An Optimization Model of Crop’s Planting Structure using Linear Programming

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Abstract — The optimization box of Matlab was used in agricultural planting programming in this paper, and the optimization problem of crop’s planting structure was solved successfully. First we set up a mathematical model, then determined some constraints which affect the programming and lastly solved the problem by function “Fmincon” in Matlab. Results show that this method of optimizing planting structure can help improve profit and increase farmers’ income.

Keywords—linear programming; planting structure; optimization

I. INTRODUCTION
At present, China’s agriculture is transforming from traditional agriculture to modern agriculture, but the family of independent type agriculture is dominated by the traditional management mode, planting crops and how much is still by the habit determines, the allocation of resources depends on subjective. The farmer to market economy, to optimize the understanding of crop planting structure is not deep, the limited resources for maximum benefit without complete understanding. From the development trend of world agriculture, agriculture is not only to ensure sufficient food production, it is more important to the optimization of crop planting structure, minimizing the cost, at the same time to meet the diversified needs of agricultural human. Especially important is how to guarantee the sustainable development of agriculture, how in the limited resource conditions, agricultural production efficiency improved step by step, is also the planting structure optimization problem, the linear programming method is used to solve the problem.

Linear programming is a mathematical approach to optimize the management of people, it mainly studies in resource allocation, allocation scheme can not only meet the basic requirements of how various aspects, but also can obtain good economic benefit and social benefit, provide service for the scientific decision.

II. OPTIMIZATION THEORY
Optimization theory is a branch of Applied Mathematics, is essentially the extreme of function. In twentieth Century 30 at the end of 1980s, due to the rapid development of the military and industry, put forward to solve the problem of a series of optimization problems, and using the method of differential classical and variation law cannot solve, in many scholars' efforts, gradually developed and formed some new mathematical methods, namely the method of optimization.

III. OPTIMIZATION PROBLEMS DEFINITION
The optimization problem is from all possible solutions to achieve optimal target selected the most reasonable, (maximum or minimum) scheme, that is the optimal scheme, the optimal scheme is search method for optimization problems. By the definition of mathematical methods are as follows.

To solve the optimization problem of type (1), is the requirement of type (1) for the global optimal solution, but in general, we often can find out a local optimal solution of it.

IV. GREAT PROBLEMS TRANSFORMATION
The definition of optimization problems is given only standard for the minimum definition, but the linear programming model to practical problems is varied, can use some methods they transformed into equivalent standard. Requirements such as the maximum of the objective
function $z = f(x)$, as long as the target function of the maximum value for the minimum of the objective function can be, i.e. $\max z = \min f(-x)$.

V. OPTIMIZATION MODEL ESTABLISHMENT

Using fmincon function in MatLab can be very convenient for solving constrained optimization problems. The known constraints type (2), the minimal solution of the vector function; ()

\[
\begin{align*}
&c(x) < 0 \\
&ceq(x) = 0 \\
&A \cdot x \leq b \\
&Aeq \cdot x = beq \\
&lb \leq x \leq ub
\end{align*}
\]

Among them, \(x, b, beq, lb\) and \(ub\) are vector; \(A\) and \(Aeq\) is the matrix; \(c(x)\) and \(ceq(x)\) is the return value for the vector function; \(f(x)\) is a return value for the scalar function; \(c(x), ceq(x)\) and \(f(x)\) can be a nonlinear function.

VI. EMPIRICAL ANALYSIS

Zhenjiang City Jingkou District belongs to the subtropical monsoon climate, the annual average temperature of 15.5 degrees C, frost free period of 237.2 days, 2057.2 hours of sunshine hours, rainfall of 1070 mm. Located in the South Bank of the Yangtze River downstream, the ancient canal to the East, latitude 32 degrees 10'-32 degrees 15', longitude 119 degrees 26'-119 degrees 38'. A hilly area and the Yangtze River alluvial plain area, the terrain is high in southeast, northwest during downstream, the ancient canal to the East, latitude 32 days, 2057.2 hours of sunshine hours, rainfall of 1070 mm.

VII. PUT FORWARD PROBLEMS

Jingkou zone climate and geographical environment are suitable for these four crops, how to optimize plant structure, an important constraint condition is limited available resources. To make the maximum total profit, hand hope planted high profit crops; but on the other hand, high profit crops resources needed is much also, bringing costs, that could reduce the total profit. So the essence of optimizing planting structure is in a resource constrained conditions, the constrained optimization problem to seek the maximum profit, the available MATLAB optimization toolbox to solve.

Because of the influence of crop economic profit by policy, market, natural conditions of the larger, in different time and different crop resources also have the difference, the data in the table is obtained in a simple research foundation, and the purpose is to clarify a planting structure optimization method for obtaining the maximum profit. Data show that the number of each type of crops per acre required resources and profits and resources available, the requirements under the conditions of limited resources, determined for each crop planting area, to make the maximum profit.

VIII. THE ESTABLISHMENT OF MODEL

The total profit:

\[INCOME = 200 \cdot x_1 + 1000 \cdot x_2 + 800 \cdot x_3 + 650 \cdot x_4,\]

Of which: \(x_1\) : Grain planting area ; \(x_2\) : vegetable planting area; \(x_3\) : Tea cultivation area ; \(x_4\) : Orchard planting area; \(INCOME\) : The total profit.

The conditions of constrained resource:

1. Land restrictions: the total planting area is 22137 mu, i.e. \(x_1 + x_2 + x_3 + x_4 = 22137\)

(2)Labor restrictions: growing three crops of labor and can not exceed the allowable value of 553000 works, i.e. \(10 \cdot x_1 + 25 \cdot x_2 + 30 \cdot x_3 + 30 \cdot x_4 \leq 553000\)

(3) The water restrictions: growing three crops in the water and can not exceed the allowable value of 690000 tons, i.e. \(22 \cdot x_1 + 33 \cdot x_2 + 25 \cdot x_3 + 44 \cdot x_4 \leq 690000\)

(4) Fertilizer, pesticide restrictions: growing three crops with fertilizer and medicine and can not exceed the allowable value of 3320000 work,

i.e. \(100 \cdot x_1 + 150 \cdot x_2 + 250 \cdot x_3 + 800 \cdot x_4 \leq 3320000\)

(5) The non NULL constraint, i.e. \(x_1, x_2, x_3, x_4 \geq 0\)

In summary, our problem is in the (1) ~ (5) of the constraint conditions, to work out the optimal \(x_1, x_2, x_3, x_4\) in order to make the maximum. Therefore, the mathematical model of the problem is as follows:

\[\max INCOME = \max(200 \cdot x_1 + 1000 \cdot x_2 + 800 \cdot x_3 + 650 \cdot x_4)\]

As a constraint:

\[
\begin{align*}
&x_1 + x_2 + x_3 + x_4 = 22137 \\
&10 \cdot x_1 + 25 \cdot x_2 + 30 \cdot x_3 + 30 \cdot x_4 \leq 553000 \\
&22 \cdot x_1 + 33 \cdot x_2 + 25 \cdot x_3 + 44 \cdot x_4 \leq 690000 \\
&100 \cdot x_1 + 150 \cdot x_2 + 250 \cdot x_3 + 800 \cdot x_4 \leq 3320000 \\
&x_1, x_2, x_3, x_4 \geq 0
\end{align*}
\]

To solve the model

In accordance with the standard form, the original problem is transformed into:

<table>
<thead>
<tr>
<th>TABLE 1 PLANTING INPUT-OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Emplo-yment</strong></td>
</tr>
<tr>
<td>Grain</td>
</tr>
<tr>
<td>Vegetable</td>
</tr>
<tr>
<td>Tea garden</td>
</tr>
<tr>
<td>Orchard</td>
</tr>
<tr>
<td>Available resources</td>
</tr>
</tbody>
</table>
Through the comparison of planting structure can be found using linear programming to determine the most fully rational use of existing resources, and making profits have greatly improved.

X CONCLUSIONS

Linear programming energy distribution for energy, make the optimal choice when empty, in the energy supply is becoming increasingly tense situation becomes more and more important. There are many methods to solve the linear programming model of MATLAB, compared with other methods, it has high calculation speed, modeling is relatively easy, rich features such as scalability, but also can avoid some tedious programming. According to the Jiangsu area climate characteristics and plant species, mathematical model is established by linear programming method of Jingkou District of Zhenjiang City, planting a detailed location, quantitative research, finally choose a planting structure scheme, this scheme makes full use of local advantages of water, heat and other resources. But in practical application should consider many factors, such as the change of the market, change the cost and profit; the premise to ensure the ecological balance of the grain and grain under the protection of planting structure optimization etc.

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REFERENCES