OPTIMUM ALLOCATION OF WORKING HOURS FOR PLANT TISSUE CULTURE

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ABSTRACT

In this paper we developed Goal programming model in Plant Tissue culture. As on today this technique not entered in to this field. We concluded that by using this model a fresher easily will get expert results without expertise.

This paper describes Goal Programming Model to allocate working hours for skilled and unskilled labour in Plant Tissue Culture by considering four priorities. a) Meet the production goal for eight generations and rooting. b) Limit the overtime operations for skilled labour. c) Avoid the underutilization of regular working hours for both skilled and unskilled labour.

KEYWORDS: Goal Programming, Priorities, Skilled Labour, Un Skilled Labour, And Plant Tissue Culture

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INTRODUCTION

Plant tissue culture is called as micro propagation. The ability of a plant cell to produce a complete plant under controlled climatic conditions in a synthetic medium. Total plant tissue culture depends on Totipotency.

Banana is one of the world's famous fruit crop as it contains good source of carbohydrates, proteins, vitamins and minerals. Widely known and distributed fruit, eaten raw, cooked or processed. In general, It is treated as symbol of prosperity and fertility owing to its greater socio-economic significance and utility, it is referred to as kalpatharu and kalpavriksh (Singh, 2009). Bananas occupy, among tropical fruits among temperate fruits. A larger number of edible clones are cultivated in India than in any other country. Recently India is the largest producer of bananas accounting to 14.18% in 1992 of world's production. In terms of both harvest weight of the yield of banana per acre ranks higher than that of many other tropical fruit crops.

Now a day's Banana Plant Tissue Culture plants playing a major role in the market as the traditional methods are having so many challenges like availability of mother plant sources, uniformity in the crop and yields. At present more number of laboratories in the world are producing more than 500 million plants per year.

Tissue-culture techniques established for banana include shoot and meristem culture, callus culture, somatic embryogenesis, cell suspension, and protoplast cultures.

As there is a large market for banana fruits and plant tissue plants are having huge demand for planting

material. There are more varieties in Banana. Here to develop Goal Programming model we worked on Grand nine varieties.

Multiplication

In this multiplication step the tissues are rapidly multiplied in an appropriate culture medium which contains all macro, micro elements, and growth promoters. We need to encourage recurrence for 7 to 8 times.

Rooting: After recurring of few cycles, plants growth will become two to three centimeters which are very convenient to transmit to rooting media. This step will help to generate roots to the plants.

Literature Survey

Charnes[6] made modeling tools of linear programming for industrial applications. Ijri [7] explained in his research paper how to categorize different priorities and how to assign weights to the same priority goals. David[8] developed a goal programming structure to aggregate production and work force. Ignizio [9] pointed out real world issues which involve non-deterministic and inconsistent goals. GP provides a single optimal solution to these conflicting goals.

Goal Programming Model

One of the flexibility Multi Criteria Decision Making method is Goal Programming. The structure of this method is follows:

$$\text{Minimize } M = \sum_{i=1}^m Q_i (V_i^- + V_i^+)$$

Subject to constraints

$$\sum_{j=1}^n b_{ij} y_j + (v_i^- + v_i^+) = r_i, i = 1, 2, 3, \dots, n$$

$$\text{and } y_j, v_i^-, v_i^+ \geq 0 \forall i, j$$

Where n goals are expressed by an n component column r_i ,

the weights of each goal and v_i^- and v_i^+ deviational variables representing the amount of under achievement and over achievement of i^{th} goal respectively. By considering the preference of the goals need to assign the constants as priority factors. First priority must be assigned highest constant next priority must be assigned a constant which is more than the third priority and lesser than the first priority. Least priority must be assigned by smallest constant among all other factors.

Data of the Problem

To develop a Goal Programming model for optimum allocation of working hours at Plant Tissue Culture unit we collected data from K.F.Bio.Tech.Pvt.Ltd. Theniyur village, Sulibele Hobli, Hoskote Taluk, Bangalore Rural, Karnataka India-562 129 which is one of the biggest Bio-Tech company in India.

About Company

This company is having a state of art technology laboratory which is recognized by the Department of Bio-Technology Government of India. It is a plant tissue culture unit which produces very good quality banana tissue culture plants and potato seeds. There are so many protocols for the production of banana tissue culture plant which includes selection of

mother plant, processing of ex-plant initiation inside the laboratory under controlled climatic conditions further multiplication and rooting procedures will be done. And ex-plants are kept under plant growth rooms which have controlled climatic conditions with 16 hours photo period and 8 hours of dark period will be provide in every generation. After rooting, plants will be sent for acclimatization.

Assumptions

- Operating cost of both teams are same.
- Five percent contamination for each generation
- Multiplication ratio is 2.5.

Priorities

- P₁: Meet the production goal of first generation is 5000 culture
- P₂: Meet the production goal of second generation is 11,875 culture
- P₃: Meet the production goal of third generation is 28,202 culture
- P₄: Meet the production goal of fourth generation is 66,980 culture
- P₅: Meet the production goal of fifth generation is 1,59,077 culture
- P₆: Meet the production goal of sixth generation is 3,77,807 culture
- P₇: Meet the production goal of seventh generation is 8,52,425 culture
- P₈: Meet the production goal of eight generation is 21,31,062 culture
- P₉: Meet the production goal of rooting is 60,73,528 culture
- P₁₀: 60 hours are regular operating hours for skilled labour
- P₁₁: 60 hours are regular operation hours for unskilled labour
- P₁₂: 72 hours are overtime for skilled labor

Constraints of the Model

Production Capacity

The total production is a function of the sum of production rate for each production line multiplied by the number of hours each line is in operation. Total production period will divide into eight generations and each generation carries four weeks. To fix the target of each generation we will remove 5% acceptable contamination from previous generation target and consider 2.5 as multiplication ratio.

First Generation

The production goal of 5000 culture for the first generation will be based on this production function:

$$185y_1 + 150y_2 + v_1^- - v_1^+ = 5,000$$

Where y_1 = number of working hours of skilled labour

y_2 = number of working hours of unskilled labour

v_1^- = under achievement of production goal which is set at 5000 culture

v_1^+ = production in excess of 5000 culture.

Second Generation

By considering 5%contamination and 2.5 multiplication ratio second generation target will be 11,875 culture.

$$185y_1 + 150y_2 + v_2^- - v_2^+ = 11,875$$

Where y_1 = number of working hours of skilled labour

y_2 = number of working hours of unskilled labour

v_2^- = under achievement of production goal which is set at 11,875 culture

v_2^+ = production in excess of 11,875 culture.

Third Generation

By considering 5%contamination and 2.5 multiplication ratio third generation target will be 28,202 culture.

$$185y_1 + 150y_2 + v_3^- - v_3^+ = 28,202$$

Where y_1 = number of working hours of skilled labour

y_2 = number of working hours of unskilled labour

v_3^- = under achievement of production goal which is set at 28,202 culture

v_3^+ = production in excess of 28,202 culture.

Fourth Generation

By considering 5%contamination and 2.5 multiplication ratio fourth generation target will be 66,980 culture.

$$185y_1 + 150y_2 + v_4^- - v_4^+ = 66,980$$

Where y_1 = number of working hours of skilled labour

y_2 = number of working hours of unskilled labour

v_4^- = Under achievement of production goal which is set at 66,980 culture

v_4^+ = Production in excess of 66,980culture.

Fifth Generation

By considering 5%contamination and 2.5 multiplication ratio fifth generation target will be 1,59,077 culture.

$$185y_1 + 150y_2 + v_5^- - v_5^+ = 1,59,077$$

Where y_1 = number of working hours of skilled labour

y_2 = number of working hours of unskilled labour

v_5^- =under achievement of production goal which is set at 1,59,077 culture

v_5^+ = production in excess of 1,59,077culture.

Sixth Generation

By considering 5%contamination and 2.5 multiplication ratio sixth generation target will be 3,77,807 culture.

$$185y_1 + 150y_2 + v_6^- - v_6^+ = 3,77,807$$

Where y_1 = number of working hours of skilled labour

y_2 = number of working hours of unskilled labour

v_6^- =under achievement of production goal which is set at 3,77,807 culture

v_6^+ = production in excess of 3,77,807culture.

Seventh Generation

By considering 5%contamination and 2.5 multiplication ratio seventh generation target will be 8,52,425 culture.

$$185y_1 + 150y_2 + v_7^- - v_7^+ = 8,52,425$$

Where y_1 = number of working hours of skilled labour

y_2 = number of working hours of unskilled labour

v_7^- =under achievement of production goal which is set at 8,52,425 culture

v_7^+ = production in excess of 8,52,425culture.

Eighth Generation

By considering 5%contamination and 2.5 multiplication ratio eighth generation target will be 21,31,062 culture.

$$185y_1 + 150y_2 + v_8^- - v_8^+ = 21,31,062$$

Where y_1 = number of working hours of skilled labour

y_2 = number of working hours of unskilled labour

v_8^- =under achievement of production goal which is set at 21,31,062 culture

v_8^+ = production in excess of 21,31,062culture.

Rooting

By considering 5%contamination and 2.5 multiplication ratio of eighth generation rooting target will be 60,73,528 culture

$$185y_1 + 150y_2 + v_9^- - v_9^+ = 60,73,528$$

Where y_1 = number of working hours of skilled labour

y_2 = number of working hours of unskilled labour

v_9^- =under achievement of production goal which is set at 60,73,528 culture

v_9^+ = production in excess of 60,73,528 culture.

Regular Operating Hours

The regular working hours are usually limited to 60 hours for both production lines. However, if overtime is required to meet the production goal, working hours have to be increased accordingly.

$$y_1 + v_{10}^- - v_{10}^+ = 60$$

$$y_2 + v_{11}^- - v_{11}^+ = 60$$

Where y_1 = number of working hours of skilled labour

y_2 = number of working hours of unskilled labour

v_{10}^- = Under utilization of skilled labour regular working hours 60

v_{10}^+ = Over achievement of skilled labour regular working hours 60

v_{11}^- = Underutilization of unskilled labour regular working hours 60

v_{11}^+ = Over achievement of unskilled labour regular working hours 60.

Overtime Operation for Skilled Labour

The limitation of overtime working hours will be 72 hours for skilled labour.

$$y_1 + v_{12}^- - v_{12}^+ = 72$$

Where y_1 = number of working hours of skilled labour

y_2 = number of working hours of unskilled labour

v_{12}^- = under utilization of skilled labour regular working hours 72

v_{12}^+ = over achievement of skilled labour regular working hours 72

Objective Function

$$\text{Min } M = p_1 v_1^- + p_2 v_2^- + p_3 v_3^- + p_4 v_4^- + p_5 v_5^- + p_6 v_6^- + p_7 v_7^- + p_8 v_8^- + p_9 v_9^- + p_{10} v_{12}^+ + 4p_{11} v_{10}^- + 3p_{12} v_{11}^- + 4p_{13} v_{11}^+ + 3p_{14} v_{10}^+$$

Constraints

$$185y_1 + 150y_2 + v_1^- - v_1^+ = 5,000$$

$$185y_1 + 150y_2 + v_2^- - v_2^+ = 11,875$$

$$185y_1 + 150y_2 + v_3^- - v_3^+ = 28,202$$

$$185y_1 + 150y_2 + v_4^- - v_4^+ = 66,980$$

$$185y_1 + 150y_2 + v_5^- - v_5^+ = 1,59,077$$

$$185y_1 + 150y_2 + v_6^- - v_6^+ = 3,77,807$$

$$185y_1 + 150y_2 + v_7^- - v_7^+ = 8,52,425$$

$$185y_1 + 150y_2 + v_8^- - v_8^+ = 21,31,062$$

$$185y_1 + 150y_2 + v_9^- - v_9^+ = 60,73,528$$

$$y_1 + v_{10}^- - v_{10}^+ = 60$$

$$y_2 + v_{11}^- - v_{11}^+ = 60$$

$$y_1 + v_{12}^- - v_{12}^+ = 72$$

RESULTS

By using LIPS software we are going to get the following results. To get the results we assign integers as priorities. There are 26 variables and 12 constraints.

$$p_1 = 1000, p_2 = 900, p_3 = 800, p_4 = 700, p_5 = 600, p_6 = 500, p_7 = 400, p_8 = 300, p_9 = 200, p_{10} = 100, p_{11} = 10, p_{12} = 11, p_{13} = 4, p_{14} = 3.$$

Variable	Value
y_1	72
y_2	40,401.4
v_1^-	0
v_1^+	6.0685
v_2^-	0
v_2^+	6.0616
v_3^-	0
v_3^+	6.0453
v_4^-	0
v_4^+	6.0065
v_5^-	0
v_5^+	5.9144
v_6^-	0
v_6^+	5.6957
v_7^-	0
v_7^+	5.2211
v_8^-	0
v_8^+	3.9424
v_9^-	0
v_9^+	0
v_{10}^-	0
v_{10}^+	12
v_{11}^-	0
v_{11}^+	40341.4
v_{12}^-	0
v_{12}^+	0

Minimum : 6,45,570

Result and Analysis

All eight generations production capacity over achieved. Rooting target fully achieved. Skilled labour regular operating hours over achieved by 12 hours and unskilled labour operating hours over achieved by 40,341 hours. Overtime target fully achieved. With this result we can conclude that with the skilled staff without any constraint, company can achieve the

target in proper prescribed time frame. Whereas with the unskilled labour the results showing that extra 40,401 working hours required which equals to 56 working days .We can suggest to users to appoint skilled labour to achieve the production in time.This model is recommendable to Optimize working hours for Plant Tissue Culture.

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