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Role of Mathematics in Agriculture

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Abstract
Mathematics is considered as the 'Queen of Science' since every phenomenon that occurs in the cosmos involves mathematics directly or indirectly. Mathematics has a vital role in our daily life activities as it helps us to think analytically and reasonably. One cannot imagine life without mathematics. All our activities are governed by some or other law of mathematics. The knowledge of mathematics is very important in the agriculture development.

Key words: Linear programming, simplex method, agriculture,

Introduction

Mathematics is used in each and every moves of the universe. One of the important field which works on the application of Mathematics is 'Agriculture'. Mathematics is used in agriculture in many ways, measuring land, analysing soil, predicting crop yield. Land is measured in acres and hectares. Proportions can be used to convert units. Mathematics is used to measure the moisture of soil. To be a farmer it is more important to have problem solving, decision making and money management abilities. They use advanced mathematical technology to calibrate machines and irrigation pumps. This paper brings to light some of the important role of mathematics in the agricultural field.

Mathematics and Agriculture

The agriculture industry is one of the key areas where mathematics is applied. Be it problem solving, decision making or money management skills, all the more crucial for success as an agriculturist. The study of mathematics and agriculture go hand in hand. Using mathematics, it is possible to determine how much water may be utilised in proportion to the area available for cultivation, the amount of investment in a certain crop, use of fertilizer epidemiology, DNA sequencing, gene technology measuring fertility of soil and other fields all use mathematics. In order to feed the growing population and

supply raw materials for industries, agriculture has historically been the foundation of every country`s economy. It is evident that applying mathematics for the growth of agriculture is important and desirable. The different mathematical models used in agriculture include empirical, deterministic and stochastic approaches. These models are dynamic in nature and involve the different branches of mathematics like algebra, dynamics, mensuration, differential equations, linear programming, mechanics etc.

Here is the focus on linear programming which is used in agriculture.

Number System

Conversion:

A very simple concept used in day to day agricultural process is Conversion. A land must be measured in acres. Land is being converted from square feet to acres. This is the foremost simple thing for which the conversion concept is used.43,560 square feet is said to be an acre. To plant different kinds of crops in same field for a huge area the land is divided into quarters and sections. A quarter is said to be 160 acres and section is said to be 4 quarters. The prices of the grains will be calculated per tons but producers want it to be known per bushel. Hence tons will be converted into bushels.

Linear Programming:

Linear programming is a mathematical technique used in agriculture to optimize resource allocation and maximize profits. It can also help with crop rotation, water irrigation, and land allocation. Linear programming is a special case of mathematical programming to achieve the best outcome such as maximum profit or minimum cost.

Solving Agricultural Problems by Applying Linear Programming

The application of linear programming is widely used in many fields. It is used to maximize profit of farm by changing the crop structure. Linear programming is the technique for optimizing the linear objective functions subject to linear equality and inequality constraints. It is the powerful technique to find the optimal allocation of resources. Let us use the simplex method to solve a problem in agriculture.

Example:

Let us consider a problem. From the table below we shall use simplex method for finding the way of increasing the yield

	Output(acres)	Land (acres)	Capital (acres)
Rice	102	28	60
Wheat	75	30	52
Maize	76	26	46
Barley	50	34	30
		118	188

Maximize

$$Z = 102X_1 + 75X_2 + 76X_3 + 50X_4$$

Subject to constraints,

$$28x_1 + 30x_2 + 26x_3 + 34x_4 \leq 118$$

$$60x_1 + 52x_2 + 46x_3 + 30x_4 \leq 188$$

To equate the constraints we have to introduce the slack variables

$$\text{Max } Z = 102X_1 + 75X_2 + 76X_3 + 50X_4 + 0X_5 + 0X_6$$

Subject to,

$$28x_1 + 30x_2 + 26x_3 + 34x_4 + x_5 = 118$$

$$60x_1 + 52x_2 + 46x_3 + 30x_4 + x_6 = 188$$

Constructing the constraints in matrix form

$$\begin{bmatrix} 28 & 30 & 26 & 34 & 1 & 0 \\ 60 & 52 & 46 & 30 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \end{bmatrix} = \begin{bmatrix} 118 \\ 188 \end{bmatrix}$$

Initial basic feasible solution is given as

$$\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} x_5 \\ x_6 \end{bmatrix} = \begin{bmatrix} 118 \\ 188 \end{bmatrix}$$

C_j			102	5	76	50	0	0
C_b	Yb	Xb	Y1	Y2	Y3	Y4	Y5	Y6
0	Y5	X5= 118	28	30	26	34	1	0
0	Y6	X6= 188	60	52	46	30	0	1
Zj=ΣXibi			0	0	0	0	0	0
$Z_j - C_j$			-102	-75	-76	-50	0	0

Y1 enters the basis

Min [118/28, 188/60]

→ Min [4.2 3.1]

C_j			102	75	76	50	0	0
C_b	Yb	Xb	Y1	Y2	Y3	Y4	Y5	Y6
0	Y5	X5= 30.36	0	5.92	4.72	20	1	0
102	Y1	X1= 3.13	1	0.86	0.76	0.5	0	0
Z_j			102	87.76	77.52	51	0	0
$Z_j - C_j$			0	12.76	1.52	1	0	0

Y6 leaves the basis
Old variable-(new variable*cost variable)
118-(3.13*28) = 30.36
28-(1*28) = 0
30-(0.86*28) = 5.92
26-(0.76*28) = 4.72
34-(0.5*28) = 20
1-(0*28) = 1
0-(0*28) = 0
Max Z= 102 X1 + 0 X5
= 102 (3.13)
= 319.26

Hence the maximum yield is estimated through simplex method.

Conclusion:

Linear programming is one of the quantitative methods which can be applied not only in industry sector but also in agriculture applications. The main objective of this study is to put on efficiently the linear programming methods practicing effectively for the use of resources for significant food crops. In the contemporary study, we wished-for LP model for optimum land allocation to the two main food crops in agriculture. The results are gained by Simplex method.

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