Agricultural Economics Research Review
Vol. 18 July-December 2005 pp 241-252

A Study on Economic Analysis of Elephant Foot Yam Production in India

T. Srinivas[1] and S. Ramanathan[2]

Abstract

Elephant foot yam is traditionally cultivated on commercial scales in the states of Andhra Pradesh, Tamil Nadu, Kerala and West Bengal. The statistics on area, production and yield of this crop are not available in the literature and this paper has estimated the cost of cultivation, farm income measures and resource-use efficiency of the crop in these states, except West Bengal. The study has indicated the gross cost of cultivation as Rs 1,73,105, Rs 93,450 and Rs 1,68,032 per ha and the benefit-cost ratios as 1.38, 1.38 and 1.50 for elephant foot yam cultivation in Kerala, Andhra Pradesh and Tamil Nadu, respectively. The study has revealed excessive use of all NPK fertilizers in Kerala, indicating the need for rationalization in use of these inputs, while there is a scope for increase in the use of these inputs, except nitrogenous fertilizers, in Tamil Nadu and Andhra Pradesh. Expenditures on manures in Tamil Nadu and hired human labour in Kerala can be enhanced without any adverse effect on the productivity of the crop. The analysis has revealed the need for reorganization of farm resources so as to maximize the returns on elephant foot yam farms under different production systems in India.

[1] Scientist (SS) Agricultural Economics, Email: srinictcri@yahoo.com and
[2] Principal Scientist (Agricultural Extension), Email : srjv84@yahoo.com
Central Tuber Crops Research Institute, Sreekariyam, Thiruvananthapuram 695 017, Kerala.

The authors are very much thankful to the reviewers of this research paper for their valuable suggestions for improving the paper. They also wish to extend their gratitude to the Director, Central Tuber Crops Research Institute for the encouragement, help and suggestions rendered during the project.

This study formed a part of the Institute research project entitled “Resource Productivity and Returns to Scale in Tropical Tuber Crops Cultivation in India”, funded by ICAR, New Delhi.

Introduction

Elephant foot yam [*Amorphophallus paeoniifolious* (Dennst.) Nicolson (Araceae)] is a tropical tuber crop that offers excellent scope for adoption in the tropical countries as a cash crop due to its production potential and popularity as a vegetable in various delicious cuisines. It is a crop of south-east Asian origin, and grows in wild form in the Philippines, Malaysia, Indonesia and south-east Asian countries. Many indigenous ayurvedic and unani medicinal preparations are also made using its tubers. The tubers are believed to have blood purifying characteristics and are used in medicines for the treatment of piles, asthma, dysentery and other abdominal disorders.

In India, it is commonly known as *Suran* or *Jimmikand* and is traditionally cultivated on commercial scales in the states of Andhra Pradesh, Tamil Nadu, West Bengal and Kerala. In the northern and eastern states of India, local cultivars grown in wild form are generally used for making vegetables, pickles and indigenous ayurvedic preparations for various ailments. The tubers of wild plants are highly acrid and cause irritation in throat and mouth due to excessive amount of calcium oxalate present in them. In India, the cultivation of elephant foot yam is slowly spreading to other states like Bihar and Uttar Pradesh also. The most popular variety for commercial cultivation in India is "*Gajendra*", which is a local selection from Kovuur area of Andhra Pradesh. This crop also offers excellent export potential from India, since it is not generally cultivated commercially in other countries.

The statistics of area, production and yield of elephant foot yam are not available at present and only unpublished data are available for some states where it is being cultivated on a commercial scale. Hither to no study on economic analysis of this crop in India has been found in literature. Hence a study has been made to estimate the cost of cultivation, farm income measures and resource-use efficiency of the crop in the states where it is being cultivated on a commercial scale in India.

Methodology

Purposive and multistage random sampling technique was used for the study. Three major elephant foot yam growing states, viz. Kerala, Tamil Nadu and Andhra Pradesh, were selected. One district in Kerala (Ernakulam), two districts in Tamil Nadu (Virudhnagar and Tirunelveli) and two districts in Andhra Pradesh (East and West Godavari), where elephant foot yam is largely grown, were selected for identification of two blocks from each district. From each block two villages were selected on the basis of concentration of elephant foot yam cultivation. Thus, 4 villages, 2 blocks from each selected district were covered for collecting the sample. Thirty

farmers in each state, making a final sample of 90 elephant foot yam farmers, were selected randomly from the selected blocks for data collection. Primary data were collected from lowland production systems in Kerala and irrigated production systems in Tamil Nadu and Andhra Pradesh. Data were collected using pre-tested and well-structured interview schedule. Data corresponded to the agricultural year 2002-2003. Tabular and percentage analyses were conducted to work out the cost concepts and farm income measures for elephant foot yam.

A functional relationship was developed between the output and inputs to study the resource-use efficiency of elephant foot yam farms. In the present study, Cobb-Douglas production function was fitted after observing the scatter diagram.

The production function had the form as given by Eq. (1):

$$Y = a\ X_1^{b1}\ X_2^{b2} \ldots .\ X_n^{bn} \quad \ldots(1)$$

where, Y is output and X_1 to X_n are inputs

This function was fitted in the log-term with gross returns (y) as dependent variable and inputs as explanatory or independent variables.

The production function after logarithmic transformation is represented by Eq. (2):

$$\log Y = \log a + b_1 \log X_1 + b_2 \log X_2 + \ldots\ldots. + b_n \log X_n \quad \ldots(2)$$

where,

Y = Gross returns in Rs per ha
a = Constant or intercept
X_1 = Farm size in ha
X_2 = Cost on human labour in Rs per ha
X_3 = Cost on family labour in Rs per ha
X_4 = Expenditure on planting material in Rs per ha
X_5 = Expenditure on manures in Rs per ha
X_6 = Expenditure on nitrogenous fertilizers in Rs per ha
X_7 = Expenditure on phosphatic fertilizers in Rs per ha
X_8 = Expenditure on potassium fertilizers in Rs per ha
X_9 = Expenditure on irrigation in Rs per ha

The sum of regression co-efficient ($\sum b_i$) indicates returns to scale. The marginal value productivity (MVP) for each input (X_i) was calculated using Eq. (3):

$$Y_i = (\bar{Y} / \bar{X}_i)\ b_i \quad \ldots (3)$$

where,

Y_i = Marginal value productivity of input
$\bar{Y}$ = Geometric mean of gross returns
$\bar{X}_i$ = Geometric mean of the i^{th} input
b_i = Elasticity of output with respect of factor x_i.

The ratio of marginal value products to opportunity cost for each factor was calculated to determine the resource-use efficiency.

Results and Discussion

Amorphophallus is cultivated in lowland production system in Kerala, and irrigated production system in Andhra Pradesh and Tamil Nadu. In Kerala, the crop is planted at a spacing of about 1m × 1m on mounds, whereas in Andhra Pradesh and Tamil Nadu, it is planted on flat beds. NPK ratio was observed to be 401:189:446, 451:214:207 and 131:246:91 in Kerala, Andhra Pradesh and Tamil Nadu, respectively. Two planting seasons were followed in Andhra Pradesh.

Cost Concepts and Farm Income Measures for Elephant Foot Yam

The cost concepts, farm income measures and labour days involved in Amorphophallus cultivation are presented in Table 1.

Lowland Production System in Kerala

The gross cost of cultivation was estimated as Rs 1,73,105 per ha, in which expenditure on planting material (Rs 69,864) was maximum. Among the labour costs, operations like harvesting, interculturing, pit making and transplanting and land preparation were found to be expensive. Expenditure on electricity/fuel for irrigation was also high, Rs 8,198. On an average, farmers got an yield of 33.5 tonnes per ha with a gross income of Rs 2,36,368 at the average selling rate of Rs 7.15 per kg of tuber. Benefit cost ratio was worked out to be 1.38:1. Farm business income, owned-farm business income, farm investment income and family labour income were estimated to be Rs 91,395, Rs 85,033, Rs 67,353 and Rs 80,943, respectively. The cultivation of elephant foot yam required on an average 203.17 hired human days, 114.13 family labour days and 4.22 tractor labour days.

Irrigated Production System in Andhra Pradesh

The gross cost of cultivation was estimated to be Rs 93,450 per ha, in which expenditure on the planting material (Rs 24,847) was maximum. The

Table 1. Cost concepts and farm income measures of elephant foot yam cultivation under lowland production system in Kerala and irrigated production system in Andhra Pradesh and Tamil Nadu

(Rs/ha)

Particulars	Kerala		Andhra Pradesh		Tamil Nadu	
	Low-land	Per cent to Cost C	Irriga-ted	Per cent to Cost C	Irriga-ted	Per cent to Cost C
Planting material	69864.50	40.36	24846.83	26.59	84235.37	47.62
Manures	13651.04	7.89	7895.19	8.45	12530.62	8.25
Fertilizers	12402.96	7.16	10068.34	10.77	6491.44	4.59
Plant protection chemicals	–	–	303.75	0.33	–	–
Gross material costs	95918.50	55.41	43114.11	46.14	103257.43	60.46
Gross labour costs	36096.78	20.85	21291.52	22.78	29200.94	19.22
Land revenue	136.95	0.08	390.01	0.42	492.50	0.33
Depreciation	1141.11	0.66	550.54	0.59	719.48	0.78
Interest on working capital	3481.58	2.01	1672.68	1.79	5461.99	3.11
Electricity/fuel for irrigation	8198.01	4.74	3469.19	3.71	8120.41	3.21
Cost A_1	144972.93	83.75	70488.05	75.43	147252.77	87.11
Lease amount	6362.53	3.68	3044.87	3.26	0	0
Cost A_2	151335.47	87.42	73532.92	78.69	147252.77	87.11
Imputed rental value of owned land	3351.81	1.94	17836.54	19.09	16067.13	9.40
Interest on owned fixed capital	737.77	0.43	475.46	0.51	1030.24	1.12
Cost B	155425.05	89.79	91844.92	98.28	164350.13	97.63
Imputed value of family labour	17680.00	10.21	1604.88	1.72	3682.32	2.37
Cost C	173105.05	100.00	93449.80	100.00	168032.45	100.00
Cost of production	5.17		3.42		4.85	
Yield (t)	33.50		27.29		34.66	
Farm income measures: (Rs)						
Price/kg tubers	7.15		4.83		7.26	
Gross returns	236368.56		129257.60		251445.00	
Net returns	63263.51		35807.75		83412.55	
Farm business income	91395.62		58769.51		104192.24	
Owned farm business income	85033.09		55724.63		104192.24	
Family labour income	80943.51		37412.63		87094.87	
Farm investment income	67353.09		54119.76		100509.91	
Benefit cost ratio	1.38		1.38		1.50	

Contd

Table 1. Cost concepts and farm income measures of elephant foot yam cultivation under lowland production system in Kerala and irrigated production system in Andhra Pradesh and Tamil Nadu — *Contd*

Particulars	Kerala		Andhra Pradesh		Tamil Nadu	
	Low-land	Per cent to Cost C	Irriga-ted	Per cent to Cost C	Irriga-ted	Per cent to Cost C
Labour days involved						
Hired labour days	203.17		396.57		409.66	
Family labour days	114.13		24.01		52.60	
Tractor labour days	4.22		1.39		1.64	
Bullock labour days	0		0		17.36	
NPK applied by farmers	401:189:446		474:231:214		131:246:91	

operations involving labour like interculturing, harvesting, irrigation, pit making and transplanting and land preparation were expensive. Expenditure on electricity/fuel for irrigation was also high, Rs 3,469. On an average, farmers got an yield of 27.29 tonnes per ha with a gross income of Rs 1,29,257 at an average price of Rs 4.83 per kg of tuber. Benefit cost ratio was worked out to be 1.38:1. Farm business income, owned farm business income, farm investment income and family labour income were estimated to be Rs 58,770, Rs 55,725, Rs 54,120 and Rs 37,413, respectively. Elephant foot yam cultivation required on an average 396.57 hired human days, 24.01 family labour days and 1.39 tractor labour days.

Irrigated Production System in Tamil Nadu

The gross cost of cultivation was estimated to be Rs1,68,032 per ha, in which expenditure on the planting material (Rs 84,235) was maximum. Among the labour costs, operations like land preparation, interculturing, harvesting, pit making and transplanting were found expensive. The expenditure on electricity/fuel for irrigation was also high, Rs 8,120. On an average, the farmers received an yield of 34.66 tonnes per ha with a gross income of Rs 2,51,445 at an average price of Rs 7.26 per kg of tuber. Benefit cost ratio was worked out to be 1.50:1. Farm business income, farm investment income and family labour income were estimated to be Rs 1,04,192, Rs 1,00,510, Rs 54,120 and Rs 87,095, respectively. Elephant foot yam cultivation required on an average 409.66 hired human days, 52.60 family labour days, 1.64 tractor labour days and 17.36 bullock labour days .

Corms weighing 2 to 3 kg were found to have the market preference for elephant foot yam in Kerala. Therefore, farmers were using large sized

seed material (400 to 500 g) so that corms could acquire the weight of 2 to 3 kg at the time of harvesting, after six to seven months of planting. This was found to be the reason for high cost of planting material in the elephant foot yam cultivation in Kerala.

In Tamil Nadu, the market preference is for small corms of one kg weight. Eventhough farmers were using seed material of 150 to 250 g weight per pit in Tamil Nadu, the total seed material required to plant one hectare was very high due to planting the corms at closer spacing, leading to high plant population. This had resulted in the high cost of planting material.

Most of the production of elephant foot yam in Andhra Pradesh is marketed in West Bengal where the preference is for medium-sized corms. Therefore elephant foot yam growers in Andhra Pradesh were using seed material weighing around 250 g for each pit with recommended spacing so that corms of 1.5 to 2 kg could be harvested after seven to eight months of planting. This ultimately led to relatively less cost of planting material in Andhra Pradesh than in Tamil Nadu and Kerala.

High expenditure on irrigation in Kerala and Tamil Nadu was due to the fact that diesel engines were used for irrigating the crop, while in Andhra Pradesh, electrical engines were used for irrigation. In addition, power is also supplied to farmers at subsidized rates. High labour costs in Andhra Pradesh were due to more number of labour days involved (71.49 hired human days and 19.93 family labour days) in irrigating the crop. The labour cost for irrigation in Kerala was low due to the involvement of family labour in this operation.

In all the three states under different production systems, indiscriminate and imbalanced use of fertilizers was observed. Farmers had the misconception that using more of fertilizers after every irrigation and rainfall led to increase in the bulking of corms, i.e. better yield. Hence, sustained efforts are needed to make the farmers aware of this misconception.

Variation in the price of elephant foot yam in the three states depended on various factors like production during the year, area under the crop, etc. However, it requires a thorough study to understand the price fluctuations in different states.

Resource-use Efficiency of Elephant Foot Yam Farms

Production elasticities and their respective standard errors for lowland farmers in Kerala and irrigated farmers in Tamil Nadu and Andhra Pradesh are given in Table 2. A perusal of Table 2 revealed that coefficient of multiple

Table 2. Production elasticities of elephant foot yam cultivation under lowland production system in Kerala and irrigated production system in Andhra Pradesh and Tamil Nadu

Production system and state	Particulars	Production elasticity	t-value
Lowland (Kerala)	Constant	4.5291	1.62
	Farm size	0.0007	0.02
	Hired human labour	0.3808**	4.19
	Planting material	0.4573*	2.30
	Manures	0.0121	0.17
	Family labour	0.1643**	2.33
	Nitrogenous fertilizers	-0.1417**	-2.08
	Phosphatic fertilizers	-0.0062	-0.77
	Potassium fertilizers	-0.1952*	-3.48
	Returns to scale	0.67	
	R^2	0.82	
	F	11.69	
Irrigated (Tamil Nadu)	Constant	5.9986	5.09
	Farm size	-0.0282	-0.51
	Hired human labour	-0.1629	-1.60
	Family labour	0.0064	1.12
	Manures	0.0720	1.18
	Planting material	0.1334**	2.43
	Nitrogenous fertilizers	-0.0571	-1.11
	Phosphatic fertilizers	0.0530	0.98
	Irrigation	0.6327*	6.85
	Returns to scale	0.65	
	R^2	0.86	
	F	14.37	
Irrigated (Andhra Pradesh)	Constant	6.6524	2.14
	Farm size	0.045	0.61
	Hired human labour	-0.072	-0.03
	Planting material	0.4381**	2.35
	Manures	-0.0111	-1.82
	Nitrogenous fertilizers	0.0166	0.08
	Phosphatic fertilizers	0.0523**	2.49
	Potassium fertilizers	0.0384*	3.15
	Returns to scale	0.57	
	R^2	0.56	
	F	3.32	

* Indicates significance at 1 % level of variation

** Indicates significance at 5% level of variation

determination (R^2) for lowland farmers in Kerala, irrigated farmers in Tamil Nadu and Andhra Pradesh were 0.8238, 0.8646 and 0.56, respectively, indicating that 56 to 82 per cent variation in gross income was influenced by the selected variables.

The sum of elasticities ($\sum b_i$) of production, which is an indication of the returns to scale, had the values 0.6722, 0.6492 and 0.57 for lowland farmers in Kerala and irrigated farmers in Tamil Nadu and Andhra Pradesh, respectively. This indicated that a decreasing return to scale was in operation in these farms.

Production Elasticities

In the case of lowland elephant foot yam farmers in Kerala, out of eight independent variables selected, hired and family labour, seed/planting material, nitrogenous and potassium fertilizers were found to influence the gross production and in turn, the gross income. N and K fertilizers were found to influence negatively and significantly, i.e. there was excessive use of these fertilizers by lowland farmers. Phosphatic fertilizers showed a negative but non-significant relationship with gross income while farm size and manures depicted positive and non-significant relationship with the gross income.

In the case of irrigated farmers in Tamil Nadu, out of eight independent variables selected, seed/planting material and irrigation were found to influence the gross production and in turn, the gross income positively. Farm size, human labour and nitrogenous fertilizers showed a negative but non-significant relationship with gross income while family labour, phosphatic fertilizers and manures depicted a positive and non-significant relationship with the gross income.

In Andhra Pradesh, out of the seven selected independent variables, seed/planting material, phosphatic and potassium fertilizers were found to influence the gross production and in turn, the gross income positively and significantly. Hired human labour and manures showed a negative and non-significant relationship with gross income, while farm size and nitrogenous fertilizers revealed a positive but non-significant relationship with the gross income.

Resource-use Efficiency

The estimated marginal value products (MVP) of all the inputs used in the cultivation of elephant foot yam were tested using 't'- test to find out whether MVP and opportunity costs differed significantly. The values of MVP, OC and ratio of MVP and OC for lowland farmers in Kerala and for irrigated farmers of elephant foot yam, in Tamil Nadu and Andhra Pradesh

are presented in Table 3. Since the farmers were using various forms of NPK fertilizers ranging from simple to complex ones, it was not possible to arrive at the opportunity cost of each fertilizer. Therefore, the opportunity cost of fertilizer was considered as one rupee. Similarly, for the other variables for which monetary values were used in estimating the Cobb-Douglas production function, opportunity cost was considered as one rupee.

In Kerala, the utilization of inputs—hired labour, family labour and seed/planting material — was optimal, indicating that use of these inputs could be increased sufficiently. The utilization of farm size, manures, N, P and K fertilizers was not at optimum levels and there were significant differences between MVP and OC values as MVPs were much less than the acquisition

Table 3. Marginal value product (MVP), opportunity cost (OC) and ratio of marginal value product and opportunity cost for the elephant foot yam farmers under lowland production system in Kerala and irrigated production system in Andhra Pradesh and Tamil Nadu

Type of production system	Factors	Marginal value product (MVP)	Opportunity cost (OC)	MVP/OC
Lowland	Farm size	318.51	12150.31	0.026
(Kerala)	Hired human labour	3.16	1.00	3.16
	Planting material	1.64	1.00	1.64
	Manures	0.21	1.00	0.21
	Family labour	2.40	1.00	2.4
	Nitrogenous fertilizers	-7.55	1.00	-7.55
	Phosphatic fertilizers	-1.26	1.00	-1.26
	Potassium fertilizers	-11.68	1.00	-11.68
Irrigated	Farm size	-4834.72	16067.13	-0.92
(Tamil Nadu)	Hired human labour	-1.40	1.00	-1.40
	Family labour	0.26	1.00	0.26
	Manures	1.58	1.00	1.58
	Planting material	0.44	1.00	0.44
	Nitrogenous fertilizers	-9.83	1.00	-9.83
	Phosphatic fertilizers	7.85	1.00	7.85
	Irrigation	53.55	1.00	53.55
Irrigated	Farm size	3596.24	19577.99	0.18
(Andhra Pradesh)	Hired human labour	-0.05	1.00	-0.05
	Planting material	2.26	1.00	2.26
	Manures	-127.61	1.00	-127.61
	Nitrogenous fertilizers	0.41	1.00	0.41
	Phosphatic fertilizers	5.69	1.00	5.69
	Potassium fertilizers	9.95	1.00	9.95

costs. Hence, these inputs were used excessively than required by this group of elephant foot yam farmers. There is a need to reduce these inputs to achieve higher productivity.

In Tamil Nadu, the inputs — manures, phosphatic fertilizers and irrigation —were used optimally, indicating that the utilization of these inputs could be increased sufficiently. The utilization of farm size, nitrogenous fertilizers, hired and family labour and planting material was not at optimum levels and there were significant differences between MVP and OC values as MVPs were much less than the acquisition costs. Hence, these inputs were used excessively than required by this group of elephant foot yam farmers. There was a need to reduce these inputs to reduce the cost of cultivation and achieve higher productivity as well as higher gross returns.

In Andhra Pradesh, the inputs—planting material, phosphatic and potassium fertilizers—were used optimally, indicating that the utilization of these inputs could be increased sufficiently while utilization of farm size, manures, nitrogenous fertilizers and hired labour was not at optimum levels and there were significant differences between MVP and OC values as MVPs were much less than the acquisition costs. Hence, these inputs were being used excessively at present than required by this group of elephant foot yam farmers. There is a need to reduce these inputs to reduce the cost of cultivation and achieve higher productivity.

Conclusions

The study has revealed excessive use of all NPK fertilizers by elephant foot yam farmers in Kerala, indicating the need for rationalization of these inputs while in Tamil Nadu and Andhra Pradesh, there is a scope to increase the use of these inputs, except nitrogenous fertilizers. There is a scope to enhance the expenditure on planting material in Kerala and Andhra Pradesh, while it has to be reduced in Tamil Nadu to achieve optimum productivity and thereby higher gross income. Expenditure on manures in Tamil Nadu and hired human labour in Kerala can be enhanced without any adverse effect on the productivity of the crop.

References

Badal, P.S. and R.P. Singh, (2000) Resource productivity and allocative efficiency in maize production in Bihar, *Agricultural Situation in India*, **LVI** (10): 593-596.

Basu, N.K. and P.K. Sen, (1999) Analysis of Cobb-Douglas production function and study of agricultural zones in West Bengal, *Agricultural Situation in India*, **LV** (3): 129-140.

Heady, E.O. and J.L. Dillon, (1988) *Agricultural Production Functions*, New Delhi: Kalyani Publishers.

Sekar, C., C. Ramasamy, and S.Senthilnathan, (1994) Size productivity relations in paddy farms of Tamil Nadu, *Agricultural Situation in India*, **49** : 859-863.

Sharma, G.C. and S.K. Sharma, (1998) Resource use efficiency on various sizes of farms in north bank plain zone of Assam, *Agricultural Situation in India*, **LVI**: 437-440.

Sucharita, G., I.Narender, K.Suhasini and P.B. Parthasarathy (1995) Resource use and productivity of turmeric crop in Nizamabad district of Andhra Pradesh, *Agricultural Situation in India*, **IL** (11) : 727-730.