Area Allocation of Major Crops in Bapatla District Using Linear Programming

S GANAPATHI PRASAD[1], P PAVANI[2], B AMBEDKAR[3], D KESAIAH[4] J YESU BABU[5]
[1]*Assistant Professor, Department of Civil Engineering, Bapatla Engineering College, Bapatla, Andhra Pradesh, India*
[2, 3, 4, 5] *B. Tech Students, Department of Civil Engineering, Bapatla Engineering College, Bapatla, Andhra Pradesh, India*

Abstract— The study was under taken Bapatla district Andhra Pradesh, India. The data is collected from the farmers through the questionary form which includes details of crops sown, labour cost, machinery cost, cost of seeds, fertilizers, water cost, total cultivated area of crops, operating cost and net returns. Farmers face difficulties while allocating the limited resources optimally. To solve this problem mathematical modelling technique is used. LINGO 20.0 software are used to analyze the result. As a result the net returns are increased by 34% by adopting new crop pattern.

I. INTRODUCTION

Agriculture sector plays a major role in social and economic development of a country. The study is undertaken in bapatla district located in Andhra Pradesh. Some of the major crops grown in bapatla district are maize, paddy, chillies, blackgram. These crops plays a crucial role in the economy of the region and provide livelihoods to a significant portion of population. Farmers in bapatla follow a systematic crop rotation pattern too ensure soil health and maximize crop yields. By rotating crops, farmers can replenish soil nutrients, and improve overall soil structure. Crop rotation also increase income for farmers in Bapatla District. By developing a variety of vegetation farmers can get entry to one of the kind markets and take benefit of fluctuations in the prices of various plants. This could stabilize earnings and mitigate the monetary risks of relying on simply one crop. Additionally, diversifying crops can help to use water and land more correctly considering that one of the kind crops have exceptional water and land needs. Farmers face difficulties while selecting the type of the crop, crop combination, allocating the resources. To solve this problem linear programming mathematical tool is used. A crop planning is developed by using this mathematical tool, it includes various factors like seeds, fertilizers, water, labour, machinery, and land availability. The linear programming is applicable to many fields like military, agriculture, hospital, financial, and marketing management. There are wide variety of applications of linear programming in agriculture field like crop rotation, land allocation, and irrigation. Ganesh kumar [1] [2021] developed a linear programming model which considers crop rotation, water availability, crop variety to maximize the yield and productivity. A cropping pattern is developed to maximize the crop production under limited resources and linear programming model is used tomaximize the yeild of command area. Kharisma[2][2019] developed a crop production planning by using mix integral linear programming model which encompasses the crop rotation. By using this mix integral linear programming method weekly crop rotation scheduling plans are developed and the profit is maximized. M.S Tonk[3][2019] introduced a suitable cropping plan to get returns more than the existing net average returns of farmers using mathematical approach. By using the linear programming technique a cropping pattern is developed. The net returns are increased from 9.66% to 26.15% by adopting this cropping pattern. Anil rana[4][2020] proposed a cropping pattern to maximize the yield and to reduce the production cost of the crop. A farm model is developed by using the linear programming tool and the results of the mathematical model formulated show an increase in farm output by adopting optimized cropping pattern. The study used linear programming for decision making in agriculture with the objective of optimum land allocation to four major crops with respect to various constraints like land, operating cost, labour, seeds, fertilizers, machinary and water.

II. STUDY AREA

The study was undertaken in bapatla district of Andhra Pradesh. Net sown area of the bapatla district is about 107720 ha and gross sown area is about 153133 ha. Based on the profit analysis we have chosen four major crops in bapatla district like maize, paddy, chillies, black gram.

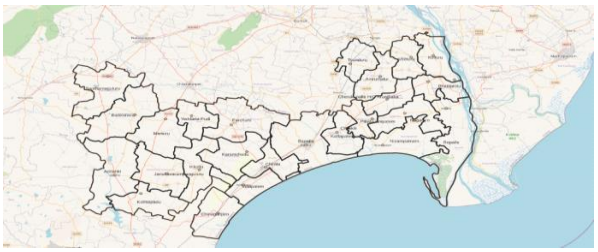

Fig – 1: Bapatla district (source: google image)

III. METHODOLOGY

The objective of the study is to maximize the farm returns by allocating the limited resources optimally. In this study the data was collected about four major crops i.e. maize, paddy, chillies, blackgram during the kharif season. The data regarding land allocation, cost of seeds, cost of fertilizers, cost of labour , cost of machinery , water cost is collected from the farmers. The linear programming technique is used in this study. The linear programming model is developed by using the averages of the sampling data with the objective to maximize the net returns. The resource constraints considered in this study are seeds, fertilizers, water, labour, machinery.

Linear programming is a mathematical method for optimizing the allocation of resources in a system. It involves finding the best possible solution to a problem characterized by linear relationships among variables, where certain constraints and an objective function need to be satisfied. The goal is to optimize the objective function while satisfying the constraints. The solution provides the values of the decision variables that produce the most favorable results and is known as the optimal solution.

In this study LINGO 20.0 software are used. LINGO 20.0 is used to analyse the results. LINGO is a tool that is designed to solve linear, non-linear, quadratic, integer models and provide an accurate result.

The general form of linear programming model is

Max $Z = \sum c_i x_i$ $i=1,2,3\ldots,n$

C_i=represents the cost vector

X_i= represents the decision variables

IV. RESULTS AND DISCUSSIONS

Table-1: Existing farm plan in Addanki mandal in Bapatla district

Addanki					
Particulars	Paddy	Maize	Chillies	Black gram	RHS
Land in acres	1	1	1	1	984
cost of seeds(Rs)	2500	3000	30000	800	36300
Cost of fertilizers(Rs)	12000	12000	65000	9000	98000
cost of water(Rs)	1000	2000	4000	1500	8500
cost of labour(Rs)	16000	12000	65000	6000	99000
cost of machinary(Rs)	4000	23000	10000	3500	40500
Operating capital(Rs)	35500	52000	174000	20800	282300
Net returns(Rs)	24500	11000	76000	13200	124700

Linear programming equation

MAX = 24500X1+11000X2+76000X3+13200X4

The decision variables of linear programming were

X1 = Areas allocated for paddy

X2 = Areas allocated for maize

X3 = Areas allocated for chillies

X4 = Areas allocated for black gram

Subjected to

$X_1+x_2+x_3+x_4 <=984$ (Land constraint)

$2500x_1+3000x_2+30000x_3+800x_4 <=36300$ (cost of seeds)

$12000x_1+12000x_2+65000x_3+9000x_4 <=98000$ (Cost of fertilizers)

$1000x_1+2000x_2+4000x_3+1500x4_4$ <=8500 (Cost of water)
$16000x_1+12000x_2+65000x_3+6000x_4$ <= 99000 (Cost of labour)
$4000x_1+23000x_2+10000x_3+3500x_4$ <=40500 (Cost of machinary)
$35500x_1$++$52000x_2+174000x_3+20800x_4$<=282300 (Operating capital)
X_1,x_2,x_3,x_4 >=0

Maximization of profit and land allocation in Addanki mandal

Table-2: Crop plan suggested by LP model

Particulars	LHS	RHS
Land (acres)	976.52	984
Net returns(Rs)	159841	

By adopting the Linear programming method the net returns are increased by 28%.

Table-3: Existing farm plan in Karlapalem mandal in Bapatla district

Karlapalem					
Particulars	Paddy	Maize	Chillies	Black gram	RHS
Land in acres	1	1	1	1	5295
cost of seeds(Rs)	2200	3200	35000	1200	41600
cost of fertilizers(Rs)	14000	13600	50000	9000	86600
cost of water(Rs)	1500	2500	1500	500	6000
cost of labour(Rs)	15700	10500	12000	6000	44200
cost of machinary(Rs)	5000	22000	7000	2000	36000
Operating capital(Rs)	38400	51800	185500	13300	216600
Net returns(Rs)	6600	11200	185500	13300	216600

Linear programming equation

MAX = 6600X1+11200X2+185500X3+13300X4

The decision variables of linear programming were
X1 = Areas allocated for paddy
X2 = Areas allocated for maize
X3 = Areas allocated for chillies
X4 = Areas allocated for black gram

Subjected to
$X_1+x_2+x_3+x_4$ <=5295 (Land constraint)
$2200x_1+3200x_2+35000x_3+1200x_4$ <=41600 (cost of seeds)
$14000x_1+13600x_2+500000x_3+9000x_4$ <=866000 (Cost of fertilizers)
$1500x_1+2500x_2+1500x_3+500x4_4$ <=6000 (Cost of water)
$15700x_1+10500x_2+12000x_3+6000x_4$ <= 44200 (Cost of labour)
$5000x_1+22000x_2+7000x_3+2000x_4$ <=36000 (Cost of machinary)
$38400x_1$++$51800x_2+185500x_3+13300x_4$ <=216600 (Operating capital)
X_1,x_2,x_3,x_4 >=0

Table-4: Crop plan suggested by LP model

Particulars	LHS	RHS
Land (acres)	5290.21	5295
Net returns(Rs)	246362	

By adopting the Linear programming method the net returns are increased by 13% by allocating the maximum land to black gram.

The net returns of farmers plan and crop plan suggested by LP model of all mandals in bapatla district are compared.

Maximization of profit and land allocation in karlapalem mandal

Table-5: Comparision of net returns

Mandals	Existing farm plan (Rs)	Crop plan suggested by LP model (Rs)
Vetapaelm	270200	305726
Inkollu	125700	157879
Korisapadu	126200	159841

Ballikurava	10755	127643
Santhamangulluru	209350	211733
Chirala	270700	306802
Chinaganjam	269900	309907
Kolluru	85000	93958
Vemuru	85000	94142
Karlapalem	216600	246562
Karamchedu	26810	309984
Addanki	124700	159841
Parchuru	125300	133417
Nagaram	68400	95267
Yeddanapudi	80150	136832
Bapatla	218400	247314
Pittalavanipalem	218100	253114
Martur	195800	232896
Amarthalur	18020	192075
Repalle	85500	95645
Janakavarampanguluru	126200	157879
Bhattiprolu	84000	95117
T.sunduru	180700	200978
Cherukupalle	93900	142718.2
Nizampatnam	86500	94680

Maximizing the profit in bapatla district

Table-6: Comparision of total net returns of entire bapatla district

District name	Exiting farm plan (Rs)	Crop plan suggested by LP model (Rs)
Bapatla	3401885	4561950

Table-7: Comparision of Land allocation in bapatla district

Mandals	Existing area (acres)	Land allocation by LP model (acres)
Vetapaelm	371	365.85
Inkollu	745	737.56
Korisapadu	1113	1105.52
Ballikurava	1086	1079.19
Santhamangulluru	1527	1523.09
Chirala	119	113.69
Chinaganjam	367	362.27
Kolluru	4149	4143.09
Vemuru	6481	6475.05
Karlapalem	5295	5290.21
Karamchedu	3181.33	3176.06
Addanki	984	976.52
Parchuru	1216	1212
Nagaram	9136	9127.33
Yeddanapudi	508	499.52
Bapatla	8977	8972.07
Pittalavanipalem	4418	4413.07
Martur	928	921.14
Amarthalur	9929	9926.05
Repalle	8073	8066.47
Janakavaram panguluru	1330	1322.56
Bhattiprolu	4663	4657.23
T.sunduru	7641	7638.25
Cherukupalle	6541	6532.03
Nizampatnam	4953	4946.91
Total	93731.33	93582.73

CONCLUSION

In this study linear programming model is used to determine the crop plan for the farmers of bapatla district. The objective is to maximize the net returns of the farmers by optimum resource allocation. In this study are Four major crops are selected. The comparative analysis of the result of the LP model and existing plan shows that the LP model increases the net returns by 34%.

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