fertilizers and pesticides, selective breeding, and the mechanization of tools during the past century. However, agriculture has recently been related to many issues like water, land, bio-fuels, genetically modified organisms, farm subsidies, human resources, capital, tariffs, and import/export (Chirwa, Kumwenda, Jumbe, Chilonda, & Minde, 2008; World Bank, 2012). To solve these issues, multiple criteria have been considered (e.g., Hayashi, 2002) in studies on mechanized agricultural activities, support for the organic movement, and sustainable agricultural development (Bellon, Cabaret, Debaeke, Ollivier, & Penvern, 2014; Kassam, Friedrich, Reeves, & Pretty, 2011; Reynolds, Hobbs, & Braun, 2007). Agricultural production is an important issue as the farming

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