

Production Planning Through A Goal Programming Approach

Suma T¹, Praveena Kumara KM²

¹Department of Mathematics, New Horizon College of Engineering, Bengaluru, Karnataka, India.

²School of Applied Sciences, REVA University, Bengaluru, Karnataka, India.

Corresponding Author: - praveenmsk82@gmail.com

DOI: 10.47750/pnr.2022.13.S08.53

Abstract

Karnataka occupies the third position in the natural rubber production in the country. Karnataka is considered to be a non-traditional region for growing rubber, but it is being successfully grown in the state. This study presented Goal Programming approach for maximize rubber production and planted areas of rubber and statistical planning for the cultivation of rubber plants using Goal Programming approach.

Keywords: Goal Programming, Strategic planning, Agriculture, Optimal Solution, Rubber production.

INTRODUCTION

The rubber in India was first brought by Britishers in the early 1873 and the first commercial plantation was established at Thattekadu, Kerala in 1902. Now, Kerala is the no one state in India for rubber production and later expanded to neighboring states such as Tamilnadu, Karnataka, Andra-pradesh, Goa and North eastern states. Rubber is widely used in the manufacture of Tyres, Plastic Industries, Industrial applications etc and hence it has more demand in the market.

Rubber is harvested in the form of latex (Natural Rubber) from trees. Life of economic rubber plants varies from 32-40 years and takes place in two phase such as immature phase and productive phase. The immature phase continues for about 7 years and the productive phase continues for about 25 years.

Over the last few years, continuous remarkable developments were done in improving the algorithm for solving the Goal programming model. New methodologies were evolved in recent years for decision making especially in multi-criteria decision making. Goal programming is one among the MCDM tool in which multiple objectives are considered and the solution thus obtained theoretically satisfies with practical results.

Karnataka occupies the third position in the natural rubber production in the country. Karnataka is considered to be a non-traditional region for growing rubber, but it is being successfully grown in the state. Coorg and Chikmagalur are the main districts where rubber plantation is carried out in the state. Dakshina Kanada and Kodagu also grow rubber on moderate scales.

Bhandary said that nearly 65,000 growers in Karnataka have taken up rubber cultivation on around 55,000 hectares in the State. The rubber is grown in Dakshina Kannada, Shivamogga, Chikmagaluru, Udupi, Uttara Kannada, Coorg, Hassan and Mysuru. Karnataka produces around 60,000 tonnes of natural rubber

Belaid Aouni and Ossama kettani[3], brief that the Goal Programme model has a massive future in adjusting and obtaining results for any stated problems. Charnes and cooper[4] has introduced the linear programming model in 1960 but now the Goal Programming model which is an extension of LP model, is widely used and has become popular in 21st century. Today a network of researchers are using GP model for various applications and fields in order to make the decisions which are complex in real life. YUAN Xiaojun et al. [10], presented Multiple regression and correlation analysis by SAS statistic software were used to examine the nutrient data's of Clone RRIM600 and Clone PR107, and to construct mathematical models including monthly nutrient content, biomass increment, among leaves and the full tree, and analytical fertilization in production. Swathi et al. [7], developed a mathematical model for the cultivation of rubber plants using Goal Programming approach. . Abhik Majumder et al. [1], has given a case study on high bulk rubber estates working on local atmosphere.

Praveena Kumaraet al. [5], have presented Goal programming model based on Analytic Hierarchy Process (AHP) for budget allocation planning in hospital administration. Antje Arhends et al.[2], has investigated the development of rubber from 2005 to 2010 and saw that the rubber plantations are adapted which are economically unsustainable. Veeresh Malagi et al. [9], presented a multiple criteria decision making approach for Creating and Estimating Replacement when the user requirements are expressed in terms of certain operational measures such as time, price, risk, etc. Sean francis kennedy[6], has proposed a thesis on supply and demand on natural rubber production, he presented mainly three object "i) to analyse natural rubber supply chain decision making models, ii) to formulate presentation measurement model by using maintainable balanced scorecard approach, iii) to develop decision support system prototype using systems approach". Tripti Sharma and Nigus Girmay[8], has developed a Linear Programming Model for Teff- plantation in minimizing the utilization of fertilizers.

The first goal is maximize rubber production in each district like Dakshina Kannada, Shivamogga, Chikmagalur, Udupi, Uttara Kannada, Coorg, Hassan, Mysuru respectively by increasing the rubber production up to 10%. The second goal is the maximize rubber planted area in each district. There will be no decrement in each of the planted area. However, because of the difficulty on acquiring data, the scope of this paper is limited to increase the planted area without covering the economic perspective.

| State | Planted Rubber areas (Hectare) | Rubber Production in tones | Production per area (tone/hectare) | Weights | Target Rubber Production (tones) |
|------------------|--------------------------------|----------------------------|------------------------------------|---------|----------------------------------|
| Dakshina Kannada | 6,850 | 7,249 | 1.0582 | 0.14 | 7,973.9 |
| Shivamogga | 8,475 | 9,675 | 1.1415 | 0.12 | 10,642.5 |
| Chikmagalur | 11,780 | 13,150 | 1.1162 | 0.09 | 14,465.0 |
| Udupi | 2,450 | 2,356 | 0.9616 | 0.15 | 2,591.6 |
| Uttara Kannada | 7,450 | 7,593 | 1.0191 | 0.15 | 8,353.3 |
| Coorg | 9,753 | 10,897 | 1.1172 | 0.12 | 11,986.7 |
| Hassan | 4,658 | 4,865 | 1.0444 | 0.14 | 5,351.5 |
| Mysuru | 3,578 | 4,015 | 1.1221 | 0.08 | 4,416.5 |
| | 54,994 | 59,800 | 8.5756 | | 65,781 |

Decision variables denotes to the rubber planted area in hectare. Dakshina Kannada, Shivamogga, Chikmagaluru, Udupi, Uttara Kannada, Coorg, Hassan, Mysuru.

FORMULATION OF A GP MODEL:

Goal programming model formulation can be expressed as

$$\text{Maximize } Z = 0.14 d_1^- + 0.12 d_2^- + 0.09 d_3^- + 0.15 d_4^- + 0.15 d_5^- + 0.12 d_6^- + 0.14 d_7^- + 0.08 d_8^- + d_9^- + d_{10}^- + d_{11}^- + d_{12}^- + d_{13}^- + d_{14}^- + d_{15}^- + d_{16}^- + d_{17}^- + d_{18}^-$$

Subject to constraints (Total Rubber production in tones)

$$1.0582y_1 + 1.1415y_2 + 1.1162y_3 + 0.9616y_4 + 1.0191y_5 + 1.1172y_6 + 1.0444y_7 + 1.1221y_8 + d_{17}^- - d_{17}^+ = 65,781$$

Total planted areas of the rubber plant

$$y_1 + y_2 + y_3 + y_4 + y_5 + y_6 + y_7 + y_8 + d_{18}^- - d_{18}^+ = 55,000.00$$

Production area in each District.

$$\begin{aligned} 1.0582 y_1 + d_1^- - d_1^+ &= 7,973.9 \\ 1.1415 y_2 + d_2^- - d_2^+ &= 10,642.5 \\ 1.1162 y_3 + d_3^- - d_3^+ &= 14,465.0 \\ 0.9616 y_4 + d_4^- - d_4^+ &= 2,591.6 \\ 1.0191 y_5 + d_5^- - d_5^+ &= 8,353.3 \\ 1.1172 y_6 + d_6^- - d_6^+ &= 11,986.7 \\ 1.0444 y_7 + d_7^- - d_7^+ &= 5,351.5 \\ 1.1221 y_8 + d_8^- - d_8^+ &= 4,416.5 \end{aligned}$$

No decremented in each of the planted area

$$\begin{aligned} y_1 + d_9^- - d_9^+ &= 6,850 \\ y_2 + d_{10}^- - d_{10}^+ &= 8,475 \\ y_3 + d_{11}^- - d_{11}^+ &= 11,780 \\ y_4 + d_{12}^- - d_{12}^+ &= 2,450 \\ y_5 + d_{13}^- - d_{13}^+ &= 7,450 \\ y_6 + d_{14}^- - d_{14}^+ &= 9,753 \\ y_8 + d_{15}^- - d_{15}^+ &= 4,658 \\ y_9 + d_{16}^- - d_{16}^+ &= 3,578 \end{aligned}$$

Results and Discussion

The values of the underachievement variables are zero ($d_i^- = 0$) for all $i = 1, 2, 3, \dots, 18$. This implies, that there is no decrement in rubber planted areas. The over-achievement variable values are ($d_i^+ = 0$) for all $i = 1, 2, 3, \dots, 8$. and for $i = 9, 10, \dots, 16$ values are given in the Table-2. Hence this implies that in each state groups increases their planted area by their corresponding d_i^+ yielding values in the 3rd column.

The values of d_{17}^+ and d_{18}^+ are 0.1 and 5,499.4. These suggest that there is a production surplus of 0.1 tone from the aspired value of 65,781 tones and that the total planted area exceeded the target value of 55,000 hectares by 5,499.4 hectares.

Table-2: Deviation from the Goals

| State | Total Rubber Planted areas in 2019 | Suggested rubber planted area | d_i^+ | d_i^- |
|------------------|------------------------------------|-------------------------------|---------|---------|
| Dakshina Kannada | 6,850 | 7,535 | 685.0 | 0 |
| Shivamogga | 8,475 | 9,322.5 | 847.5 | 0 |
| Chikmagalur | 11,780 | 12,958 | 1178.0 | 0 |
| Udupi | 2,450 | 2,695 | 245.0 | 0 |
| Uttara Kannada | 7,450 | 8,196 | 745.0 | 0 |
| Coorg | 9,753 | 10,728.3 | 975.3 | 0 |
| Hassan | 4,658 | 5,123.8 | 465.8 | 0 |
| Mysuru | 3,578 | 3,935.8 | 357.8 | 0 |

CONCLUSION:

Rubber plantation in Western Ghats of Karnataka has a great role to improve the socio-economic conditions of people. This model shows that rubber production can be increased by increasing the area for rubber plantation. However, for future planning of rubber plantations, we can use this model for predicting the costs incurred during pre-mature phase of rubber plantation and also profit gain during post mature phase. Based on real time data, the solution may vary from time to time. The solution can be obtained either by solving hand calculation or by solving through software such as Lingo or LIPS.

References:

1. Abhik Majumder, Sadrita Datta , Bal krishan Choudhary and Koushik Majumdar, "Case study on Rubber plantation", Current World Environment, Vol. 9(3), 768-779, 2014.
2. Antje Ahrends, Peter M. Hollingsworth, Alan D. Ziegler, Jefferson M. Fox, "Current trends of rubber plantation expansion may threaten biodiversity and livelihood", Global Environmental Change Vol.34, 48–58, 2015.
3. Belaid Aouni and Ossama kettani, "Goal programming model-A glorious history and a promising future", European Journal of Operation Research, Vol. 133(2), 225-231, 2001.
4. Charnes, A., W.W. Cooper, "Goal programming and multiple objective", European Journal of Operational Research Vol. 1, 39–54, 1977.
5. Praveena Kumara K M, Harish Babu G A and Uday Kumar K N, "Budget Allocation for Hospital Administration by an AHP through Goal Programming Model", GEDRAG & ORGANISATIE REVIEW, Vol. 33(02), PP. 2389-2398, 2020.
6. Sean Francis Kennedy, "Case study on Natural rubber supply chain", University of California, 2014.
7. Swathi A S, Praveena Kumara K M, Uday Kumar K N, Harish Babu GA, "A Goal Programming Model for Rubber Plantation Planning in Western Ghats of Karnataka", International Journal of Mechanical and Production Engineering Research and Development, Vol. 10(2), PP. 13897-13904, 2020.
8. Tripti Sharma and Nigus Girmay, "Compost Management For Teff Plantation In North Ethiopia-A Goal Programming Approach", Review of Business and Technology Research, Vol. 15(3), 2018.
9. Veeresh Malagi, Praveena Kumara K M, Harish Babu GA, Uday Kumar K N, "Creating and Estimating Replacement in Evaluation Process through Multiple Criteria Decision Making", International Journal of Engineering Research and Technology, Vol. 13(9), PP. 2132-2136, 2020.
10. YUAN Xiaojun, CAO Jianhua, CHEN Junming , "Constructing on Mathematical Model in Nutrient Cycle of Rubber Plantation", Chinese Journal of Tropical Crops, Vol. 38(8), 1418-1422, 2017.

Authors:

Dr. Praveena Kumara KM is working as a Assistant Professor, School of Applied Sciences at REVA University. He holds Ph.D. Degree in Applied Mathematics from REVA University, M.Phil degree (Applied Mathematics) from Madhurai Kamaraja University. M.Sc. degree (Applied Mathematics) from Bangalore University. His area of interest

in research is Operation research (Goal programming Approach). He has 15 years of teaching experience and 3 years of research experience. He has published more than 6 research articles in peer reviewed national and international journals.

Email ID: praveenmsk82@gmail.com

Dr. Suma T is working as a Senior Assistant Professor in the department of Mathematics at New Horizon College of Engineering, Bengaluru. She has completed her Ph.D. Degree in the subject Applied Mathematics from REVA University in the year 2019, M.Phil degree (Applied Mathematics) from Madhurai Kamaraja University, M.Sc. degree (Applied Mathematics) from Bangalore University . Her Research area is Operation research (Subtask scheduling algorithm). She has 15 years of teaching experience and 3 years of research experience. She has published 5 International journal papers in highly reputed journals, filled 1 patent and received ISBN for 4 books.

Email ID: sumatmaths@gmail.com