Productivity and Farmer's Efficiency under Contract Farming: a Case Study of Rice Seed Cultivation in Southern India

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Abstract

Increasing interest for knowing whether input linkage and supervision in contract farming increases the farm productivity and efficiency, this paper thus provides empirical evidence. Though some researches have been done, very few have addressed the above issues in India. The aims were to examine the productivity and efficiency among rice seed contract farm households in Andhra Pradesh. Empirical results indicate that productivity of contract crop is higher than that of the non-contract crop. Further, farmers are able to attain higher level of technical efficiency (89 per cent) in case of contract crop compare to non-contract crop (82 per cent). Factors like region, number of times the fertilizer and pesticide use helps farmer to attain higher efficiency in case of contract crop and region, farmer's education and pesticide use are in case of non-contract crop. Though contract farming increases productivity and efficiency, at the same time it has negative impact on environment and also traditional knowledge. Thus it needed further research in different crop and geographical context noted.

Key Words: ***Contract Farming, Productivity and Technical Efficiency***
JEL: Q1, Q12

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1: Introduction

The adverse impact of globalisation on farmers in developing countries especially in India needs to be seen against the fact that agricultural sector is not internationally competitive on account of low productivity, higher cost of production and other factors. In addition, low productivity prevails dominantly among the small farmers. To address these issues, there is a need for a proper institutional arrangement among the stakeholders (e.g. research institution, extension service provider, agro-industries and farmers). There is considerable agreement on using contract farming for possible increase in productivity and output growth in the agricultural sector, particularly among small scale producers[2] since last one and half decade. The studies have shown that contract farmers are able to achieve higher productivity compared to non-contract farmers (Kumar, 2006; Ramswami et al. 2005; Dileep et al. 2002; Chang et al. 2006) and contract farming has improved the economic status of farmers through linking them with market (Key and Rusten, 1999; Dev and Rao, 2005; Singh, 2002, 2005; Kumar et al. 2007). Contract farming is an "alternative market, which establishes an agreement (formal or informal) between grower(s) and firm(s) (Exporters, Processors, Retail outlets, or Shippers, for example) to produce and to supply the agricultural commodity under forward contract[3]". The contract basically includes four things-pre-agreed price, quality, quantity or acreage (maximum and minimum) and time (Singh, 2002; Eaton and Shepred, 2001). In view of the development, it is a situation in which the relationship between the agribusiness firm and the farmers takes the form of an expert endowing the apprentice with resources, knowledge and skills.

Generally the agro-processing firms, with whom farmers enter into contract agreement to produce a particular crop, provide new techniques of production for accessing the recommended quality and quantity for meeting the consumer's demand (Key and Rusten, 1999; Key and MacBride, 2003; Singh, 2002; Eaton and Shepred, 2001). Since firms

[2] Empirical evidence suggests that small farms are desirable not only because they provide a source of reducing unemployment but also provide a more equitable distribution of income as well as effective demand in the economy.

[3] This is a contract where price is agreed for commodities and securities to be delivered at a future date. It may be used for hedging, to decrease risk, or as a speculation, taking on risk for the sake of an expected profit

have direct interest for improving the quality of product, they usually offer improved and better technical assistance more effectively than government's agricultural extension services (Minto, 1986). In addition, they have also an incentive to learn from farmer's experience and modify their advice accordingly. Better technology and management practices in contract farming brought by the processing firms thus increases the overall efficiency of the farmer.

Very few have discussed the farm efficiency and productivity under contract farming in India. Further, these studies have discussed the average efficiency (Kumar, 2006 and Ramswami et al. 2005) but no study has discussed so far the farm level efficiency. Thus it needs special attention to scrutinize the productivity of contract crop and non-contract crop and the level of efficiency achieved among farmers. The contribution of this paper is thus to provide an empirical evidence on the supervision and input linkage in contract farming arrangement in Andhra Pradesh. In this context, the present paper seeks to analyze 1) is productivity higher for contract crop compare to non-contract crop? 2) Does farmer attain higher level of technical efficiency in case of contract crop compared non-contract crop? If so what are the determinants?

This paper is broadly divided into two parts. In first part, it discusses the productivity difference between contract and non-contract crop. The farm level technical efficiency is estimated in second part. This second part is pursued first by estimating a stochastic production frontier which provides the basis for measuring the farm level technical efficiency (TE). As the second step, separate OLS equations for TE are estimated as a function of various attributes of the farms/farmers in the sample.

The paper is divided into seven sections including the present one. Section two reviews the previous studies on the impact of contract farming on productivity and farmer's efficiency. Section three offers a discussion of efficiency measurement. Section four discusses in turn the estimation strategy and empirical model is used in the analysis. The data are presented alongside variable construction and some descriptive statistics in section five. In section six, the empirical results are presented and discussed. Section seven concludes.

2: Contract Farming, Productivity and Efficiency: Insight from Previous Studies

Contract farming is expected to increase the productivity and efficiency of a farm (Bauman, 2000; Eaton and Shepred, 2001; Ramswami et al. 2005). The argument is that for growing crop contract, contractor facilitates the production[4] so it reduces risks like credit, input, technology and also the price. The technical assistant of contract firm visits the grower, to manage the production strategy – advice grower to apply seeds, pesticide, and fertilizer at the right time and in correct proportions. Contracting could therefore, serve to relieve farmer from credit constraint and market constraint, and thus enabling them to apply inputs at an optimum level. On the other hand, farmer has to incur entire cost of production for growing non-contract crop, and farmers may not apply inputs at optimal level because the market imperfections. The decline in use of inputs reduces the efficiency of land and labor, result in reduces the farm efficiency. Thus, farmer is likely to be more productive and efficient in growing contract crop compared to non-contract crop.

Productivity

Very few empirical studies have focused on the impact of contract farming on farm productivity and efficiency (Kumar, 2006; Ramaswami et al. 2005; Chang et al. 2006; Key and McBride, 2003; Bellemare, 2009). Amongst them some studies observed no such difference in productivity between contract and non-contract farmer and other studies have noted the differences. The study by Kumar (2006) on tomato and potato contract in Punjab has noted that though no differences observed in farm productivity, the difference is observed in factors induces the production across contract and non-contract farmers. One interesting point he noted that chemical inputs have higher elasticity on production in case of the contract farmers, whereas, the opposite is observed among non-contract farmers. Further, he pointed out the productivity differences between contract

[4] Most studies have observed that contractor provides all variable inputs such as parent seed, fertilizer, pesticide and techniques for growing contract crop (Singh, 2002; Eaton and Shepred, 2001).

and non-contract crop grown by contract farmer. A study on rice contracting in Taiwan Chang et al. (2006) found that farm size contributes to the output for contract farmers, whereas for non-contract farmer, other than farm size all other inputs such as fertilizer, labor contributes to output. Studied on broiler contracting from the processor's viewpoint, Ramaswami et al. (2005) found that contract farms are more productive than that of non-contract farms.

It is argued that effect of supervision in contract farming increases the efficiency and productivity of farms. In this regard, Bellemare (2009) studied the effect of supervision in vegetable contract on crop productivity in Medagascar and noted that the number of times of field visit by technician has a significant positive impact on productivity. And the growers who have completed a few years of education, the number of visits by technician is more effective. Key and McBride (2003) studied the hog contracting in USA, have found that contract farmers are substantially more productive (around 20 per cent higher over non-contract farmers) after correcting the sample selection bias. They explained the productivity difference in terms of technology – contract farmers used better technology compared to non-contract farmers.

Efficiency

Estimating the technical and allocative efficiency by using profit function, Kumar (2006) found that contract farmers are economically more efficient than non-contract ones in case of potato, whereas, no difference is observed for basmati rice. Dileep et al. (2002) has calculated marginal value of product (MVP) and marginal factor cost (MFC), and found that tomato contract farmers use resources efficiently compare to non-contract ones. Chang et al. (2006) studied on rice contracting in Taiwan and reported that contract farmers are more efficient than non-contract ones. Further, they noted, age of the farmer has negative impact on efficiency with the older farmers tend to be inefficient when they produce independently. However, no significant variation is observed in inefficiency by farm scale, by full-time versus part-time, or by location.

An analysis of broiler contract in Thailand, Delgado et al. (2003) found large farmers are more efficient as compared to small farms. Similar result is also observed from Brazil[5]. However, the result is different in India - large farmers are inefficient compared to small farmers. Further, they noted that contract farmers are efficient than non-contract ones. By estimating the production efficiency Ramaswami et al. (2005) noted that due to the lower feed-conservation ratio in contract broiler production, contract production is efficient compared to non-contract ones.

3: Measurement of Technical Efficiency

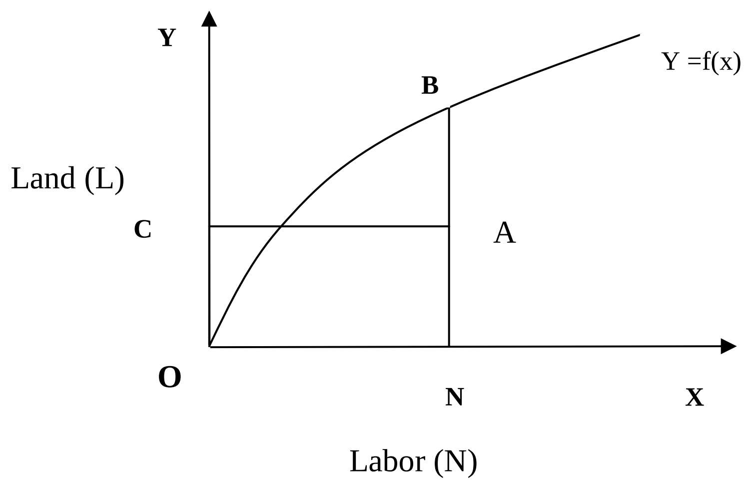
The efficiency of a production unit means a comparison between observed and optimal values of its output and input. Generally the comparison takes the form of the ratio of observed to maximum potential output accessible from a given bundle of inputs, or on the other hand the ratio of minimum potential to observed input bundle required to produce a given level of output. The literature on measuring efficiency is extensive (Farrell, 1957; Kumbhakar and Lovell, 2000; Lovell, 1992; Aigner et al. 1977). Measurement of efficiency first brought forward by Farrell, defines that efficiency is the architecture of a firm, it's success in producing as large possible of output from a given set of inputs. Prior to Farrell's work, Koopmans (1951) has provided a formal definition of technical efficiency - producer is technically efficient (TE) if an increase in any output requires a reduction in at least one other output or an increase in at least one input. And furthermore, if a reduction in any input requires an increase in at least one other input or a reduction in at least one output. Thus, a technically inefficient producer could produce the same outputs with less of at least one input, or could use the same inputs to produce more of at lest one output.

In general, $0 \le TE \le 1$, where TE = 1 when the household is producing on the production frontier and is said to be technically efficient, while TE$\le$ 1 implies that the farm household is not technically efficient in production of contract crop. This is illustrated in figure-1. Consider a production activity which employs two factors such as land (L) and

[5] Large farmers attained higher level of profit efficiency for both broilers and layers compared to small farmers.

labor (N) to produce a single output Y as depicted in figure-1. In figure-1, A is a point below the production frontier $f(x)$, and B is a point on the production frontier. Being at point A implies a technical efficiency, TE = NA/NB.

Figure: 1
Output-Oriented Measurement of Technical Efficiency



4: Empirical Model

Production function approach is followed for measuring the productivity and technical efficiency. A Cobb-Douglas production function in log-linear form is fitted to the observations using ordinary least squares for productivity difference alone. The estimation of production function involved two steps. In first step, production function for individual crop is estimated. In second step, the sample contract and non-contract crop grown by farmers have pooled and regressed output as well as output interacted by a contract dummy (one is for a contract crop and zero is otherwise) in an additive form for the intercept. The specific Cob-Douglas that is fitted in step one is as follows:

Model 1:

$$LnQ = Ln\alpha + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 LnX_3 + \beta_4 LnX_4 + \beta_5 LnX_5 + B_6 X_6 + \varepsilon$$

Where,

LnQ = Log of total output of contract/non-contract crop (in quintal)

α = the intercept

LnX_1 = Log of total land under contract/non-contract crop (acres)

LnX_2 = Log of total labor employed for contract/non-contract crop (no of days)

LnX_3 = Log of total cost of power (animal and machine) is used for contract/non-contract crop (in rupees)

LnX_4 = Log of total expenditure on manure for contract/non-contract crop (in rupees)

LnX_5 = Log of total expenditure on chemicals for contract/non-contract crop (in rupees)

X_6= Dummy variable (Region)

Model 2:

$$LnQ = Ln\alpha + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 LnX_3 + \beta_4 LnX_4 + \beta_5 LnX_5 + B_6 X_6 + B_7 X_7 + \varepsilon$$

In second model contract dummy variable (X_7) (one is for a contract crop and zero is otherwise) has taken as independent variable.

Technical efficiency

Production frontier[6] approach is followed to measure technical efficiency. The stochastic production frontier function that fitted is as follows:

$$\ln y_i = \alpha_0 + \sum_{i=1}^{6} \beta_i \ln x_i + v_i - u_i \ldots\ldots..1$$

Where, v_i is the two-sided 'noise' component, and u_i is the non-negative technical inefficient component of error term. Since the equation-1 has two components, the stochastic production frontier model is often referred to as a "composed error" model. The noise component v_i is assumed to be symmetric, distributed independently of u_i. Thus the error term in stochastic production frontier becomes $\varepsilon_i = v_i - u_i$[7].

5: Data and Variable Construction

The data were collected from Karimnagar District of Andhra Pradesh State in southern India during the months November, 2007 to January, 2008. The survey was comprised of 86 farm households, those who have a contract with two companies (e.g. Pioneer and Pro- Agro) to produce and to supply the rice seed under pre-agreed price[8]. 81 farm

[6] The production frontier provides the upper boundary of production possibilities, and the input-output combination of each producer is located on or beneath the production frontier.

[7] The productivity and technical efficiency have estimated with help of STATA 10.

[8] The contractual environment between rice seed grower and firms are very simple. Farmers are provided with free foundation seed and extension advice and must deliver rice seed to respective processors. The

households have taken for this analysis. Farmers are growing both contract and non-contract crop. Among non-contract crop, rice is the major crop, where farmers share more than sixty five per cent gross cultivated area. For comparing the contract crop (rice seed[9]) with non-contract crop, rice is selected.

Two stage sampling method has been followed to select farm households. In first stage four villages were selected purposefully based on the area where contract farming was in operation. The second stage involved random sampling method. After selection of villages, the survey identified contract farm households. From each village 15 to 20 farm households were surveyed. Data were collected through a well-structured questionnaire designed for collecting information on land holdings, output, different inputs use for contract and non-contract crop.

Variable Construction

Output is taken as the total output (in quintal) produced in reporting season. Labor is taken is the number of days of labor actually used for contract and non-contract crop, which includes both human labor and mechanical power (harvester[10]). Further, labor also includes the operator's labor, family and hired labor. Power is estimated total amount (in rupees) is spent for both animal and mechanical power (tractor). The estimation process

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organizer (who is intermediate between farmer and firms) arranges a number of technical staff required for conducting periodic field inspections at various stages in growth of seeds. It is the duty of organizer to ensure field inspections by seed certification staff. Farms are usually visited four times by the technical staff and are paid by the intermediary agency to undertake advisory and monitoring role. Technical staff visits farms during land preparation, 30 days after sowing, then between 40-60 days during pre-flowering stage and then a week prior to harvest. The organizer arranges for completion of all formalities to get seed certified from concerned processor. For the service of organizer, firm pays minimum commission. The amounts of commission fee decide at the annual meeting conducted between service providers and firm.

[9] Rice seed is a self-pollinated crop like rice, is quite tedious. The production of rice seed is fairly straightforward and requires no special equipment beyond a seed cleaner. Since certified seed production requires cross-fertilization between male and female plants, crop management is more complicated than usual rice used for consumption. Production of rice seed requires separation from standard plants, to avoid cross-pollination. Since rice seed is not treated with chemicals, unsold seed can be taken back to the grain market. Thus the risk is lower in rice seed compared to many other types of seed. However, it needs higher use of fertilizer and pesticide compared to that other seeds. Number of plants used in rice seed cultivation is significantly lower than the conventional rice. Two varieties of rice corns are produced –one is male (which is used for consumption) and the other is female (which is used for seed).

[10] 1 hour machine work = 30 days of human labor work (Field Survey)

for the value of own and hired animal is explained in cost of cultivation. Chemicals include value of both fertilizer and pesticide used. Manure is taken in total value (in rupees). Table-1 reports the mean difference of inputs used for contract and non-contract crop. The table highlights several differences of inputs used in production between contract and non-contract crop. However, no difference is observed for the input power (animal and machine). Further, significant difference of output per acre is observed between contract and non-contract crop.

Table: 1

Test of Equality of Means of Inputs used for Contract and Non-contract Crop

(Per acre)

Variables	Rice Seed*	Rice**	Mean Difference	T-Statistics	Prob.> $\|t\|$
Production (quintal)	18.52	20.81	-2.30	-6.49	0.00
Labor (Days)	127.12	58.58	68.54	73.07	0.00
Chemicals (Rupees)	2283.58	1290.07	993.51	21.56	0.00
Power (Animal and Machine)	3317.91	3307.68	10.23	0.08	0.93
Manure (Rupees)	1768.27	1577.17	191.09	2.14	0.03

Note:

*, ** Shows the contract and non-contract crop

6: Results and Discussion

Cost and Return

Prior to measure the efficiency, scrutinizing the cost and return per acre will give insights the economics of scope of the farm. Because the heterogeneity nature of crop and region, there are various methodological issues involved in the estimation process in cost of cultivation. The following study has adopted the methods followed by farm management studies (FMS) in India (Sen and Bhatia, 2004). The cost of cultivation includes all elements of inputs involved in the production of crop right from the stage of preparatory tillage to the final stage of collecting produce in the form of grains and their by-products[11].

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[11] Following costs are involved in the estimation process of cost of cultivation; i) imputed value of own human labor and value of hired human labor, ii) imputed value of own bullock labor and value of hired bullock labor, iii) value of owned machinery, v) value of hired machinery, vi) values of seed (a) farm produced & b) purchased, vii) value of insecticides and pesticides, viii) value of manure (owned and Purchased), ix) value of fertilizers, x) depreciation of implements and machinery, xi) irrigation charges, xii) land revenue, xiii) interest on working capital, xiv) rent paid for leased land and xv) misc. expenses (artisan etc), (Sen and Bhatia, 2004).

Value of own land is estimated on the basis of prevailing rents in the village for identical type of land, and also as reported by the sample farmers subject to the ceilings on fair rents in the land legislation of the concerned. There are two ways for estimating the value of family labor: (a) the wages paid to attached farm labor, (b) by imputing the wage paid to hired labor, if attached farm labor is absent. The present study has followed the second method to estimate the value of family labor. Value of owned animal power is estimated by imputing the payment made to hired animal labor. Value of farm produced manure is evaluated at the prices/rates prevailing in the village. Interest on owned fixed capital and working capital are estimated by charging a rate of interest of 12.5 per cent per annum for number of months of crop grown. Land revenue is calculated based on revenue paid divided by land share for particular crop.

Table: 2

Costs and Returns per acre of Contract and Non-Contract Crop

Factor Inputs	**Rice Seed (CC)**	**Rice (NC)**
Cost of Animal and Machine Power	4902 (27.60)	4926 (36.36)
Seeds	353 (1.99)	342 (2.52)
Cost of Human Labor	4878 (27.46)	1430 (10.56)
Cost of Chemicals and Manure	3859 (21.72)	2654 (19.59)
Total Variable Costs (A)	13992 (78.77)	9352 (69.03)
Total Other Costs* (B)	722 (4.06)	710 (5.24)
Total Cultivation Cost (C)	14714 (82.83)	10062 (74.27)
Rental Value of Land (D)	3050 (17.17)	2962 (21.86)
Transaction Costs** (E)	0.0	524 (3.87)
Total Costs	17764 (100)	13548 (100)
Production in (Qtl)	18.52	20.81
Gross Return	33519	14932
Return Over Variable Costs	19527	5580
Return Over C	18805	4870
Return Over C and D	15755	1908
Net Return	15755	1384
Benefit Cost Ratio (Over Variable Costs)	1.40	0.60
Benefit Costs Ratio (Over C and D)	0.89	0.15
Benefit Costs Ratio (Over Total Costs)	0.89	0.10
Total Cost (Qtl)	959.18	651
Gross Return (Qtl)	1809.88	717.54
Net Return (Qtl)	850.70	66.51

Note: Figure in parentheses indicates percentage to total costs.

* Total other costs is comprise land revenue, depreciation on farm inputs (12.5 per cent)

** Total Transaction costs include cost of transportation and market commission.

The cost of growing per acre of contract and non-contract crop and their returns are presented in table-2. It is observed that there is a variation in cost of cultivation between these two crops. A glance at the statistics reveals that out of the total costs of cultivation, the rental value of land constituted around 17 per cent for contract crop and 22 per cent for non-contract crop. There is not much variation of rental value of land across farm size[12].

Cost of human labor, animal and machine power constitutes the major costs of total variable costs and also total cost for contract crop but only cost of animal and machine power constitute the major cost for the non-contract crop. If one compares the share of chemical and manure to total cost, small difference is observed between contract and non-contract crop. Furthermore, the cost of chemicals and manure per acre use for contract crop is 45 per cent higher than that of non-contract crop. The high expenditure on this particular component for contract crop raises concern (as expressed by a number of researchers) over heavy use of fertilizer and pesticide for contract crop, which would adversely affect the soil health as well as the environment. Since contractor procures crop directly from field, and hence such transaction cost is zero for contract crop, there is around 4 per cent of total cost for non-contract crop. On the whole the cost of growing contract crop per acre is 31 per cent higher than non-contract crop. Per acre gross return from contract crop is observed to be two times more than that of non-contract crop. Further, net return from contract crop is eleven times higher than that of non-contract crop. In addition, the benefit costs ratio over total costs is higher for contract crop. The net return per quintal of output is very high for contract crop (e.g. Rs. 941 per quintal) and for non-contract crop it is only Rs. 66.

Productivity

In this section, first I have analysed the average contribution of each inputs to output without polling both crops (contract and non-contract) together. In second part, productivity difference between contract and non-contract crop is examined by keeping

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[12] For instance, the rental value of land of small farmer constituted for contract farmers is 17.69 percent to total costs, whereas, for large farmer it is 17.33 per cent.

contract dummy as independent variable. Cobb-Douglas production function is estimated through ordinary least square method for contract and non-contract crop. The standard error of the estimates, coefficient of multiple determinations (Adjusted-R^2) and coefficients of independent variables are presented in table-3[13]. The result can be interpreted as measures of the average performance of sample farmers evaluated at the sample mean input levels because of the nature of the OLS (Meeusen and Van den Broeck, 1977). The coefficient of determination corrected for its degrees of freedom shows the explanatory power of the regression equation. More than 95 per cent of variation in output is explained by the selected direct inputs in the analysis of contract and non-contract crop. The entire coefficient of both contract and non-contract crop have the expected signs and magnitudes.

Table: 3
OLS Estimates of Average Performance Using Cobb-Douglas Production Function for Sample Farmers

Variables	**Rice Seed**	**Rice**	**Aggregate[a]**
Constant (α)	0.51 (0.31)	0.93 (0.84)	1.06 (0.96)
Land (β_1)	0.57 (2.04)**	0.78 (373)*	0.77 (4.38)*
Labor (β_2)	0.19 (0.82)	-0.12 (-0.63)	0.016 (0.11)
Power (β_3)	0.05 (0.99)	0.15 (2.11)**	0.08 (1.68)**
Manure (β_4)	0.07 (1.67)***	0.01 (0.68)	0.01 (0.97)
Chemical (β_5)	0.05 (0.55)	0.19 (1.63)***	0.11 (1.60)***
Region (β_6)	0.04 (3.35)*	-0.02 (-1.64)***	0.01 (0.97)
Dummy (β_7) Contract =1, Non-Contract = 0			0.19 (1.60)***
Adjusted R^2	0.95	0.96	0.95
No of Observation	81	81	162
F	0.00	0.00	0.00

Note:

The stander errors are robust

*, **, *** shows the significant level ate one, five and ten per cent level respectively

() shows the t-value

(a) In this equation both contract and non-contract crop pooled and keep contract dummy as independent variable.

Land, manure, and region have shown a significant contribution to output of contract crop and land, power, chemical and region have shown significant contribution output of

[13] The result of non-contract crop grown by both contract and non-contract farmer is reported without testing sample selection problem.

non-contract crop. Positive sign of land in contract and non-contract crop shows a direct relationship between land and output achieved. This result is in the line of Ching-Cheng et al. (2006) and Kumar (2006). Ching-Cheng et al. (2006) have observed that the increase in farm size lead to increase the output. Kumar (2006) has noted that the production showed an increasing trend with increase of farm size. There is a positive trend in output of contract crop with manure. Variable, chemicals shows a significant contribution to the output of non-contract crop.

Both contract and non-contract crop have polled together, but used a dummy independent variable (one for contract crop and 0 for non-contract crop) in an additive form for the intercept to examine the productivity difference between contract and non-contract crop. It turns out that the differential intercept among contract and non-contract crop and slope coefficients are statistically significant (at 10 per cent level). The result of dummy variable implies that the output per cropped is on an average, 19 per cent higher for contracted crop compared to non-contract crop. It could be thus argued that contract farming has positive impact on farm productivity.

Technical efficiency

Measurement of technical efficiency through half-normal and exponential maximum likelihood methods give similar results. The present study reported half-normal because it is slightly tighter than exponential (Kumbhakar et al. 2006). The empirical results of the maximum likelihood estimation of the best performance production function are given in table-4. In the case of contract crop, variables like labor, manure and chemical are statistically significant at 10 and 5 per cent level. However, for non-contract crop, all variables are statistically significant at one per cent level.

With these estimated coefficients, the crop and farm specific output for individual sample farmers can be evaluated. This is achieved by multiplying the full technical efficiency coefficients with the corresponding actual levels of inputs and adding the constant terms of the frontier for each individual sample farmers. The resultant output is the output, which sample farmers could have obtained if they had used the technology efficiently. The difference between log value of frontier output and log value of actual output of these farmers is due to the compared variable $(u+v)$ of inefficiency of the sample farmers, and the statistical random factors.

Table: 4
Half-Normal of Maximum Likelihood Estimation of Frontier Production Function for Selected Sample Farmers

Parameters	Variables	Seed (Contract Crop)	Rice (Non-contract Crop)
α	Constant	0.40 (0.29)	0.28 (2719)*
β_1	Land	0.38 (1.49)	0.70 (4973.78)*
β_2	Labor	0.34 (1.60)***	0.01 (-333.04)*
β_4	Animal	0.04 (0.98)	0.31 (33104)*
β_5	Manure	0.06 (1.99)**	0.04 (72019)*
β_6	Chemical Inputs	0.13(1.91)***	0.03 (2496.05)*
Log likelihood		72.71	56.49
σ_u^2		-6.63 (-12.14)*	-37.85 (-0.12)
σ_v^2		-3.58 (-17.34)*	2.84 (-18.12)*
λ (Lambda)		4.59	4.01
Chi-square		28.28 (0.00)	19.89 (0.00)
Sample Mean Efficiency		88.98	82.36
Number of Observation		81	81

Note:
*, **, *** shows the significant at one, five and ten per cent level respectively
() shows the Standard Error

Table-5 reports the farm level technical efficiency between contract and non-contract crop. There is a wide variation in efficiency across crops. Mean efficiency 89 per cent is observed for contract crop and 82 per cent for non-contract crop. The testing here is based on the means of two series, viz. says mean of contract crop and that of non-contract crop, to know whether they are statistically different from one another or not. It implies that farmers are technically more efficient for growing contract crop compared to non-contract crop. Further, the results indicate that around 56 per cent of farmers could be able to achieve 91 to 100 per cent of the output obtained by the most technically efficient in case of contract crop, whereas it is only around 22 per cent for non-contract crop. Result of variance shows that large variation of technical efficiency is observed for non-contract crop. The result supports our argument that growing contract crop farmer will be more efficient technically than non-contract crop because the supervision and technical assistant in contract farming.

Table: 5
Frequency Distribution of Firm-Specific Technical Efficiency in Stochastic Production Frontier

Technical Efficiency (%)	Contract Farmer	
	Rice Seed	Rice
41-45		1 (1.2)
46-50		
51-55	1 (1.23)	
56-60	1 (1.23)	
61-65	1 (1.23)	
66-70	1 (1.23)	6 (7.4)
71-75		11 (13.6)
76-80	2 (2.47)	9 (11.1)
81-85	11 (13.58)	22 (27.2)
86-90	19 (23.46)	14 (17.3)
91-95	30 (37.04)	11 (13.6)
96-100	15 (18.52)	7 (8.6)
Total	81	81
Mean	88.98	82.35
SD	8.44	9.91
Variance	71.31	98.27
Difference	6.63*	

Note:
* Shows the significant at one per cent level

An attempt has been made here to examine the efficiency level across farm size (small, medium and large). From table-6, it is observed that in the case of contract crop, farmers those who have allocated less than one acre of land (considered small farmers) are able to attain higher level technical efficiency compared to others who have allocated more than two acres of land (considered as large farms). However, the pattern is opposite in the case of non-contract crop. In explaining why small farmers attain higher level technical efficiency, Bardhan (1973) argued that, small farmers use more current inputs (labor and fertilizers) per acre due to market imperfections in agriculture and hence produce more output per acre. In this context, Sen (1962) argued it in the framework of labor market imperfection in a dual agrarian economy. The large farmer is more dependent than the smaller farm on hired labor to which the wage has to be paid at the market rate, whereas for the more family-based small farmer, the family members are prepared to work on the farm at a rate less than market wage rate. In other words, the imputed price of labor to the small farmer is lower than that of large farmer and hence small farmer uses more labor per acre. The output of small farmer thus increases.

Table: 6
Average Technical Efficiency across Farm Size

Farm Size	Contract Crop	Non-Contract Crop
≤ 1 Acres (Large)	90.13	81
1.01-2 Acres (Medium)	89.50	82.3
≥ 2.01 Acres (Small)	87	82

Determinants of Technical Efficiency

Based on the Schumpeterian theory of economic development, technical efficiency is assumed to depend on factors which determine the individual's technical knowledge and understanding, and the socio-economic environment in which he is working (Kalirajan, 1990, 1994). Factors affecting the efficiency of sample farmers, therefore, can be classified into two groups, such as those associated with technical knowledge and socio economic variables. The regressions that identify the contributions of the selected variables in explaining the variation in production efficiency among the sample farmers are reported in table-7.

The results indicate that region, number of time of fertilizer and pesticide use have contributed significantly to the efficiency of contract crop, whereas for non-contract crop, the determinants are region, education of farmer and dummy (pesticide use). It is expected that the year of participation in contract farming could increase the technical efficiency, but the result does not support the hypothesis. This result can be explained in the line of internalization of knowledge by firm. The result of region shows that farmers of specific region have gained from contract farming where others are not. Insignificant education in contract crop is understandable because production strategy is guided by the processor and there is little space for farmer's knowledge, whereas for non-contract crop education plays an important role for attaining higher level of efficiency. It is observed that if the year of schooling of the farmer increases, his efficiency increases. On the whole, results reflect that in case of contract crop, farmers have little space in the decision making of production (Morvaridi, 1995) because firms control the production or management process, use of pesticide, fertilizer and also water, whereas it is different in case of non-contract crop.

Table: 7
OLS Estimates of Factors Influencing Farm Specific Production Efficiency for Sample Farmers[14]

Variables	Rice Seed (Contract Crop)	Rice (Non-Contract Crop)
Constant	70.84 (6.49)*	81.62 (17.00)*
Age of Farmer	0.07 (0.73)	0.06 (0.95)
Year of Cultivation	1.21 (1.27)	
Region (Village)	3.41 (4.11)*	-1.99 (-2.82)*
Education (Number of Years)	-0.07 (-0.37)	0.57 (3.22)*
Non-Farm Income	0.01 (1.58)	5.48 (1.41)
Times of pesticide Use	-5.50 (-2.15)**	
Times of Fertilizer Use	6.00 (2.02)**	
Dummy (pesticide Use or not)		-4.16 (-2.25)**
R^2	23	0.16
	Prob > F*	Prob > F*

Note:
*, ** shows the significant at one and five per cent level respectively

7: Conclusion

To sum up, contract farmers are more efficient in growing the contract crop compared to non-contract crop. A small variation in cost of growing contract and non-contract crop has observed, however large variation observation in turns of return per acre. For instance, cost of growing contract crop per acre is 31 per cent higher than non-contract crop but gross return is two times more over non-contract crop. Further, net return from contract crop is eleven times higher than that of non-contract crop. Cost of labor, animal and machine power constitutes the major parts of variable costs and also total costs for contract crop, only cost of animal and machine power is the major cost for non-contract crop. However, it is observed that cost of chemicals per acre use for contract crop is higher than that of non-contract crop.

There appears to be wide variation in the cultural practices used, the input applications and yield per acre across crop. Land significantly contributes to output for crop. It is also

[14] In one stage method is more consistent for measuring the determinants of technical efficiency; however, we have used two stage methods because of the problem of non-availability of statistical package. First we have estimated farm level technical efficiency, and then in the second step we have taken this farm level technical efficiency as dependent variable.

observed that productivity of contract crop is higher than that of the non-contract crop. Region, numbers of times the use of fertilizer and pesticide are the major factors which helped farmers to attain higher level of technical efficiency in case of contract crop, whereas region, education of farmer, and pesticide use contribute to the technical efficiency of non-contract crop.

The result open up many avenues for future research: for instance, the autonomy of farmer in contract farming and spillover effect of technology? Furthermore, the impact of modern technology in contract farming on traditional knowledge of farmer and local environment should be examined in greater depth. In addition, the factors which induce farmers to participate in contract farming also should be examined.

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