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Optimum allocation of resources in vegetable cultivation

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ABSTRACT

The study has been carried out with reference to vegetable crops grown in Kakdwip block of South 24 Parganas district in West Bengal. Optimum allocation of resources has been exercised by working out an optimal crop plan for an average farm. Analytical tool of linear programming has been used for the purpose. A portion of resources has been allocated to potato for home consumption before the allocation of resources optimally. In optimal crop plan resources have been allocated in favour of two crops viz. brinjal and pointed gourd. Net return earned from optimal crop plan has been found to increase by 49.79 per cent over the net return earned in existing crop plan.

Key words: Existing crop plan, linear programming, optimum allocation of resources, optimal crop plan, resource restrictions

An efficient management of a farm is highly related to a decision making process in farm business. So many decisions are taken by farmers at various stages of farming operation. One of the important decisions in farming pertains to allocation of resources. So management of a farm largely depends on resource allocation. Resource of farmers is limited. Scarcity of resources necessitates judicious allocation for maximum return of the farmers. Limited resources are allocated to a number of crop enterprises by the farmers. They face problem in allocating their scarce resources optimally. Incidence of suboptimal level of resource use in farming keeps the farmers away from achieving their highest returns. In this study an attempt has been made to find the effect of optimum allocation of resources on returns of the farmers. This study has been carried out in respect of vegetable crops grown by the farmers in Kakdwip block under South 24 Parganas district of West Bengal.

MATERIALS AND METHODS

Optimum allocation of resources has been exercised through formulating an optimal crop plan by the technique of linear programming. Optimum allocation of resources in farming is one from which the highest returns are accrued to the farmers. Similarly optimal crop plan is one than which no other crop plan is better from the point of view of economic return. Prior to this attempt a portion of resources has been laid aside for allocation to potato crop as it has been found to be a common vegetable consumed across all the rural families. The objective function of linear programming is set out as follows :

Maximize $Z = \sum_{j=1}^{n} C_j X_j - rHL$

In conformity with the number of crop enterprises undertaken by the farmers in the area under study the above objective function is written in the following form :

Maximize

$$Z = (C_1X_1 + C_2X_2 + C_3X_3 + ... + C_{14}X_{14}) - rHL \quad ..... (1)$$

Subject to the following resource restrictions :

$$A_1X_1 + A_2X_2 + A_3X_3 + ... + A_{14}X_{14} \leq A \quad ..... (2)$$

$$W_1X_1 + W_2X_2 + W_3X_3 + ... + W_{14}X_{14} \leq W \quad ..... (3)$$

$$hl_1X_1 + hl_2X_2 + hl_3X_3 + ... + hl_{14}X_{14} - HL \leq FL \quad ....(4)$$

and non-negativity conditions: $X_1, X_2, X_3, ..., X_{14} \geq 0$, $HL \geq 0$

Where, Z is total net return (in Rupees) to fixed factor, $C_1, C_2, C_3, ..., C_{14}$ are net returns per hectare (in rupees) for j-th crop enterprises respectively. $X_1, X_2, X_3, ..., X_{14}$ stand for area under j-th crop enterprises in hectare (j = 1,2,.....,n, n=14) HL is total hired labour (in man-days) and r stands for wage rate (rupees /mandays);

$A_1, A_2, A_3, ...A_{14}$ are land coefficients for j-th crop enterprises respectively and A is total land available (in hectare); $W_1, W_2, W_3, ..., W_{14}$ are working capital coefficients (in Rs.) for j-th crop enterprises respectively and W is total working capital available on the farm (in Rupees); $hl_1, hl_2, hl_3, ..., hl_{14}$ are labour coefficients (in man-days) for j-th crop enterprises respectively and FL is family labour available (in man-days) for utilization in vegetable cultivation.

The study is based on primary data collected from 48 vegetable farmers residing in two villages namely Gholapara and Santrapara in Kakdwip block of South 24 Parganas district in West Bengal. The reference period of the study is 2001-2002. Information have been collected from the farmers on size of operational holding, area of land under different vegetable crops, gross value of crops, cost of cultivation, requirement of human labour for

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growing crops, family labour utilized in different crops, etc.

RESULTS AND DISCUSSION

A large number of vegetable crops have been found to be grown in the area under study. Vegetable crops along with area under different crops and percentage distribution of land to various crops are presented in table 1. Chilli is noted to account for the highest percentage of cropped area. Other crops are potato, cauliflower, lady's finger, cabbage, cucumber, bitter gourd etc., Average size of the cropped area has been estimated as 0.1135 hectare. The crops are alternative activities or enterprises to an average farm and compete for resources like land, working capital and family labour.

Table 1: Vegetable crops grown by farmers in the area under study

Crops	Area (ha)	% area under crops	Mean area under crops (farm ha^{-1})
Brinjal	0.14	2.57	0.0029
Tomato	0.20	3.67	0.0042
Cucumber	0.30	5.50	0.0062
Cauliflower	0.45	8.26	0.0094
Cabbage	0.35	6.42	0.0073
Chilli	2.43	44.59	0.0506
Potato	0.46	8.44	0.0096
Knolkhol	0.16	2.94	0.0033
Spinach	0.06	1.10	0.0012
Bitter gourd	0.26	4.77	0.0054
Pointed gourd	0.08	1.47	0.0017
Ridge gourd	0.06	1.10	0.0012
Lady's finger	0.42	7.70	0.0088
Cowpea	0.08	1.47	0.0017
Total	**5.45**	**100.00**	**0.1135**

Optimum allocation of resources has been attempted by working out an optimal crop plan for an average farm. Basic data incorporated in the programming are furnished in table 2 and table 3. Resource coefficients for different crop enterprises and net returns are presented in table 2. Resource like irrigated land, working capital and human labour have been taken into programming with a view to yielding an optimal crop plan. Irrigated land, working capital and family labour are limited. There is a provision for hiring-in of human labour in the programming framework. Resource constraints, average consumption requirement of potato and requirement of resources for its production are displayed in table 3. A portion of each type of resource is utilized in the production of potato. Residual amounts of resources are considered as resource restrictions in the programming framework.

Effect of optimum allocation of resources is observed in optimal crop plan worked out for an average farm. A comparison between existing and optimal crop plans has been drawn in terms of allocation of land to different crops and net return. Table 4 displays the comparative figures of two plans. Crop profile in existing plan is found to be wider than that in optimal plan. In optimal crop plan land has been allocated in favour of brinjal and pointed gourd. Net return earned in the optimal crop plan is found to be higher than that earned from existing plan. Net return is observed to increase in optimal plan by 49.79 per cent over the net return in existing plan. By allocating resources optimally farmers can considerably increase their net returns.

Reallocation of resources through optimum crop planning is found to lead to crop specialization. If vegetable cultivators in a particular area allocate their resources to some vegetable crops, production of those crops would exceed the demand of people (consumers) for those commodities just after harvest. Vegetable crops being highly perishable in nature require to be stored properly for future supply in the market. The study calls for provision of improved storage facility in the proximity of farming community growing vegetable crops and efficient structure of marketing for enabling the farmers to reap the benefit of improved cropping pattern.

Table 2: Resource coefficients for different crops and net returns used in linear programming

Crops	Working capital (₹ ha^{-1})	Human labour ha^{-1} (man-days)	Net return (₹ ha^{-1})
Brinjal	39000	475.43	46200
Tomato	37520	563.06	39354
Cucumber	17761	504.20	28352
Cauliflower	27750	334.95	34688
Cabbage	37500	342.67	40500
Chilli	15300	384.39	23082
Potato	18084	244.70	21997
Knolkhol	20669	320.25	26206
Spinach	13114	497.74	19613
Bitter gourd	18754	385.84	30052
Pointed gourd	19615	522.48	43385
Ridge gourd	20226	435.24	36594
Lady's finger	25803	471.72	29410
Cowpea	22688	477.08	28098

N. B.: Land requirement: 1 ha

Table 3: Average consumption requirement of potato per agricultural household, resource requirement for production of this crop and resource constraints used in linear programming

1.	Total number of agricultural households with vegetable farm	48
2.	Total population (Male + Female + Child)	260
3.	Annual consumption of potato	59.04 q
4.	Average annual level of consumption of potato per agricultural household	1.23 q
5.	Resource requirement for producing potato	
	i) Land	0.0112 ha
	ii) Working capital	₹ 202.54
	iii) Family labour	2.74 man-days
6.	Level of resources available on the farm	
	i) Land	0.1135 ha
	ii) Working capital	₹ 2672
	iii) Family labour	245 man-days
7.	Residual resources after production of potato (resource constraints used in programming framework)	
	i) Land	0.1023 ha
	ii) Working capital	₹ 2469.46
	iii) Family labour	242.26 man-days

N.B : i) Yield of potato is 109.85 quintals/hectare

ii) Resources constraints under serial number 7 are obtained by subtracting the resources under Sl. No. 5 from the corresponding resources under Sl. No. 6.

Table 4: Comparison of net return in existing and optimal crop plans

Crops	Crops grown in (ha)		Net return earned in (₹)	
	Existing plan	Optimal plan	Existing plan	Optimal plan
Brinjal	0.0029	0.0239	133.98	1104.18
Tomato	0.0042		165.28	
Cucumber	0.0062		175.78	
Cauliflower	0.0094		326.06	
Cabbage	0.0073		295.65	
Chilli	0.0506		1167.94	
Potato	0.0096	0.0112	211.17	246.36
Knolkhol	0.0033		86.47	
Spinach	0.0012		23.53	
Bitter gourd	0.0054		162.28	
Pointed gourd	0.0017	0.0784	73.75	3401.38
Ridge gourd	0.0012		43.91	
Lady's finger	0.0088		258.80	
Cowpea	0.0017		47.76	
Total			3172.36	4751.92

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