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Research Article

An economic analysis of papain production under contract farming in Western Zone of Tamil Nadu

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SUMMARY : The study has evaluated cost of raw papain production, technical efficiency of farmers engaged in papain contract farming and determinants of participation of contract farming in Erode and Dindigul districts of Tamil Nadu. The study reported that papain production was a profitable enterprise but there is a potential to further increase the profit. The stochastic frontier analysis for technical efficiency reveals that the mean technical efficiency of the papain farmers was 94.43 and labour was used most efficiently compared to other factors of production. The logit analysis for determinants of participation in papain contract farming shows that household size, age and economic status of farmers has a positive impact on farmers' participation in papain contract farming. Contract farming of untraditional products like papain should be implemented under the close supervision of developmental department to avoid contract breach.

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KEY WORDS :
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BACKGROUND AND OBJECTIVES

Contract farming is necessary and most successful in export oriented, untraditional crops/ products like gherkins, papain, rosemary oil and other exotic fruits and vegetables. Due to cheaper resources (like labour and land), diversified climate and also the liberalization of agricultural markets, most of the private companies (including MNCs) were attracted to venture in contract farming in India (also in other developing countries).

Papain is one such product, introduced to India in 1990s, it is an endolytic plant cysteine protease enzyme which is isolated from papaya (*Carica papaya* L.) latex. It has a wide industrial uses, particularly in food processing industries for tenderising meat, as a clarifying agent, digestive enzyme for dietary supplements, chewing gums and as a whitening agent in tooth paste. Democratic Republic of the Congo (DRC) is major exporter along with Australia, India and Sri Lanka. Major importing countries are Japan, Europe and the USA (is also a major market for Indian papain) (ADC, 2000).

As taping latex from unripe papaya fruits and selling it as main product was a new practice and farmers were not confident to adopt this untraditional farming due to lack of knowledge, skills and specialised labours to tap the latex and niche market for papain. But, considering the export potential of papain a large number of private contract farming companies encouraged the farmers to adopt the papain taping practice by providing training, consultancy, skilled labours, inputs and more importantly assured market for the produce at a pre-fixed price under contracting agreements. Hence, in India area under papaya cultivation was considerably increased from 45200 ha in 1991-92 to 106000 ha in 2010-11. Gujarat, Andhra Pradesh, West Bengal, Maharashtra, Karnataka and Tamil Nadu were major papaya producing states. But, considerable proportion of area under papaya cultivation of Gujarat and Tamil Nadu was deviated for papain production.

There are some risks associated with contract farming in view point of both farmers and contractors. Farmers normally face both production and market risk while producing a new product/crop/variety. Social and cultural constraints may affect farmer's ability to produce

to managers specifications. Further, poor management and lack of consultation with farmers may lead to farmer discontent and farmers may sell outside the contract (extra-contractual marketing), thereby reducing factory processing throughout and sponsoring companies may also be unreliable or exploit a monopoly position.

In this backdrop, to provide directions to both private and public bodies for the policy initiatives for efficient functioning of all stake holders of contract farming (particularly in production of non-traditional products like papain), this paper specifically analysed the economics of raw papain production, technical efficiency of papain production, constraints and determinants of adoption of papain production under contract farming in Erode and Didigul Districts of Tamil Nadu.

RESOURCES AND METHODS

Data collection:

Senthil Papain and Food Products (Pvt) Ltd Company (SPFPC) is practising contract farming of papaya in Dindigul and Erode districts of Tamil Nadu and these districts happen to be highest producers of papaya under contractual agreement. From the list of farmers who are currently producing papaya with SPFPC 83 farmers (60 farmers from Dindigul district and 23 farmers from Erode district) were selected by employing systemic sampling and random sampling technique was used in selection of 23 farmers (20 farmers from Dindigul district and 8 farmers from Erode district) who were neither growers of papaya nor participated in the papain contract farming to analyse the determinants of papain production under contract farming and a total of 111 farmers were contacted for data collection during December 2009 to February 2010.

Data analysis:

Cost of cultivation of papain:

Simple tabular analysis and the concept of 'variable' and 'fixed' cost was used in arriving cost of cultivation of Papain.

Cost concepts:

Variable cost (VC):

Variable costs represent the sum of expenditure on variable inputs which vary with the level of output and these includes hired and family labour, hired and owned bullock labour, planting material, manure (own and purchased), fertilizers, plant protection chemicals, irrigation, owned and hired machineries and interest on working capital and other miscellaneous expenses.

Fixed cost (FC):

Fixed costs refer to the sum of expenditures which will be incurred irrespective of output level. These costs comprised of rental values of land, land revenue, depreciation of owned fixed assets like farm buildings, irrigation structures and farm machineries etc.

Establishment cost (EC):

It included all the inputs and operational costs for establishing the plantation till bearing stage of the crop (*i.e.*, one year in case of papaya).

Maintenance cost (MC):

It included operational and material costs in maintaining plantation in a year during its bearing stage.

Capital recovery factor (CRF):

CRF was calculated in order to estimate the annualised/ amortized fixed cost of the papaya plantation using the following formula :

$$CRF = \frac{i(1+i)^n}{(1+i)^n - 1}$$

where, i = existing bank rate of interest, n =economic life period of the plantation in years and three years in case of papaya.

Annualised fixed cost (AFC) of papaya plantation:

AFC is a product of capital recovery factor and establishment cost.

$$AFC = CRF \times EC$$

Technical efficiency:

Aigner *et al*. (1977) proposed the stochastic frontier production function with two independent error components. The one accounts for the presence of technical inefficiencies in production and other accounts for measurement errors in output, weather etc and the combined effects of unobserved inputs in production. In this study the general production function (Battese and Coelli, 1995) is defined as:

$$Y_i = f(x_i; \beta) \exp(v_i - u_i) \qquad i=1, 2, 3, \ldots\ldots\ldots n \quad (1)$$

where Y_i denotes the output quantity of the i^{th} farm, x_i is a (1x J) vector of input quantities and β is a (J x 1) vector of unknown parameters to be estimated. The v_i are two-sided random variables associated with measurement errors in output and other noise in the data which are beyond the control of firms. v_i are assumed to be independently and identically distributed $N(0, \sigma_{v2})$ and independent of u_i. In the absence of stochastic term u_i, the model in equation (1) reduces to purely deterministic (mean) production function. The u_i are defined as non-negative random variables which account for technical inefficiency effects in production. Maximum likelihood estimation methods were used to estimate the stochastic frontier. For the likelihood function the variance term are parameterized as:

$\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\gamma = \frac{\sigma_u^2}{(\sigma_u^2 + \sigma_v^2)}$ with $0 \leq \gamma \leq 1$ (Battese and Coelli,1995)

The technical inefficiency for the i^{th} firm is estimated as the expectation of u_i conditional on the observed value (v_i - u_i):

$$TE_i = E[\exp(-u_i) \mid v_i - u_i] = E[\exp(-\delta_0 - \sum_{k-1}^{k} \delta_k z_{ik} - \varpi i \mid v_i - u_i)$$

Empirical model:

In present study Cobb-Douglas production function was employed to study the technical efficiency of papain production

$$Y = \beta_0 + \sum_{i=1}^{3} \beta_i \ln X_i + v_i - u_i$$

where,

Y= Yield of papaya in Kg per ha, $\beta_0, \beta_1, \beta_2, \beta_3$= Parameters to estimated; X_1 = Cost of plant protection chemical '/ha per year, X_2 = Cost of fertilizer applied in '/ha per year, X_3 = Labour employed in mandays/ha per year.

Logit model:

Maddala in 1997 first introduced the theoritcal framework of Logit model, in which the dependent variable is binary in nature. Tefera *et al*. (2010) analyzed the determinants of factors that affect the adoption of coffee husk manure by using the standard Logistic adoption model. In the present study also logistic regression analysis was applied to find out the probability of becoming adopter and non- adopter of papain contract farming with the following specification.

$$Log\ it\ (p_i) = \ln\left(\frac{p_i}{1-p_i}\right) = \theta_0 + X_1 + \theta_2 X_2 + \theta_3 X_3 + \theta_4 X_4 + \theta_5 X_5 + e_i$$

where, P_i= Probability of farmer adopting/non-adopting of papain contract farming, θ_0, θ_1, θ_2, θ_3, θ_4 and θ_5= Parameters to be estimated, X_1= Household size (No.), X_2= Age of the head of the household (years), X_3= Economic status of household # , X_4= Dummy (for type of house) 1 for Pucca house, 0 otherwise, X_5= Dummy of risk factor and 1 for risk averters; 0 for risk takers (Behavioural/Physiological variable)*.

* To identify the risk averters and risk takers among the selected farmers a psychological game was conducted. In which two options were given to the farmers; Option-I farmers could participate in coin tossing game and if head appeared farmers got '80.00 or else '20.00. Option-II is if farmers didn't wish to participate in the tossing game got assured amount of '40.00. Those farmers who opted option-I were risk takers and option-II were risk averters.

#X_3= 1if the selected farmer is among the poorest of 20%

= 2 if the selected farmer is poor but not among the poorest of 20%

= 3 if the selected farmer is about/at average

= 4 if the selected farmer is above average but not among richest of 20%

= 5 if the selected farmer is among the richest of 20%

OBSERVATIONS AND ANALYSIS

The results obtained from the present investigation have been discussed in the following sub heads:

General characteristics of selected farmers:

Majority of the papaya contract farmers as well as non contracting farmers were in the age group of 31-45 years. 95 per cent of papaya contract farming households and 86 per cent of non papaya contracting farmers were headed by males, and the literacy level among the papaya contract farming was higher than the non contract farming.

An over view of papain contractual arrangement:

Initially the field officials of the contract farming companies approaches the innovative and progressive farmers to promote their respective companies and thereby innovative farmers encourages directly or indirectly in adoption of contract farming. In this case also SPFPC followed the same approach to promote papain contract farming in the study area. The company and farmers forms an agreement and as per the agreement, contracting company supplies the CO_2 variety (good yielder of papain) of papaya seeds, skilled labours for taping latex (raw papain) and other inputs like fertilizers, pesticides etc., for which farmer either pay in cash at time of purchase or company deduct the input costs during the payments (for produce) in future. Apart from this the company may provide free consultancy and training to less experienced farmers particularly during the seedling stage of the crop. Farmers are liable to transport the tapped latex as early as possible in a company provided containers to the common collection centres which were in the radius of 5 to 8km.

Brix meter is used to monitor the quality of raw papain and farmers were paid '90/kg of raw papain at 17^0Bx (Brix meter reading). Company also liable to purchase the latex taped papaya fruit at '1/kg and payment were made for both latex and fruit within fortnight of delivery.

Why do farmers honour contract?:

Price certainty, anticipated profits and positive perception on papain contract farming were identified as three major reasons to adopt the contract farming. 74.47 per cent of small farmers and 77.78 per cent of large farmers felt that it was moral to honour the contract and they were following rules and regulations of contract meticulously and don't sell the produce out of the contract.

Cost of cultivation of papain under contract farming:

The total establishment cost (cost incurred during the

first year) was ‘36690.46 and the major components of establishment were human and labour, seeds, manures and fertilizers and out of these, human (57.84 %) and machine (13.47 %) labour cost proportion was highest; roughing of male plants, irrigation and intercultural operation consumed around 70 per cent of labour force. Total variable cost was ‘108220.30 and accounting for 71.52 per cent of the total cost of cultivation of papaya. Total fixed cost was at ‘43108.31 (28.48 % of total cost) out of this annual share of establishment cost was highest (46.81 %) followed by rental value of owned land (29.22 %). The average papain yield was 2689 kg per hectare and realized was ‘90/kg whereas the average papaya fruit yield was 107.56 tonnes/ha and sold for ‘1/kg, this makes the annual gross return of ‘349570/ha and net income over variable cost and total cost was ‘241349.70/ha and ‘198241.39/ha, respectively (Table 1).

Yield, income and employment generation under papain contract farming:

Generation of employment and income are important parameter to understand impact of any economic activity on the livelihood. Production of papain under contract farming, triennially generated 712.48 man-days/ha and 258.13 women-days/ha of employment among small farmers, in case of large farmers it was 729.93 man-days/ha and 273.3 women-days/ha. Further, out of total employment generation in papain contract farming, 42 per cent of male and 15 per cent of female were family labour in case of small farmers and among large farmers family labours were 25 per cent of male and only two per cent of female. In large farms, most of the farm work was attended by the hired labour. By engaging other production factors with labours, farmers are taping minimum papain yield in the range of 25 to 50kg/week with 40 per cent probability. Whereas the maximum papain yield realized was in the range of 35 to 75kg/week with 60per cent probability of sustaining this yield. Minimum profit generated was in the range of ‘7501 to ‘15000/ha/month with a probability of 48 per cent and with 60 per cent probability contract farmers of papain were realised maximum profit of ‘22501 to ‘50000/ha/month. Horticultural crops are generally labour intensive and as in the case of papain production under contract farming not only creates adequate employment opportunities but also generates assured returns by reducing price risk.

Technical efficiency of papain production:

The maximum likelihood estimates of the stochastic frontier production function of papain production are given in Table 2. Output elasticity was highest with labour employed

Table 1: Cost and returns of papaya contract farming for the year 2008-09

Sr. No.	Cost components	Value (`/ha)
i	Land Revenue	102.18 (0.24)
ii	Rental value of owned land	12,594.00 (29.22)
Iii	Depreciation	5,613.63 (13.02)
Iv	Annual share of establishment cost	20179.75$^{\Delta}$ (46.81)
v	Interest on fixed capital	4618.75 (10.71)
1.	Total fixed cost (i+ii+iii+iv+v)	43,108.31 (100.00) [28.48]
2.	Total variable cost	1,08,220.30 [71.52]
3.	Total cost (TFC+TVC)	1,51,328.61 [100.00]
4.	Papain yield (kg/ha)	2689.00
5.	Papaya fruit yield (kg/ha)	107560.00
6.	Gross return from papain$^{\Psi}$	242010.00
7.	Gross return from fruit$^{\lambda}$	107560.00
8.	Total gross return (6+7)	3,49,570.00
9.	Net return over variable cost (8-2)	2,41,349.70
10.	Net return over total cost (8-3)	1,98,241.39

Figures in ( ) indicate per cent to total fixed cost and figures in [ ] indicate per cent to total cost

$^{\Delta}$ Capital Recovery Factor (CRF)= 0.55 $^{\Psi}$ Average papain production of 2689kg/year/ha @ `90/kg

$^{\lambda}$ Average papaya fruit production of 107.56 tonnes/year/ha @ `1/kg

Table 2 : Maximum likelihood estimates of stochastic frontier function of papain

Variables	Parameters	‘t’ value
Constant	1.6873	5.1009
Plant protection cost (`)	0.0347**	2.3695
Fertilizer cost (`)	0.1526***	3.9244
Labour employed (man-days)	0.7414***	7.8534

***, ** and * indicate significance of values at P=0.01, 0.05 and 0.10, respectively.

followed by use of fertilizers and plant protection chemical and one per cent increase in use labour from mean level likely to increase the papain production by 0.74 per cent, by spending one per cent more of cost to purchase additional fertilizers (and applying it to papaya) may result in 0.15 per cent rise in papain production. The estimated mean technical efficiency(MTE) of papain production was 94.43 per cent and technical efficiency of most of the farmers (63.85 %) was more than or equal to the mean technical efficiency, this shows higher efficiency among papain producing farmers (Table 3).

Table 3 : Frequency distribution of technical efficiency

Efficiency range (%)	Number of rarms
< 90	3 (3.61)
90-94	27 (32.53)
94-96	42 (50.60)
>96	11 (13.25)
Number of farmers	83 (100.00)
Mean Technical Efficiency	94.43

Figures in parenthesis represent per cent to total

Factors influenced the farmers to participate in contract farming:

Through psychological game it was identified that among contract farmers 59 per cent were risk takers and 41 per cent were risk averters. Similarly, among non contract farmers 61 per cent were risk takers and 39 per cent were risk averters. Majority of contract and non contract farmers were found to be risk takers but the proportion of risk takers among non-contract farming was marginally higher that the contract farming.

The factors influencing farmers decision to participate in the contract farming of papain was estimated using logit regression model and presented in Table 4. The highly significant positive coefficients of economic status indicate the high participation of economically well positioned farmers. Similarly, household size and age of the farmer has positive effect on participation this shows that higher participation of older farmers due to less risk taking ability of older farmers.

Table 4 : Determinants of participation in papain contract farming

Variables	Co-efficient	't' value
Intercept	-35.019*	-2.744
House hold size	1.9448**	2.331
Age	0.3901**	2.265
Economic status	3.2186***	2.434
House type	3.0698*	1.928
Risk factor	-0.9921	-0.777
Number of observations	111	

***, ** and * indicate significance of values at P=0.01, 0.05 and 0.10, respectively

Conclusion:

From the study, papain production under contract farming was profitable enterprise and there was a scope to enlarge for more profits. From frontier production function analysis, efficiency in labour use was highest than other factors of production and there was a potential to increase the efficiency of other resources (fertilizers and plant protection chemicals) used in papain production. A few farmers performance in terms of resource use efficiency was lower than the MTE and there is a possibility to raise the MTE by increasing efficiency level of poor performing farms through training and consultancies. Age, household size and economic status of farmers were found to be positively influenced for adoption of contract farming and by specifically targeting farmers with desirable socio-economic characters may reduce the breaching of contracts and efficient production. Contract farming approach in production of innovative products like papain was a good approach only under the close supervision of concern developmental department (like Dept. of Horticulture, Agriculture or Animal Husbandry) for ensuring assured market, payment and honouring of contract agreement by both the parties.

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