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Application of Operation Research in Agriculture Sector

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***Abstract*: Operation research gives useful medical methods/gear employed in planning and management of agribusiness. Right from 1954 researchers commenced analyzing the applications of Operations studies in agriculture. Agriculture makes provision for food and is vital for the GDP of India with the ever-growing population. This paper makes a try to use numerous Operations research techniques inclusive of Linear Programming troubles to provide an explanation for how the combination of these strategies in agriculture will no longer only assist in reducing the triumphing problems in agriculture however additionally lead to better efficiency.**

***Keywords*: Linear programming problem, Maximization, Minimization, Optimization.**

1. Introduction

Facts from the food organization of India (FCI), the agency that buys grains for the central pool for public distribution and different welfare schemes, suggests the mixed inventory of rice and wheat at extra than 71 million lots (mt), apart from 8mt of unfilled paddy – the highest for August. That is almost three instances the minimum stock had to run welfare schemes. Country wide garage ability is around 8mt - 7mt blanketed and 13mt blanketed place plinth (CAP).

2. Literature

[1], [2] explains how to make better decisions in agricultural sector. [3] say the application of assignment problem in Agricultural. [4] say MOSPI Retrieved for government of India. [5], [6] say operation research technique in farm management.

3. Linear Programming Problem and Agricultural Sector

Agriculture is the backbone of any country, keeping in line with this many European countries, Japan and limited parts of the USA are highly invested in using the linear programming model approach also called "programmed planning" in order to optimize their produce and for an optimal running of their resources Concept used for a Linear Programming Model.

A. Finding values of the objective function at the extreme points

- The problem that arises while solving a linear programming problem is to find an efficient set of extreme points of a convex polyhedral set determined by the objective function.
- In a linear programming problem, every extreme point is a basic feasible solution under the set of constraints,
- Similarly, every basic feasible solution is also an extreme point of the set of feasible solutions.

1) Choosing the optimum value

Furthermore, the maximum or minimum optimum value of
Max or Min Z= c_1 x_1 + c_2 x_2 + ... + $c_n x_n$
Subject to,

$$a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n \ (\le = \ge)\ b_1$$
$$a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n \ (\le = \ge)\ b_2$$
$$\vdots$$
$$a_{m1}x_1 + a_{m2}x_2 + \cdots + a_{mn}x_n \ (\le = \ge)\ b_m$$

$x_j \geq 0$, j=1 ,2 ,3…. N

Can be also written as

Max Z= C^tX
Subject to
AX ≤ b
X≥ 0

X represents the vector of variables (to be determined) while C and b are vectors of known matrix of coefficient. The expression to be maximized is called the objective function (C^t in the case). The equation AX ≤b is the constraint which specifies a convex polyhedral set over which the objective function is to be optimized. The coefficients $(c_1, c_2, \dots, c_n)$ are the unit returns for the coming from each production process $(x_1, x_2, \dots, x_n)$.

2) Mathematical formulation

To formulate the problem mathematically, the following notations are used

Z = The objective function to be maximize
x_j= Input variables

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c_i = Cost coefficients of the objective function of Z
b_i= Maximum limit of the constraint
a_{ij}= Coefficient of the functional constraint's equation

Maximize Z= $\sum_{i=1}^{n} c_i x_j$
Subject to constraints

$$\sum_{j=1}^{n} A_{ij}\, x_j \leq b_i$$

$$x_j \geq 0$$

$$A_{ij} = [a_{ij}]m * n$$

$$x_j = [x_{ij}]m * n$$

$$b_i = [b_{ij}]n * 1$$

$$\sum_{i=1}^{n} c_i x_j$$

$$x_{ij}, c_i, b_i \in R$$

B. Application

Linear programming finds its application in a vast array of fields. Since its inception, operations research is being utilized for,

1) The problem of minimization of costs of feed

The optimal function becomes the total cost incurred while the prices and quantity become the constraints.

2) On the choice of a crop rotation plan

The model can be used to pick an optimal crop rotation pattern to gain maximum profit while the cost incurred at producing them becomes the constraints.

3) Field of feed-mixing for nutritional requirements

The model uses various combinations of feed in order to obtain an optimal feed combination keeping in mind the nutritional requirements for the animals.

C. Qualitative measures of agricultural sector in LPP

- Optimal crop pattern and production of food crops with maximum profit is important information for agricultural planning using optimization methods. Crop yield, man power, production cost and physical soil type are required to build the method.
- This technique can be highly useful for individual farmers if the quantitative measure**,** as mentioned above, of various alternative methods and resource use can be provided. Moreover, if implemented properly the benefits obtained from the implementation exceeds the cost incurred by the farmer for implementing the said technique.
- On a large scale or a macro level, this technique helps the farming population in agricultural management and spatial analysis**.**
- Spatial linear programming analysis can help studies related to inter regional production and major crop adjustments. Transportation models are the simplest of linear programming models applied in agriculture.

4. Simplex Method

The Simplex method is another technique of finding out the corner positions (extreme values). In this method, the slack variables, introduced to convert the inequalities to equalities and the coefficients of these slack variables in c vector are zero.

Maximize Z= $\sum_{i=1}^{n} c_i x_j$
Subject to constraints

$$\sum_{j=1}^{n} A_{ij}\, x_j \leq b_i$$

$$x_j \geq 0$$

A farmer wants purchases 2 types of grain containing different amounts of 3 nutritional elements A, B, and C with the given cost and minimum requirements.

Table 1

Nutrient	**Types of Grain**		**Minimum Requirement**
	G1	**G2**	
A	2	4	120
B	0	2	20
C	5	1	80
D	25	15	

The farmer can make use of L.P.P to find out how much quantity should both grains be purchased to reduce his/her cost.

Step 1: Formulating the L.P.P

The above given information can be formulated in the following L.P.P, i.e., converted into an expression of numbers and variables.

Min Z =25x_1+15x_2
Subject to
2x_1+4x_2≥120
2x_2≥20
5x_1+x_2 ≥80
x_1 +x_2 ≥ 0

Where, x_1, x_2represent the amount of grain 1 and grain 2 purchased respectively.

Step: 2 Estimation of coordinates.

To plot the above in equation on the graph, we make use of the following table.

Table 2

Inequation	**Equation**	x_1	x_2	**Region**
2x_1+4x_2≥120	2x_1+4x_2=120	0	30	NON-ORIGIN
		60	0	
2x_2≥20	2x_2=20	0	10	NON-ORIGIN
5x_1+x_2 ≥80	5x_1+x_2 =80	0	80	NON-ORIGIN
		16	0	

Step 3: Plotting the graph.

The following (Fig. 1.) graph is based on the above coordinates, and based on the information, the below given feasible region contains the solution to the above-mentioned problem.

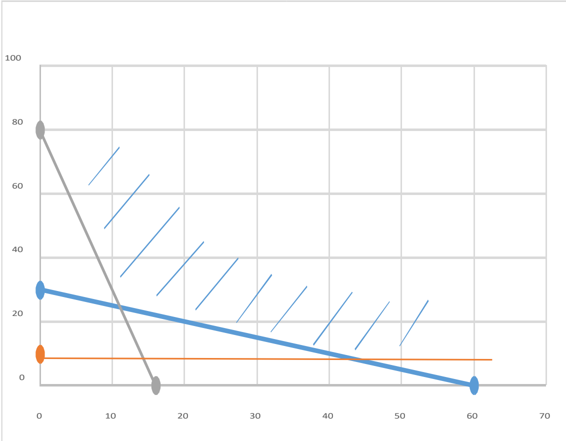

Fig. 1.

Step 4:

Finding the solution now, we can place the coordinates seen in the shaded region into the objective function to find the minimum cost.

Table 3

Point	Coordinates	Value of Z
A	(0,80)	1200
B	(11,25)	650
C	(40,10)	1150
D	(60,0)	1500

As we can clearly see, that the farmer should purchase 11 units of grain 1 and 25 units to grain 2 to incur minimum cost of Rs. 650 Thus, from the above illustration we can clearly see, how the graphical method can be helpful in finding the product mix to either maximize profits or minimize their cost. However, when we have to find a solution for more than two variables, it is not possible to make use of graphical method to find the solution, hence, when more than two variables are present, the simplex method is used to find the solution.

5. Conclusion

Agriculture as a whole is filled with complexity and issues which can easily be resolved using operation research techniques. Operation Research techniques are extremely fruitful in helping agriculture to grow as a whole and provide solution brings it about as a larger contributor to GDP. The problems of storage issues as well as warehousing can be resolved using other methods such as transportation and assignment. Based on the above illustrations we can clearly identify that L.P.P is not only helpful in determining cropping patterns but can also help in reducing costs for the same.

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