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A Quantitative Approach to Profit Optimization and Constraints of Mixed Cropping Pattern in Bargarh District Of Western Orissa

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ABSTRACT

Mix-cropping is profitable to the farmers. However there are production and marketing problems challenging its adaptation for the mass .The present study aims at analyzing profitability and constraints of mixed cropping pattern (i.e. the production of fruit, vegetable and other non-cereal crop along with the basic rice crop) in the area under study. An attempt has been made with Linear programming Model to compare the profitability of actual and suggested (optimum) production mix farming method considering the primary data collected from 400 sample farm households of three different villages (irrigated, tailed-irrigated and non-irrigated) located in three different blocks of Bargarh district of Orissa. Despite the profitability nature of the mix-cropping pattern the farmers in the area under study are not in a position to adopt and adapt this type of cropping, they are highly concentrating on the rice based and biased cropping as evident from the research result; this may be due to certain constraints that discourage them to go for Mix-cropping.

Introduction:

Individual farmers must repeatedly make decisions about what commodities to produce, by what method, in which seasonal time periods, and in what quantities. Decisions are made subject to the prevailing farm physical and financial constraints, and often in the face of considerable uncertainty about the planning period ahead. Uncertainty may arise in forecasted yields, costs, and prices for the individual farm enterprises, in enterprise requirements for fixed resources, and in the total supplies of the fixed resources available.

Traditionally, farmers have relied on experience, intuition, and comparisons with their neighbors to make their decisions. Formal techniques of budgeting and comparative analysis have been developed by farm management specialists, and these can be useful aids for making decisions in less complex situations or for analyzing selected decisions when all the other farm decisions are taken as given. It is only with the more recent advances in computers and in mathematical programming software that satisfactory procedures have been developed for whole-farm planning in more complex situations.

Whole-farm planning can assist farmers in efficiently adapting to a changing economic and technology environment. There are many examples of this normative use of linear programming. Surprisingly, though optimization models which adequately articulate the goals and constraints of representative farmers also can often predict quite accurately what these farmers do. This is particularly true in more stationary situations where farmers have time to adapt to the economics and technological environment. It is this predictive possibility of representative farm models that makes them useful for inclusion in agricultural sector models intended for aggregate policy analysis.

Literature Review: David W. Norman (1974) collected empirical data at the farmer's level in part of northern Nigeria and found mixed cropping is a rational strategy both in terms of profit maximization and risk minimization.

Laxminarayan and Rajagopalan (1977) applied LP to get the optimal cropping pattern for Punjab. They determined the area under different crops and amount of water releases from canal and tube well waters to get maximum benefit.

Khepar and Chaturvedi (1982) used LP to optimize cropping pattern using two resources of water, i.e., canal and ground water for a canal command area in Punjab. The objective was to maximize the net returns of the command area through crop production imposing constraints on land, water availability and water allocation

Butterworth (1985) indicated that in the current economic climate, linear programming could well be worth reconsidering as a maximizing techniques in farm planning

Richard et al. (1990) suggested a methodology for allocating variable input which has been used among crops and improvement of regional crop budget information.

Benli and Kodal (2003) developed a non-linear optimization model for the determination of optimum cropping pattern, water amount and farm income under adequate and limited water supply conditions

Hassan et al. (2005) mentioned that for the study, irrigated areas of Punjab province was selected for determining optimum cropping pattern under various price options

Borges et al. (2008) reported that LP models are effective tools to support initial or periodic planning of agricultural enterprises, requiring, however, technical coefficients that can be determined using computer simulation models

Salami et al. (2009) developed a LP model to estimate the direct costs on agriculture, and a macro econometric model to trace the indirect impacts on the rest of the economy in Iran.

Panigrahi et al. (2010) suggested a mathematical model for optimal allocation of area to different crop sequences with different objectives viz. minimization of soil loss, minimization of investment and maximization of net return from agriculture and was solved using LGP technique

T. Mkhabela(2005) suggested that there is a good possibility for stepping up production of these crops in marginal lands through appropriate crop diversification

Profitability of Crop Diversification: Linear programming is a method of determining a profit maximizing combination of farm enterprises that is feasible with respect to a set of fixed farm constraints.

Optimization and allocation of resources have been a high concerned for under developed and developing countries. India being the agro based economy resource utilization in agricultural sector is the prime factor influencing financial return to farmers. In that context mathematical model like linear- programming support in optimization of product mix in agriculture. In the present study a linear programming model has been developed to decide the optimal mix of cropping and a comparison is done between actual state and the optimal state of production.

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For a given farm situation the linear programming model requires specification of:

1. The alternative farm activities, their unit of measurement, their resource requirements, and any specific constraints on their production.
2. The fixed resource constraints of the farm.
3. The forecast activity returns net of variable costs, hereafter called gross margins.

To formulate the problem mathematically the following notation has been introduced.

Xj = the level of jth farm activity. Let n denote the number of possible activities; then j = 1 to n.

cj = net farm income of a unit of the j th activity.

aij = the quantity of the ith resource (e.g. acres of land or days of labour) required to produce one unit of the jth activity. Let m denote the number of resources; then i = 1 to m.

bi = the amount of the ith resources available (e.g. acres of land or days of labour).

With this notation, the linear programming model can be written as follows:

$$\max Z = \sum_{j=1}^{n} C_j X_j$$

(Objective function)

Such that

$$\sum_{j=1}^{n} a_{ij} X_j \leq b_i, \text{ where } i = 1 \text{ to } m \quad \text{(resource constraints)}$$

And

$$X_j \geq 0, \text{ all } j = 1 \text{ to } n \quad \text{(non-negativity constraint)}$$

In words, the problem is to find the farm plan (defined by a set of activity levels Xj, j = 1 to n) that has the largest possible total gross margin Z, but which does not violate any of the fixed resource constraints , or involve any negative activity levels

This linear programming model is constructed taking the pooled data of individual village's understudy .All resource constraints except land are considered in terms of unit (Rs). Whereas land is considered in terms of (acre). In the present study there are two decision variables X1 (Rice) and X2 (Vegetables and others).The objective is to maximize the gross profit (Z) with respects to the following constraints

- Bullock and Machine Labour
- Human Labour
- Seeds
- Fertilizer
- Irrigation
- Plant protection
- Marketing cost
- Interest
- Land

Objective of the study: The main objective of the study is to find the profitability position of mix-cropping and the constraints challenging its adaptation with the help of LP MODEL

Data Base and Methodology: Primary data for the study were collected (based on a pre-designed questionnaire) from 400 sample farm households of three different villages (irrigated, tailed-irrigated and non-irrigated) located in three different blocks of Bargarh district of Odisha besides the views of agriculture specialists and experts in the field of farming. Rice (paddy) crop is found dominating the cropping pattern followed by vegetables (i.e. vegetables and other horticultural crops) and other crops despite the mixed cropping pattern [a judicious combination of rice and other (mainly Vegetables) crops] is much profitable compared to the single dominant crop. This may be due to certain constraints that discourage them to go for Mix-cropping.

FORMULATION OF LP MODEL

VILLAGE-RESHAM
ALL-FARM

Max $Z=8596.21x_1 + 22864.41x_2$

Subject to

Bullock and Machine Labour	$1267.76 X_1 +1849.84X_2 \leq 1668897.26$
Human Labour	$839.05 X_1+1477.18 X_2 \leq 1121172.50$
Seeds	$783.23 X_1+1537.75 X_2 \leq 1057037.00$
Fertilizer	$1294.07 X_1+1810.53 X_2 \leq 1698422.00$
Irrigation	$139.37 X_1+209.53 X_2 \leq 183872.40$
Plant protection	$1114.51 X_1+1114.51 X_2 \leq 976409.00$
Marketing cost	$62.93 X_1+207.82 X_2 \leq 90476.56$
Interest	$451.95 X_1+492.31 X_2 \leq 583951.90$
Land	$X_1 +X_2 \leq 1286.20$

Where $X_1, X_2 \geq 0$

VILLAGE-LEMDHAR
ALL-FARM

Max $Z=5278.51x_1+14668.00x_2$

Subject to

Bullock and Machine Labour	$1325.71 X_1 +1871.90 X_2 \leq 813844.67$
Human Labour	$1438.33 X_1 +2567.61 X_2 \leq 904985.83$
Seeds	$686.15 X_1 + 1380.49 X_2 \leq 438100.00$
Fertilizer	$1278.74 X_1 +1576.65 X_2 \leq 775622.50$
Irrigation	$96.00 X_1 +182.63 X_2 \leq 60864.00$
Plant protection	$1586.13 X_1 +2267.20 X_2 \leq 974842.50$
Marketing cost	$91.71 X_1 +177.55 X_2 \leq 58272.37$
Interest	$486.70 X_1 + 648.83 X_2 \leq 297204.69$
Land	$X_1 +X_2 \leq 597.00$

Where $X_1, X_2 \geq 0$

VILLAGE-BADPADAR
ALL-FARM

Max $Z=8028.44x_1+21663.05x_2$

Subject to

Bullock and Machine Labour	$1198.32 X_1 +1741.33 X_2 \leq 1022332.44$
Human Labour	$909.37 X_1 + 1265.97 X_2 \leq 772957.82$
Seeds	$591.13 X_1 + 1166.39 X_2 \leq 520148.43$
Fertilizer	$1268.55 X_1 +1765.70 X_2 \leq 1078249.00$
Irrigation	$186.85 X_1 + 378.75 X_2 \leq 164933.72$
Plant protection	$940.39 X_1 + 1293.12 X_2 \leq 798501.40$
Marketing cost	$110.40 X_1 + 198.44 X_2 \leq 96140.07$
Interest	$476.81 X_1 + 539.98 X_2 \leq 398913.59$
Land	$X_1 +X_2 \leq 829.80$

Where $X_1, X_2 \geq 0$

ALL-FARM (VILLAGE-ALL)

Max $Z=7701.18x_1+29378.93x_2$

Subject to

Bullock and Machine Labour	$1259.22 X_1 +1820.25 X_2 \leq 3505074.36$
Human Labour	$990.90 X_1 +1690.89 X_2 \leq 2799116.16$
Seeds	$703.58 X_1 +1376.20 X_2 \leq 2015285.43$
Fertilizer	$1282.96 X_1 +1735.37 X_2 \leq 3552293.50$
Irrigation	$144.40 X_1 +257.62 X_2 \leq 409670.12$
Plant protection	$985.19 X_1 +1471.17 X_2 \leq 2749752.90$
Marketing cost	$83.66 X_1 +196.93 X_2 \leq 244889.00$
Interest	$467.09 X_1 +548.36 X_2 \leq 1280070.18$
Land	$X_1 +X_2 \leq 2713.00$

Where $X_1, X_2 \geq 0$

These above LP models are run with the help of linear programming software (Lindo) and final result is compared with the actual in the following table-1.It is found from the result that in all villages under study maximum profit results from the production of vegetables and other crops (X2) and some acre of land remained unused (S2) called slack. It is suggested that this unused land can be used for production of rice by making some necessary arrangement in the other resources. This optimal result is quite contradictory with the actual production mix adopted by the farms in all villages under study. In actual practice more lands are contributed towards production of rice.

It is observed from the above table that the cultivation of rice(Paddy) along with certain horticultural crops (like vegetables and fruits) and other non-cereals crops is more profitable compared to the cultivation of only rice. As evident from the table the allocation of land may be said to be optimum for more profit of the farms in all the villages (irrespective of irrigation status) provided major percentage of the total cultivated land is allocated towards the production of horticultural and non-cereal crops leaving a few space only for rice production. But despite the profitability nature of the above stated cropping pattern the farmers in the area under study are not in a position to adopt and adapt this type of cropping, they are highly concentrating on the rice based and biased cropping as evident from the table this may be due to certain constraints that discourage them to go for this. The constraints are discussed subsequently based on farmers' perception as follows.

Problems (Constraints) of Mixed Cropping Pattern: The table given below shows the perceptions of the various categories of farms belongs to different agro-climatic zones on the factors responsible for discouraging them to undertake more vegetables and non-cereal crops even though it is profitable.

Table: 1. Prospect (Profitability) of mixed cropping pattern

Village	Optimal				Actual			% increase in optimal profit over actual
	Z	X1	X2	Slack (S2)	Z	X1	X2	
V-I	19397150	0	848.356	437.844	11995292	1220.4	65.8	61.71
V-II	12588859	0	581.121	248.679	7364183	778.3	51.5	70.95
V-III	5942234	0	405.116	191.884	3536237	556	41	68.04
ALL	53469699	0	1820.002	892.998	24324885	2554.7	158.3	119.81

Table: 2. Perceptions of farmers on the factors discouraging for cultivating vegetable & other non-cereal crops (in %)

	Market/marketing Constraints		Infrastructural/ institutional Constraints		Resource Constraints		Attitudinal Constraints	
	Agreed	Disagreed	Agreed	Disagreed	Agreed	Disagreed	Agreed	Disagreed
V-1								
Small	60.24	39.76	66.27	33.73	36.14	63.86	50.60	49.40
Medium	64.52	35.48	70.97	29.03	38.71	61.29	48.39	51.61
Large	75.00	25.00	62.50	37.50	37.50	62.50	50.00	50.00
All	65.57	34.43	59.02	40.98	32.79	67.21	28.69	71.31
V-2								
Small	60.00	40.00	65.00	35.00	50.00	50.00	45.00	55.00
Medium	66.67	33.33	55.56	44.44	38.89	61.11	50.00	50.00
Large	75.00	25.00	50.00	50.00	25.00	75.00	50.00	50.00
All	61.48	38.52	65.57	34.43	24.59	75.41	49.18	50.82
V-3								
Small	68.33	31.67	58.33	41.67	35.00	65.00	46.67	53.33
Medium	70.59	29.41	52.94	47.06	35.29	64.71	44.12	55.88
Large	100.00	0.00	50.00	50.00	100.00	0.00	100.00	0.00
All	64.74	35.26	51.28	48.72	42.31	57.69	61.54	38.46
All-V								
Small	63.37	36.63	62.71	37.29	40.26	59.74	47.19	52.81
Medium	67.47	32.53	60.24	39.76	37.35	62.65	46.99	53.01
Large	78.57	21.43	57.14	42.86	42.86	57.14	57.14	42.86
All	64.00	36.00	58.00	42.00	34.00	66.00	47.75	52.25

It is observed from the above table that most of the farms have opined that they are discouraged to go for vegetables and other non cereals crops due to many constraints such as marketing infrastructure and attitude constraints in order followed by resource constraints. Thus, even if the vegetables &other non-cereals crops are profitable these constraints pose as major impediments towards the production of these products in the area under study. Thus, the policymakers should take care of this fact for enabling the farmers of all size groups in all the irrigated non irrigated area to go for crops diversification to generate more income and employment for them to improve their status

The constraints broadly grouped into four categories as depicted in the above table includes the following factors.

Market/marketing Constraints:

- Unorganized market or inaccessible market
- Lack of exportability of vegetable
- Price fluctuation
- Lack of selling strategy
- Perishability nature of products
- Seasonality of produces
- Limited harvesting Period compared to demand
- Product bulkiness
- High bargaining strength of Broker and trader compared to farmers
- Price/ quantity risk
- Access to market information
- Lack of market/marketing infrastructure
- Standard and grade
- Packaging

Resource Constraints:

- Quality and availability of Land
- Management or maintenance is more for vegetables
- Lack of proper technology
- Lack of time

- Input cost in Rice production is less
- Climatic condition
- Water availability
- Labour intensive activities
- Lack of adequate input supply

Infrastructural/ institutional Constraints:

- No storage arrangement
- Bank/Banking support /facilities
- Lack of government promotion
- Lack of training or access to extension service
- Transportation problem
- Lack of strong cooperatives
- Accessibility and availability of credit
- Access to infrastructure

Attitudinal Constraints:

- Traditional practices
- Lack of awareness
- Risk averting attitude
- Rice biased cropping pattern
- Rice is the staple food and main source of livelihood

References:

[1] BENLI, B., AND KODAL, S. (2003), "A non-linear model for farm optimization with adequate and limited water supplies application to the south-east Anatolian project (GAP) region", Agric. Water Manage., 62: 187-203.

[2] BORGES JÚNIOR, J.C.F.; FERREIRA, P.A.; HEDDEN-DUNKHORST, B.; ANDRADE, C.L.T. (2008) Modelocomputacionalparasuporte à decisãoemáreasirrigadas. Parte I: Desenvolvimento e análise de sensibilidade. *RevistaBrasileira de EngenhariaAgrícola e Ambiental*, Campina Grande, v.12, n.1, p.3-11,

[3] BUTTERWORTH K (1985). "Practical applications of linear integer programming in agriculture". J. Opr. Res. Soc., 36(2): 99-107.

[4] David W. Norman (1974) "Rationalizing mixed cropping under indigenous conditions: The example of Northern Nigeria', Journal of Development Studies, Volume 11,issue 1,

[5] HASSAN, I. HUSSAIN, Z. AND AKBAR, G. (2005). "Effect of Permanent raised beds on water productivity for irrigated maize-wheat cropping system" ACIAR Proceedings No. 121, of a workshop held in Grifith, NSW, Australia, 1-3 March entitled *Evaluation and performance ofpermanent raised bed cropping systems inAsia, Australia and Mexico*

[6] KHEPAR,, S.D. AND CHATURVEDI M.C.: (1982). "Optimum cropping and groundwater management," water resource Bulletin 18(4), 655 – 660.

[7] PANIGRAHI D, MOHANTY PK, ACHARYA M, SENAPATI PC (2010). "Optimal Utilization of Natural Resources for Agricultural Sustainability in Rain fed Hill Plateaus of Orissa:.\, Agricultural Water Management. 97:7

[8] Richard E. Just, David Zilberman, EithanHochman and Ziv Bar-Shira (1990)" Input Allocation in Multicrop Systems", *American Journal of Agricultural Economics*, Vol. 72, No. 1 pp. 200-209

[9] SALAMI H, SHAHNOOSHI N & THOMSON K. (2009). "The economic impacts of drought on the economy of Iran: An integration of linear programming and macro econometric modeling approaches". *Ecological Economics*, 68(4): 1032–1039.

[10] T. MKHABELA (*2005)* "Technical Efficiency in A Vegetable Basedmixed-Cropping Sector In Tugela Ferry," Msinga District, Kwazulu-Natal, *Agrekon, Vol 44, No 2,*

[11] V.LAKSHMINARAYAN,S.RAJAGOPALAN. "Optimal cropping pattern in a river basin". Journal of Irrigation and Drainage, ASCE, 1977, 103: 53–70