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Optimum Selection of Banana Variety by using Goal Programming

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Abstract: In this work we concentrated to analyze the different types especially we worked on Grandnine and Yalakki varieties of Banana and their procedure of production in Tissue Culture Lab, their cost of production, and the sales basing on that results would suggest few key points to the Banana farmers and Tissue culturists. This is the first attempt implementation of Goal Programming in Banana Tissue Culture. This model will suggest to a fresher to reach maximum benefits in this field.

1 Introduction:

In India either commemorates cheerful celebrations or tribute to misfortunes grass roots train to use Banana as rudimentary. Apart that it is economical even a beggar can afford to purchase. Among three meals of a day one can accommodate their one meal with two big Banana's easily. It assimilates easily even for toddlers and golden-agers also. It can use to put on weight and to lose their weight for example if any one want's to put on their weight, nutrition will suggest to eat at least three Banana's per day along with their daily intake. If anyone wants to lose their weight nutrition will suggest to accommodate a meal by only two Banana's. If a normal person consumes a medium size of Banana, he can meet his daily requirement like one fourth of B6,10% of Vitamin C,10% of Manganese,13% of Potassium and 10% to 12% of Fiber. The cost of Banana will be one rupee to five rupees depending on the variety of that fruit and season. In festival and wedding seasons Banana cost will increase because in few states like Andhra, Telangana.. without Banana they won't prefer to do a small function. Irrespective of their community in some occasions they prefer only Banana.
An ancient popular story: Dhurvasa Mahamuny was son of the great pathivratha Arundati and Atri's son. He was very powerful and short tempered scient. One day when he was having a small nap and his wife woke him up for Sandyavandanam (evening prayer). Due to his short tempered angry eyes his wife turned into ashes. Within few minutes he realized his mistake. He wants to bless his innocent wife as "everyone has to remember his wife's name permanently", "she must be something very pure which can first offer to the god", and "she has to give very good health to the entire world". To fulfill all the above qualities with his great power he made a new tree with his wife's ashes and named his wife's name "Kathali" to that tree. The other name of Banana tree is Kathali tree.

Varieties of Banana in India:

State		Varieties grown
Andhra Pradesh	-	Dwarf Cavendish, Robusta, Rasthali, Amritpant, Thellachakrakeli, Karpoora Poovan, Chakrakeli, Monthan and Yenagu Bontha
Assam	-	Jahaji (Dwarf Cavendish), Chini Champa, Malbhog, Borjahaji (Robusta), Honda, Manjahaji, Chinia (Manohar), Kanchkol, Bhimkol, Jatikol, Digjowa, Kulpait, Bharat Moni
Bihar	-	Dwarf Cavendish, Alpon, Chinia , Chini Champa, Malbhig, Muthia, Kothia , Gauria
Gujarat	-	Dwarf Cavendish, Lacatan, Harichal (Lokhandi), Gandevi Selection, Basrai, Robusta, G-9, Harichal, Shrimati
Jharkhand	-	Basrai, Singapuri
Karnataka	-	Dwarf Cavendish, Robusta, Rasthali, Poovan, Monthan, Elakkibale
Kerala	-	Nendran (Plantain), Palayankodan (Poovan), Rasthali, Monthan, Red Banana, Robusta
Madhya Pradesh	-	Basrai
Maharashtra	-	Dwarf Cavendish, Basrai, Robusta, Lal Velchi, Safed Velchi, Rajeli Nendran, Grand Naine, Shreemanti, Red Banana
Orissa	-	Dwarf Cavendish, Robusta, Champa, Patkapura (Rasthali)
Tamil Nadu	-	Virupakshi, Robusta, Rad Banana, Poovan, Rasthali, Nendran, Monthan, Karpuravalli, Sakkai, Peyan, Matti
West Bengal	-	Champa, Mortman , Dwarf Cavendish, Giant Governor, Kanthali, Singapuri

Generally common people will believe Bananas are only two types one is which can eat as a fruit one more type which they can't eat and they can cook as a vegetable. A farmer knows above all the varieties but they are cultivating Grandnine variety because this variety fruit attracts customers with their beautiful uniform yellow colour, forbearance, best quality of bunches, Grand-Naine, an imported variety from Israel is gaining popularity and may soon become the most preferred variety due to its tolerance to abiotic stresses and good quality bunches. Fruit develops attractive uniform yellow colour with better shelf life quality than other cultivars.

2 Literature Survey:

From [1],[2] collected information regarding banana media protocols,[3],[4] helped to know about the banana tissue culture plantlets, from [5] gathered information regarding how banana and plantain in national and international scenario,[6], [7], [8], [9] gave the basic knowledge of Goal Programming,[10] helped me to write the history of Banana [13],[14],[15],[16] key research articles which helped me to construct Goal programming model.[17] helped to get the information about Grandnine production details.

3 Goal Programming Model:

The general GP model can be stated as follows
Minimize $Z = \sum_{i=1}^{m} W_i(d_i^- + d_i^+)$ Subject to constraints

$$\sum_{j=1}^{n} a_{ij}x_j + (d_i^- - d_i^+) = b_i,\ i = 1, 2, \ldots, m \qquad x_j, d_i^-, d_i^+ \geq 0 \,\forall\, i, j;$$

Where m goals are expressed by an m component column b_i,a_ij represents the coefficient for the j^{th} decision variable in the i^{th} constraint,x_j represents decision variable ,w_i represents the weights of each goal and d_i^- and d_i^+ deviational variables representing the amount of under achievement and over achievement of i^th goal respectively. According to the importance of the goals, Priority factors are assigned to deviational variables. Here p's are not given actual values, but this is simply a convenient way of indicating that one goal is important than other. The Priority factors have the relationship of p_j (j=1,2,..k).Lower priority goal can never be achieved at the expense of higher priority level.

Data of the Problem:

Grand-nine Variety:
Assumptions:
a) Operating cost of both teams are same.
b) Five percent contamination for each generation
c) 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:

$$185x_1 + 150x_2 + d_1^- - d_1^+ = 5{,}000$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_1^- = under achievement of production goal which is set at 5000 culture
d_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.

$$185x_1 + 150x_2 + d_2^- - d_2^+ = 11{,}875$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_2^- = under achievement of production goal which is set at 11,875 culture
d_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.

$$185x_1 + 150x_2 + d_3^- - d_3^+ = 28{,}202$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_3^- = under achievement of production goal which is set at 28,202 culture
d_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.

$$185\ x_1 + 150x_2 + d_4^- - d_4^+ = 66{,}980$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_4^- = under achievement of production goal which is set at 66,980 culture
d_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.

$$185x_1 + 150x_2 + d_5^- - d_5^+ = 1{,}59{,}077$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_5^- = under achievement of production goal which is set at 1,59,077 culture
d_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.

$$185x_1 + 150x_2 + d_6^- - d_6^+ = 3{,}77{,}807$$

Where, x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_6^- = under achievement of production goal which is set at 3,77,807 culture
d_6^+ = production in excess of 3,77,807 culture.

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

$$185x_1 + 150x_2 + d_7^- - d_7^+ = 8{,}52{,}425$$

Where, x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_7^- = under achievement of production goal which is set at 8,52,425 culture
d_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.

$$185x_1 + 150x_2 + d_8^- - d_8^+ = 21{,}31{,}062$$

W$here\ x_1 = number of working hours of skilled labour$
x_2 = number of working hours of unskilled labour
d_8^- = under achievement of production goal which is set at 21,31,062 culture
d_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

$$185x_1 + 150x_2 + d_9^- - d_9^+ = 60{,}73{,}528$$

Where, x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_9^- = under achievement of production goal which is set at 60,73,528 culture
d_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.

$$x_1 + d_{10}^- - d_{10}^+ = 60$$
$$x_2 + d_{11}^- - d_{11}^+ = 60$$

Where, x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_{10}^- = under utilization of skilled labour regular working hours 60
d_{10}^+ = over achievement of skilled labour regular working hours 60
d_{11}^- = under utilization of unskilled labour regular working hours 60
d_{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.

$$x_1 + d_{12}^- - d_{12}^+ = 72$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_{12}^- = under utilization of skilled labour regular working hours 72
d_{12}^+ = over achievement of skilled labour regular working hours 72

Objective Function:

$$\text{Minimize } Z = P_1 d_1^- + P_2 d_2^- + P_3 d_3^- + P_4 d_4^- + P_5 d_5^- + P_6 d_6^- + P_7 d_7^- + P_8 d_8^- + P_9 d_9^- + P_{10} d_{12}^+ + 4P_{11} d_{10}^- + 3P_{12} d_{11}^- + 4P_{13} d_{11}^+ + 3P_{14} d_{10}^+$$

Constraints:
$185x_1 + 150x_2 + d_1^- - d_1^+ = 5,000$
$185x_1 + 150x_2 + d_2^- - d_2^+ = 11,875$
$185x_1 + 150x_2 + d_3^- - d_3^+ = 28,202$
$185x_1 + 150x_2 + d_4^- - d_4^+ = 66,980$
$185x_1 + 150x_2 + d_5^- - d_5^+ = 1,59,077$
$185x_1 + 150x_2 + d_6^- - d_6^+ = 3,77,807$
$185x_1 + 150x_2 + d_7^- - d_7^+ = 8,52,425$
$185x_1 + 150x_2 + d_8^- - d_8^+ = 21,31,062$
$185x_1 + 150x_2 + d_9^- - d_9^+ = 60,73,528$
$x_1 + d_{10}^- - d_{10}^+ = 60$
$x_2 + d_{11}^- - d_{11}^+ = 60$
$x_1 + d_{12}^- - d_{12}^+ = 72$

Yelakki Variety:

Assumptions:
a)Operating cost of both teams are same
b)Five percent contamination for each generation
c)Multiplication ratio is 2.

Priorities:
P1: Meet the production goal of first generation is 5000 culture
P2: Meet the production goal of second generation is 9500 culture
P3: Meet the production goal of third generation is 18,050 culture
P4: Meet the production goal of fourth generation is 34,295culture
P5: Meet the production goal of fifth generation is 65,160 culture
P6: Meet the production goal of sixth generation is 1,23,804 culture
P7: Meet the production goal of seventh generation is 2,35,227 culture
P8: Meet the production goal of eight generation is 4,46,931 culture
P9: Meet the production goal of rooting is 8,49,168 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 as multiplication ratio.

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

$$185x_1 + 150x_2 + d_1^- - d_1^+ = 5,000$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_1^- = under achievement of production goal which is set at 5000 culture
d_1^+ = production in excess of 5000 culture.

Second Generation:
By considering 5%contamination and 2 multiplication ratio second generation target will be 9,500 culture.

$$185x_1 + 150x_2 + d_2^- - d_2^+ = 9,500$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_2^- = under achievement of production goal which is set at 9,500 culture
d_2^+ = production in excess of 9,500culture.

Third Generation:
By considering 5%contamination and 2 multiplication ratio third generation target will be 18,050 culture.

$$185x_1 + 150x_2 + d_3^- - d_3^+ = 18,050$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_3^- = under achievement of production goal which is set at 18,050 culture
d_3^+ = production in excess of 18,050 culture.

Fourth Generation:
By considering 5%contamination and 2 multiplication ratio fourth generation target will be 34,295 culture.

$$185x_1 + 150x_2 + d_4^- - d_4^+ = 34,295$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_4^- = under achievement of production goal which is set at 34,295 culture
d_4^+ = production in excess of 34,295 culture.

Fifth Generation:
By considering 5%contamination and 2 multiplication ratio fifth generation target will be 65,160 culture.

$$185x_1 + 150x_2 + d_5^- - d_5^+ = 65{,}160$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_5^- = under achievement of production goal which is set at 65,160 culture
d_5^+ = production in excess of 65,160 culture.

Sixth Generation:
By considering 5%contamination and 2.5 multiplication ratio sixth generation target will be 1,23,804 culture.

$$185x_1 + 150x_2 + d_6^- - d_6^+ = 1{,}23{,}804$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_6^- = under achievement of production goal which is set at 1,23,804 culture
d_6^+ = production in excess of 1,23,804 culture.

Seventh Generation:
By considering 5%contamination and 2 multiplication ratio seventh generation target will be 2,35,227 culture.

$$185x_1 + 150x_2 + d_7^- - d_7^+ = 2{,}35{,}227$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_7^- = under achievement of production goal which is set at 2,35,227 culture
d_7^+ = production in excess of 2,35,227 culture.

Eighth Generation:
By considering 5%contamination and 2 multiplication ratio eighth generation target will be 4,46,931 culture.

$$185x_1 + 150x_2 + d_8^- - d_8^+ = 4{,}46{,}931$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_8^- = under achievement of production goal which is set at 4,46,931 culture
d_8^+ = production in excess of 4,46,931 culture.

Rooting:
By considering 5%contamination and 2 multiplication ratio of eighth generation rooting target will be 8,49,168 culture.

$$185x_1 + 150x_2 + d_9^- - d_9^+ = 8{,}49{,}168$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_9- = under achievement of production goal which is set at 8,49,168 culture
d_9^+ = production in excess of 8,49,168 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.

$$\mathrm{x}_1 + d_{10}^- - d_{10^+} = 60$$
$$\mathrm{x}_2 + d_{11}^- - d_{11}^+ = 60$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_{10}^- = under utilization of skilled labour regular working hours 60
d_{10}^+ = over achievement of skilled labour regular working hours 60
d_{11}^- = under utilization of unskilled labour regular working hours 60
d_{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.

$$\mathrm{x}_1 + d_{12}^- - d_{12}^+ = 72$$

Where x_1 = number of working hours of skilled labour
x_2 = number of working hours of unskilled labour
d_{12}^- = under utilization of skilled labour regular working hours 72
d_{12}^+ = over achievement of skilled labour regular working hours 72

Objective Function:

$$\text{Min Z} = P_1 d_1^- + P_2 d_2^- + P_3 d_3^- + P_4 d_4^- + P_5 d_5^- + P_6 d_6^- + P_7 d_7^- + P_8 d_8^- + P_9 d_9^- + P_{10} d_{12}^+ + 4P_{11} d_{10}^- + 3P_{12} d_{11}^- + 4P_{13} d_{11}^+ + 3P_{14} d_{10}^+$$

Constraints:

$$185\mathrm{x}_1 + 150x_2 + d_1^- - d_1^+ = 5,000$$
$$185x_1 + 150x_2 + d_2^- - d_2^+ = 9,500$$
$$185x_1 + 150x_2 + d_3^- - d_3^+ = 18,050$$
$$185x_1 + 150x_2 + d_4^- - d_4^+ = 34,295$$
$$185x_1 + 150x_2 + d_5^- - d_5^+ = 65,160$$
$$185x_1 + 150x_2 + d_6^- - d_6^+ = 1,23,804$$
$$185x_1 + 150x_2 + d_7^- - d_7^+ = 2,35,227$$
$$185x_1 + 150x_2 + d_8^- - d_8^+ = 4,46,931$$
$$185x_1 + 150x_2 + d_9^- - d_9^+ = 8,49,168$$
$$x_1 + d_{10}^- - d_{10}^+ = 60$$
$$x_2 + d_{11}^- - d_{11}^+ = 60$$
$$x_1 + d_{12}^- - d_{12}^+ = 72$$

4 Result and Analysis:

From the above observations we can conclude that with 5000 culture each we started production with two types of Medias which help to produce Grandnine variety and Yalakki variety. This is total nine months project but Grandnine production will be 60,73,528 whereas yalakki will be 8,49,168. After reducing cost of production by average Grandnine will give Rs.30,367,640 whereas Yalakki will give Rs.4,245,840. From the production if climatic conditions are fine Grandnine average 30Kg fruit will come then total fruit 911,029,200, to the farmer sales will be

Rs.9,110,292,000.From the production If climatic conditions are fine Yalakki average 12Kg fruit will come then total fruit will be 50,950,080,to the farmer sales will be Rs.1,783,252,800.To the production unit Grandnine is benefitable whereas Yalakki will be benefit to the farmers because production cost will be same but a vast difference in the production quantity. For the farmers more profitable is Yalakki because plant cost is same but selling Yalakki fruit is costlier.

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