Agricultural Economics Research Review
Vol. 20 January-June 2007 pp 147-156

Research Note

Optimising Farm Plans in Different Farming Systems

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Abstract

This study has been conducted to optimize farm plans in different farming systems in Orathanadu block of the Thanjavur district in Tamil Nadu by randomly selecting 150 livestock farmers from 6 villages. A linear programming (LP) model has been developed to arrive at the optimal farm plans for different categories of farms (landless, marginal, small and large) separately. The net returns from dairying have been found as Rs 25,864, which is about 29.7 per cent to the total and it also could contribute maximum to employment (55 per cent). The optimal plan for small-farmer category has revealed that dairy animals have contributed maximum net returns (Rs 31,640) to the aggregate net returns (Rs 49,105). Dairy animals have also generated an employment of 840 humandays as against 45, 80 and 38.6 humandays, from paddy–I, paddy–II and groundnut crops, respectively. The optimal plan for marginal farmers has indicated that dairy animals and sheep could be more attractive in terms of income and employment generation. Optimal plan for landless households has revealed that 5 dairy animals, 15 goats and 15 sheep could be valuable for increasing their income and employment. Income increase in the optimal farm plans has been found maximum (223.5 per cent) in large-farmer category, followed by small (192.7 per cent), marginal (180.1 per cent) and landless households (116 per cent). The increase in employment of family labour in the optimal plan over the existing plan in all categories has indicated that optimal combination of enterprises could reduce unemployment.

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The authors are grateful to the referee for his constructive suggestions to improve the paper.

Introduction

Achieving rural prosperity through poverty alleviation has been a major objective of the country. Although several attempts have been made to achieve this objective, India still suffers from unemployment or atleast underemployment in the rural areas and is unable to generate adequate level of income to mitigate poverty. With the crop sector experiencing a high degree of risk and uncertainty due to the vagaries of nature, livestock component offers a strong potential for a more stable and continuous employment and income to the rural poor, enabling them to come over their income-generating difficulties. There has been considerable scope for increasing employment and income generation in the off-farm operations in the agricultural sector, viz. livestock and forestry (Ghayur, 1987). Integration of livestock component with the crop sector is understood to have the ability to mitigate the problems of monsoon failures by making the mutual advantages of the integration feasible through forward and backward linkages. In this context, this study has been conducted to optimize the farm plans for different farming systems, so as to reap maximum harvest from farming.

Methodology

Orathanadu block of the Thanjavur district in Tamil Nadu was purposively selected for the study, as it was the block where a typical, monsoon-relying, crop-based farming system was being followed, resulting sometimes, if not often, in uncertain farm income due to monsoon failures and thus increasing the possibilities of diversification with livestock component.

Out of 57 villages available in this block, 6 villages (around 10 per cent) were randomly selected. A sample of 150 livestock farmers was selected at random from the chosen villages. The data on landholdings, size and kind of livestock and expenditure for and income from crop and livestock farm activities relating to the year 1996-97 were gathered through the pre-structured, pretested interview schedules from the selected farmer respondents.

A linear programming (LP) model was developed to arrive at the optimal plans of production for different categories of farmers (landless, marginal, small and large) separately. The models included crop production, livestock production and labour employment as activities. The general form of the linear programming model used was as follows:

$$\text{Max } Z = \sum_{j=1}^{10} Cj\ Xj$$

$$\text{Subject to } \sum_{i=1}^{6} a_{ij} X_j \leq = \geq b_i$$

where,

Z = Total household annual net returns (in Rs)

C_j = Annual net returns per unit of j^{th} activity (in Rs)

X_j = Level of the j^{th} activity

b_i = Supply level of the i^{th} resource

a_{ij} = Requirement of the i^{th} resource per unit of the j^{th} activity (input–output coefficient)

The set of activities and constraints included in the model and identified on the basis of sample observations, have been presented in Tables 1 and 2, respectively. For the landless-households category, only 4 activities (non-crop activities) and 3 constraints (non-land constraints) were included.

All the parameters of the model were estimated using sample mean as the estimator. In the constraint set, availability of land and labour for season-I (June – September), season-II (October – January) and season-III (February – May) were calculated and used in the model. Optimal plans were developed for different categories of households without restrictions on capital and were compared with the existing plans.

Results and Discussion

Optimal Farm Plan for Large Farmer Category

The aggregate net returns and employment from crop and livestock activities for large farmer category under optimal plan arrived at using LP

Table 1. Activity set for linear programming model

Activity	Variable	Unit
Paddy – I (*Kuruvai*)	X_1	Acre
Paddy – II (*Samba*)	X_2	Acre
Groundnut	X_3	Acre
Gingelly (Sesame)	X_4	Acre
Blackgram	X_5	Acre
Soyabean	X_6	Acre
Off–farm labour employment	X_7	Human-days
Dairy animals (cow and buffalo)	X_8	Number
Goat	X_9	Number
Sheep	X_{10}	Number

Table 2. Constraint set for the linear programming models

Constraints	Relation	Level	Unit
Large farmers			
Land available for season-I	L	2	Acre
Land available for season-II	G	5	Acre
Land available for season-III	L	6	Acre
Labour available for season-I	L	312	Human-days
Labour available for season-II	L	420	Human-days
Labour available for season-III	L	430	Human-days
Small farmers			
Land available for season-I	L	1	Acre
Land available for season-II	L	2.12	Acre
Land available for season-III	L	2.12	Acre
Labour available for season-I	L	293	Human-days
Labour available for season-II	L	360	Human-days
Labour available for season-III	L	354	Human-days
Marginal farmers			
Land available for season-I	L	1.16	Acre
Land available for season-II	L	1.16	Acre
Land available for season-III	L	1.16	Acre
Labour available for season-I	L	300	Human-days
Labour available for season-II	L	300	Human-days
Labour available for season-III	L	400	Human-days
Landless households			
Labour available for season-I	L	280	Human-days
Labour available for season-II	L	300	Human-days
Labour available for season-III	L	340	Human-days

Note: L – less than or equal to; G – greater than or equal to.

technique have been depicted in Table 3. It is evident that only three out of six crops, considered in the model, appeared to be beneficial. Thus, crop-farming contributed an amount of Rs 61,364 (70.3 per cent) to aggregate net returns of Rs 87,228 under optimal plan. The net returns from the dairying were Rs 25,864, which is about 29.7 per cent of the total returns.

The maximum contribution to aggregate employment was from dairy (55 per cent), followed by paddy - II (21.6 per cent), groundnut (14.3 per cent) and paddy - I (9.1 per cent). The considerable contribution to the income and employment from dairying in the optimal plan clearly revealed that dairying could be considered as a source of increasing employment in the large-farmers category under the given situation.

Table 3. Optimal level of activities, net returns and employment from LP model for large farmers

Activity	Optimal solution	Net returns per unit (Rs)	Total net returns (Rs)	Employment per unit (human-days)	Total employment (human-days)
Paddy-I	2 acres	3900	7800	45.3	90.6
			(8.9)		(9.1)
Paddy-II	5 acres	4000	20000	43.0	215.0
			(22.9)		(21.6)
Groundnut	6 acres	5594	33564	23.7	142.2
			(38.5)		(14.3)
Dairy animals	8 Nos.	3233	25864	68.4	547.2
			(29.7)		(55.0)
Aggregate value			87228		995.0
			(100.0)		(100.0)

Figures within the parentheses indicate percentages to total
(Existing plan = Paddy-I: 0.88 acre, Paddy-II: 4.98 acres, Groundnut: 0.58 acre, Gingelly: 1.94 acres, Black gram: 0.38 acre, Soyabean: 0.40 acre; Dairy animals: 3, Goat: 1 and Sheep: 5)

Table 4. Optimal level of activities, net returns and employment from LP model for small farmers

Activity	Optimal solution	Net returns per unit (Rs)	Total net returns (Rs)	Employment per unit (human-days)	Total employment (human-days)
Paddy-I	1 acre	2600	2600.0	45.0	45.0
			(5.3)		(4.5)
Paddy-II	1.6 acres	2614	4182.4	50.0	80.0
			(8.5)		(8.0)
Groundnut	2.12 acres	5039	10862.7	18.2	38.6
			(21.8)		(3.9)
Dairy animals	7 nos.	4520	31640.0	120.0	840.0
			(64.4)		(83.7)
Aggregate value			49105.10		1003.6
			(100.0)		(100.0)

Figures within the parentheses indicate percentages to total
(Existing plan = Paddy-I: 0.22 acre, Paddy-II: 1.80 acres, Groundnut: 0.90 acre, Gingelly: 0.80 acre, Soyabean: 0.02 acre; Dairy animals: 2, Goat: 2 and Sheep: 1)

Optimal Farm Plan for Small-Farmers Category

The results of the optimal plan obtained for the small-farmers category, presented in Table 4, reveal that dairy animals contributed maximum (Rs

31,640) to the aggregate net returns (Rs 49,105) of the optimal plan. The contribution from dairy animals was 64.4 per cent, followed by groundnut (21.8 per cent), paddy - II (8.5 per cent) and paddy-I (5.3 per cent).

The dairy animals would also generate employment of 840 human-days as against 45, 80 and 38.6 human-days, from paddy-I, paddy-II and groundnut crops, respectively. The maximum contribution (64.4 per cent) to the aggregate net returns and maximum employment contribution (83.7 per cent) to the aggregate employment from dairy animals revealed that dairying practised by the small-farmers category would be a strong of potential source of income and employment generation.

Optimal Farm Plan for Marginal-Farmers Category

In the optimal plan obtained for the marginal-farmers category, shown in Table 5, only three out of six crops considered in the model appeared to the beneficial. Similarly, the dairy animals and sheep were the livestock that could be more attractive in terms of income and employment generation.

In crop enterprises, the contribution of paddy-I was maximum (9.7 per cent), followed by paddy-II (7.8 per cent) and groundnut (19.6 per cent) to the aggregate net returns. The earnings from dairy and sheep farming were quite high, Rs 16,000 (42 per cent) and Rs 7,650 (20.9 per cent), respectively.

Table 5. Optimal level of activities, net returns and employment from LP model for marginal farmers

Activity	Optimal solution	Net returns per unit (Rs)	Total net returns (Rs)	Employment per unit (human-days)	Total employment (human-days)
Paddy-I	1.16 acres	3439	3989.3 (9.7)	60.0	69.6 (7.3)
Paddy-II	1.16 acres	2567	2977.7 (7.8)	60.0	69.6 (7.3)
Groundnut	1.16 acres	6440	7470.4 (19.6)	70.0	81.2 (8.5)
Dairy animals	5 numbers	3200	16000.0 (42.0)	100.0	500.0 (52.1)
Sheep	17 numbers	450	7650.0 (20.9)	14.0	238.0 (24.8)
Aggregate value			38087.4 (100.0)		958.4 (100.0)

Figures within the parentheses indicate percentages to total
(Existing plan = Paddy-I: 0.05 acre, Paddy-II: 0.99 acre, Groundnut: 0.19 acre, Gingelly: 0.67 acre, Black gram: 0.14 acre; Dairy animals: 2, Goat: 5 and Sheep: 2)

It was also observed that dairy and sheep contributed maximum employment of 500 (52.1 per cent) and 238 (24.8 per cent) human-days to the total employment, respectively. It could thus be inferred that 5 dairy animals and 17 sheep, if maintained by the marginal farmers, can potentially augment their income and employment.

Optimal Farm Plan for Landless Households

A browse of Table 6 would reveal that 5 dairy animals, 15 goats and 15 sheep could be valuable for landless households for increasing their income and employment. Out of the livestock enterprises, the dairy animals contributed maximum (52.6 per cent), followed by equal contributions (23.7 per cent each) from goat and sheep enterprises.

Table 6. Optimal level of activities, net returns and employment from LP model for landless households

Activity	Optimal solution	Net returns per unit (Rs)	Total net returns (Rs)	Employment per unit (human-days)	Total employment (human-days)
Dairy animals	5 nos.	3505	17525	115	575
			(52.6)		(60.6)
Goats	15 nos.	525	7875.0	13	195
			(23.7)		(20.5)
Sheep	15 nos.	525	7875.0	12	180
			(23.7)		(18.9)
Aggregate value			33275		950
			(100.0)		(100.0)

Figures within the parentheses indicate percentages to total
(Existing plan = Dairy animals: 2, Goat: 6 and Sheep: 2)

The employment generated through the optimal plan was the highest in dairy (575 human-days), followed by goats (195 human-days) and sheep (180 human-days). Hence, inclusion of dairy, goats and sheep in the farm plan of landless households indicates a promising increase in their net returns and employment.

Satheesh *et al*. (1985) have examined three different farming systems in the East Godawari district of Andhra Pradesh and found that the farming system with dairy activity would increae income and employment if the capital was not a constraint. Saini and Singh (1985) have found that the cropping plans developed with livestock activity led to a marked increase in human labour employment. Deoghare and Sharma (1992) found that optimaization of farm resources including borrowed capital and the

simultaneous use of dairy and poultry enterprises increased not only the net returns but also the labour employment. Shukla *et al*. (1994), by developing two optimal plans, have shown that dairying appeared to be a potent source of increasing income and employment for marginal farms, even under the existing resource-use.

Change of Income and Employment in Optimal Plan over Existing Farm Plan

The per cent change in income, employment and unemployment under optimal farms plans over the existing plans of different categories of households has been presented in Table 7.

Change in Income

The income increase in the optimal farm plans was the maximum (223.5 per cent) in the large-farmers category, followed by small farmers (192.7 per cent), marginal farmers (180.1 per cent) and landless households (116 per cent). The increase in income over the existing plan signifies the

Table 7. Percentage change of income and employment in optimal plan over the existing plan

Particulars	Existing plan	Optimal plan	Change, %
Income (Rs)			
Large farmers	26959	87228	223.5
Small farmers	16772	49105	192.7
Marginal farmers	13597	38087	180.1
Landless labourers	15403	33275	116.0
Employment (human-days)			
Large farmers	504	995	97.2
Small farmers	422	1003	137.5
Marginal farmers	445	958	115.4
Landless labourers	693	950	37.1
Human-days available			
Large farmers	1162	1162	-
Small farmers	1007	1007	-
Marginal farmers	1000	1000	-
Landless labourers	920	920	-
Unemployment (human-days)			
Large farmers	657	167	-74.5
Small farmers	584	3	-99.4
Marginal farmers	555	41	-92.5
Landless labourers	226	-30	-113.2

potentiality of optimal plan in increasing the income and employment of the farming households.

Change in Employment

The increasing employment for family labour in the optimal plan over the existing plan in all the categories of households indicated that optimal combination of enterprises could reduce the unemployment by increasing the employment of family labour. The reduction in unemployment in the optimal plan over the existing situation was found 74.5 per cent in the large-farmers category, and 99.4, 92.5 and 113.2 per cent, respectively in the small-farmer, marginal-farmer and landless-labour categories of households. As observed by Sastry *et al*. (1993), it was the livestock, even in landed households, which gave stability to the household income rather than the land. Further, among the livestock, dairying and goat-rearing were the two important sub-systems that generated more income and employment (Prabaharan and Thirunavukkarasu, 1992).

The percentage change in the employment of family labour was highest in the small-farmers category (137.5 per cent), followed by marginal (115.4 per cent), large (97.2 per cent) and landless (37.1 per cent) households.

Conclusions

From the optimal plans for different categories of households, it could be inferred that there are significant potentials for income and employment generation in the study area. These could be achieved by making just a few adjustments in the existing farm plans, suggested by the developed optimal farm plans. However, these optimal plans would be feasible only when sufficient capital is made available to the respective farmers to meet the increased cash requirements. The increased capital / cash requirement has arisen, because the new optimal plans suggest inclusion of a higher number of the existing or new livestock species in the farming systems, which are believed to be capital intensive.

The increase in employment in optimal over the existing plans has shown a reduction in unemployment in all categories of households. The analysis has shown that livestock components contribute a larger percentage to the total income in the landless farming systems than crop-based farming systems, indicating the significance of livestock in augmenting the income of the poorer section of the society. In addition, livestock farming is able to absorb the idle family labour, specially the female labour. Despite the significance of the livestock, it is known that the rural farmers just because of the constraint – largely capital, could not harvest the attainable benefits from

livestock. It can be well understood that given the capital, the farmers would be able to rear more livestock with same land and labour and would reap better benefits in terms of income and employment.

References

Deoghare, P.R. and B.M. Sharma (1992) Prospects of increasing farm income on marginal and small farms. *Agricultural Situation in India*, **XLVII:** 925-929.

Ghayur, S. (1987) Rural Barani areas: Present state of employment and prospects – Results from a field survey of seven villages. *Journal of Rural Development and Administration*, **19** (1): 36-53.

Prabaharan, R. and M.Thirunavukkarasu (1992) *Goat Production in Tamil Nadu – Current Status, Problems and Prospects.* Research Report/ No. 18. Department of Animal Husbandry and Economics, Madras Veterinary College, TANUVAS, p.29.

Saini, A.S. and R.V. Singh (1985) Impact of diversification on income, employment and credit needs of small farmers in Punjab. *Indian Journal of Agricultural Economics,* **XL** (3): 310 – 316.

Sastry, N.S.R., P. Bullerdieck and Ch.F.Gall (1993) Contribution of livestock subsystem to the income of rural households of different categories in comparison to that from crop farming and wage earning in a South Indian Province. *Indian Journal of Animal Sciences*, **63** (2): 201-207.

Satheesh, A.V., B.M. Sharma and V.K. Sharama (1985) Impact of diversification and liberal credit policy on income and employment of non-viable farmers in Pitahpuram block of East Godawari district (AP). *Indian Journal of Agricultural Economics,* **XL** (3): 323 – 329.

Shukla, A.N., S.N. Gupta, B.L. Nantyal, S.K. Tiwari and P.G. Biswas (1994) An analysis of income and employment in crop, dairy and poultry enterprises. *Indian Journal of Dairy Science*, **47**(7): 549-555.