



Optimization techniques in agriculture sector

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Abstract

In this Paper a farm model is developed by using linear programming in order to determine the feasible optimal crop combination and how these crops will be allocated to increase the production. Appropriate utilization of land resources plays very important role in optimum agriculture Production. The Farmer has to take a decision what to grow, what crop combination should be used in different season. So to deal with these problem LPP model is used for the optimum allocation of limited resources. The objective of the study is to maximize farm returns by allocating the resources optimally. Only the crops grown in Rabi season are taken.

Keywords: Farm planning, mix Crop, linear programming

1. Introduction

Agriculture is the backbone of the Indian Economy and is the major contributor in Indian Economy. The Agricultural problems related to planning are very important from both social and economic perspective. Agriculture contributes to nearly 25% of GDP and about 70% of Indian population is dependent on agriculture for their livelihood. To See a world free of hunger and malnutrition Agriculture Planning is unavoidable. The COVID-19 pandemic has further highlighted the interrupted agrifood systems leading to further increases in world hunger and severe food insecurity. Filling up of demand-supply gap in food requirement is absolutely essential to avoid mal nutrition and under nourishment. One of the ways of achieving higher productivity is to increase the land area of the taken crop. Since the resources are scarce and limited in nature, the increased production of crops per unit area or crop intensity must be achieved by proper utilization of resources. Hence crop planning becomes very significant. Optimum crop pattern with maximum profit at minimum cost is the need of the hour. Mathematical Linear Programming Approach is applied to develop farm model, linear programming approach is to optimize the decision variable. Linear programming was developed by George B. Dantzing (1947) during 2nd world war. It has been widely used to find the optimum resource allocation. Linear programming is defined as the optimization (minimization or maximization) of a linear function subject to specific linear inequalities or equalities.

The aim of the study is to develop a farm model for Aurangabad district of Maharashtra by using linear programming to allocate suitable crop combinations in suitable season for achieving maximum production. In this study, only the crop of Rabi season is taken.

2. Literature review

Mahak Bhatia and Prof. G.M.J. Bhat [2019] ^[1] developed Linear Programming Approach to allocate the resources optimally in order to increase the production K. Pushpavalli, Dr. P. Subasree & Dr. S. Umadevi [2018] ^[2] framed LP model for land allocation to the four major cereal crops in agriculture. The solutions are obtained by Simplex Algorithm. Martina Grubišić, Biserka Kolarec, and Marijana Mamić [2019] ^[3] set up a linear programming problem of agricultural land allocation in vegetable production on a case study of a family farm in Croatia. Nordin Hj. Mohamad and Fatimah Said [2011] ^[4]. Developed a linear programming model for an agricultural farm and also formulated crop-mix planning model and transformed into a multi-period linear programming problem. Wankhade and Lunge [2012] ^[5] carried out a case study and use a linear programming model to the allocation of land optimally. KN Chinchodkar and Omprakash S Jadhav ^[6] [2018] Optimal planning for Aurangabad municipal solid waste through mixed integer linear programming. A linear programming model is developed for the mix cropping strategies and allocating the available land optimally, Data is collected from the Economic Survey of Maharashtra 2021-2022) ^[7]

3. Study Area

Aurangabad District is located at 19°53'47" N to 75°23'54" E Total geographical region of the state is 30800000 ha. Most of the people are engaged in primary sector especially those that resides in rural regions. Net sown area of the district is about 715000 ha and gross sown area is about 825000 ha. Major Kharif crops of the region includes cotton, Bajra and corn, the crops cultivated in Rabi season are Wheat, Jowar & Gram. Aurangabad's climate is tropical, with a rainy season from June to October, due to the monsoon, and a dry season from

November to May. The rains usually end in early or mid-October. The average annual rainfall is 710 mm. The city is often cloudy during the monsoon season and the cloud cover may remain together for days. The daily maximum temperature in the city often drops to around 22 °C due to the cloud cover and heavy rains. The city is located in south-central India, in the state of Maharashtra, at almost 20 degrees north latitude and 580 meters (1,900 feet) above sea level. The average temperature of the coldest month (December) is of 20.8 °C (69.4 °F), and that of the warmest month (May) is of 32.4 °C (90.4 °F).

Table 1: Area, Production and Productivity of major crops cultivated in district Aurangabad

Crop	Area ('000 ha)	Production ('000 MT)	Productivity (kg/ha)
Wheat	935	1662	1778
Maize	275	725	2636
Gram	2525	2757	1092
Jowar	1351	1362	1008
Sunflower	7	3	428

(Source of Table: Economic Survey of Maharashtra 2021-2022)

4. Mathematical Formulation

The objective of the paper is to maximize farm returns by allocating the resources optimally. Only the crop grown in Rabi season i.e. wheat, Maize, Gram and Jowar is considered for the study. The total area available for cultivation is 8.52 lakh hectares and net sowing Area is 7.15 lakh hectares. Proper allocation of crops and available resources is very important in order to increase productivity and also for the efficient utilization of resources. Agriculture is diverse in Aurangabad district, a wide range of crop are cultivated in the district. The main food grains are Jowar, pearl millet, Wheat and gram. Soya bean is the main oilseed crop while Cotton is the cash Crop. As Aurangabad district of Maharashtra, there is little rainfall throughout the year. Therefore, the variation in cropping pattern is observed within district depending upon the availability of water resources. It is observed that there is increase in production to about 25% by adopting these crop policies Farmers especially the small farmers prefer to adopt mixed cropping that includes both livestock as well as cultivation of crops within the same farm. Livestock rearing contributes to increases the farm returns to great extent.

A Linear programming problem with “n” decision variables and “m” constraints is formulated as:

$$\text{Max. } Z = \sum c_i x_i \quad i=1,2,3,\dots,n$$

$$\text{s.t. } \sum a_i x_i \leq \sum b_j \quad j=1,2,3,\dots,m$$

$$x_i \geq 0$$

x_i = represents the decision variables (to be determined by policy makers)

c_i = represents the cost vector

a_i = represents activity coefficient

b_j = represents the available resources

The objective function is

$$\text{Max. } Z = 1778x_1 + 1092x_2 + 1008x_3 + 2636x_4$$

Subject to constraints

Land

$$935x_1 + 2525x_2 + 1351x_3 + 275x_4 \leq 260000$$

Seeds & fertilizers

$$x_1 + x_2 + x_3 + x_4 \leq 75000$$

Labor

$$x_1 + x_2 + x_3 + x_4 \leq 150450$$

Non-negativity conditions

$$x_1, x_2, x_3, x_4 \geq 0$$

x_1, x_2, x_3, x_4 Hence, optimal solution is arrived with value of variables as:

$$x_1=0, x_2=0, x_3=0, x_4=945$$

x_1, x_2, x_3 and x_4 are the decision variables for wheat, gram, Jowar and Maize respectively.

5. Results: In this Paper Results obtained by Linear Programming model. LPP was used to determine the optimal crop plan for Aurangabad district of Maharashtra, India. The objective was to maximize the net returns

of the farmers by optimum resource allocation using simplex method. It is observed that farmer can get a profit of 2492218 Rs by adopting this method. The values of the decision variable are $x_1=0$, $x_2=0$, $x_3=0$, $x_4=945$. Crops considered for the study were Wheat, Jowar, Gram and maize.

6. References

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