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Research Paper

Profitability and resource efficiency in hybrid rice seed cultivation under contract farming

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ABSTRACT : The increasing demand for rice can be met only through firm increase in production and productivity. The inbred varieties' yield is stagnating; and among limited options hybrid technology is the only proven technology available for increasing rice production. The agro-climatic conditions of Telangana are conducive for hybrid rice seed production. The private companies have shown interest in hybrid rice seed production through contract farming. Present study was taken upto examine profitability and resource use efficiency in hybrid rice seed production. Primary data pertaining to 2013-14 was collected from 90 farmers of Karimnagar district. The net returns (Rs.65962 per ha) over cost C_3 indicates that hybrid rice seed production is a profitable venture. Operational cost occupied about 60 per cent of total cost. Inputs seed, manures and fertilizers, plant protection chemicals and growth regulator were used sub-optimally, while the machine power was used excessively. The farmers need training on hybridization skills and resource use. The package of practices of crop operations based on mechanical techniques need to be evolved to reduce dependence on human labour and to reduce cost of seed production.

KEY WORDS : Hybrid rice seed production, Contract farming, Profitability, Resource use efficiency

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INTRODUCTION :

Rice is staple food of more than 60 per cent of Indian population. It accounts for more than 40 per cent of total food grain production and 46 per cent of total cereal production in the country (2015-16). Rice production has recorded commendable growth with three fold increases from 30 million tonnes in 1965 to 108.86 million tonnes in 2016, helping achieve self-sufficiency and enabling India to become a rice exporting country. According to the projections made by the Population Foundation of India, the country's population will reach to 1546 million by the end of 2030. It is estimated that the demand for rice will be 126.14 million tonnes by the year 2030 (Goyal and Singh, 2002). This projected demand can be met only if there is a firm increase in productivity and production. The stagnating yield of HYV's, declining and degrading natural resources like land and water make the task of increasing rice production challenging. The current situation necessitates looking for some innovative technologies to boost rice production.

Foreseeing the fact that the yield of inbred varieties is stagnating and it is difficult to achieve the target production with the inbred varieties; and taking clue from the success of hybrid rice technology in China, systematic research efforts on hybrid rice in India were initiated in

1989. Among the limited options, the hybrid technology is the only proven technology, which is practically feasible and readily adoptable for increasing rice production to the desired level in the short run, as it is evident from its capability of producing 15–20 per cent more output over the best inbred varieties. The hybrid rice technology has been tested extensively across the country and has been adopted in an area of about 1.3 million ha in 2010. The area under hybrid rice has exceeded to 2.5 million hectares during 2014, which is about 5.6 per cent of the total rice area in the country (GOI, 2015). The success and sustenance of hybrid rice technology depends on the efficient and economic hybrid seed production, so as to provide good quality seed at reasonable price to the farmers.

Hybrid rice seed production is indispensible for success of hybrid rice technology; therefore, promotion and popularization of hybrid rice seed cultivation as a venture deserves special attention. Hybrid rice seed cultivation as a venture has gained popularity in Telangana during recent years. The importance of hybrid rice seed crop in Telangana is evident from the fact that Karimnagar, Warangal and Nizamabad districts jointly produce about 80 per cent of hybrid rice seed in the country. The agro-climatic conditions blessed to Telangana are conducive for hybrid rice seed production, where the yield of hybrid rice seed is at a satisfactorily level. The hybrid rice seed cultivation results in higher gross returns, net returns and benefit-cost ratio in comparison to inbred rice cultivation (Nirmala *et al.*, 2012). It is not only a viable and effective production system ensuring profitability to the farmers but also ensures additional labour employment of 60-80 man days per hectare over conventional rice cultivation. Though, hybrid rice seed cultivation is getting popularity in Telangana, but the farmers are not able to undertake hybrid rice seed production on their own, firstly because hybrid rice seed production can only be successful if it is supervised by well-trained technicians and carried out by experienced farmers, but farmers have shortage of skilled manpower; secondly the hybrid rice seed production is dependent on the use of growth regulator, Gibberellic acid (GA_3), which is unavailable in local markets and is highly expensive and is beyond the affordable reach of the poor famers.

The private seed companies equipped with trained human resource for transferring needed technical skills and substantial financial resources have shown interest in hybrid rice seed production in the state under contract farming. During last decade hybrid rice seed production under contract farming in Telangana has emerged as a profitable business. It is being carried on at a large scale by many private sector companies through small and marginal farmers under contractual agreement. Many resource poor small and marginal farmers have attracted toward hybrid rice seed production under contractual agreement on two accounts; first, they find it more remunerative than their conventional crops owing to premium and assured price received for their produce; second, many of their input requirements (particularly of Gibberellic acid) are fulfilled by the contract firms through credit financing, hence, they feel relieved from their worries of input and fund arrangements. In this system of seed production the seed companies and the farmers mutually depend on each other and this mutual dependence is booming the emerging business.

The profitability in hybrid rice seed production depends on the magnitudes of costs and returns; which vary from one farmer to another on account of variation in quantity and quality of inputs used and quantum of produce harvested. The variation in access to production inputs, unavailability of inputs in time, lack of technical advice, etc. bound the farmers to use their resources inefficiently. The poor resource use efficiency and low yield discourage the farmers to boost further production. In view of the above problematic situation, it becomes imperative to examine the profitability and resource use efficiency in hybrid rice seed production.

MATERIALS AND METHODS :

The study was conducted in most important hybrid rice seed producing state of Telangana. For the selection of district, mandals and villages and respondents (hybrid rice seed growers) a multistage sampling technique was followed. In the first stage Karimnagar district was selected purposefully, as it has the highest area under hybrid rice seed production and produces the highest quantity of hybrid rice seed. In the second stage out of 57 mandals in Karimnagar district six mandals, *viz.*, Sultanabad, Jammikunta, Venuvanka, Kaluvasrirampur, Manakundur and Huzurabad, having the highest area under hybrid rice seed production, were selected; and one village from each selected mandal was selected randomly. And from each selected village 15 farmers were selected randomly. Thus, the study was based on

data collected from 90 hybrid rice seed producing farmers. The data pertaining to the year 2014-15 were collected on different aspects of hybrid rice seed production through pre-tested survey schedule by personal interview.

Some farmers are interested to know the returns over direct costs involved in the crop production, while others are interested in considering the indirect costs as well. Therefore, it was considered appropriate to work out the net returns over various cost concepts. To estimate costs and returns the cost concepts adopted by the Commission for Agricultural Costs and Prices (CACP), were followed. In order to assess the resource use efficiency in hybrid rice seed production Cobb-Douglas production function was fitted to establish input-output relation between yield of hybrid rice seed per hectare as dependent variable and six inputs *viz.*, quantity of seed, expenditure on manures and fertilizers, expenditure on plant protection chemicals and growth regulators, human labour, machine power, number of irrigations, as independent variables.

Before fitting the function, zero order correlation co-efficients were estimated to test the presence of multicollinearity between independent variables. The correlation co-efficient greater than 0.80 between two variables was considered as a sign of multicollinearity. The following form of production function was used :

$$Y = aX_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} e^{\mu}$$

where,

Y = Yield of Hybrid rice seed (Q/ ha).

X_1= Seed quantity (kg/ha)

X_2= Expenditure on manures and fertilizers (Rs./ ha)

X_3=Expenditure on plant protection chemicals and plant regulators (Rs./ha)

X_4= Human labour (man days/ha)

X_5= Machine power (hours/ha)

X_6= Irrigation (Number)

a=Constant.

U=Error term,

e=Napier base/ Euler's Number (2.71828)

b_1……b_6 =Regression co-efficients.

b_1, b_2, b_3, b_4, b_5 and b_6 are the respective partial regression co-efficients (elasticity of production) of the explanatory variables.

The estimated regression co-efficients (b_i's) were tested for their significance using t-test. Following formula was used:

$$t = \frac{b_i}{SE(b_i)}$$

where,

b_i = Regression co-efficients of an i^{th} input

SE (bi) = standard error of an i^{th} input

The marginal value productivity of different resources was calculated by multiplying the marginal physical product of the i^{th} input by the unit price of the output as:

$$MVP_{xi} = MPP_{xi} (P_y) \textit{ i.e. } MVP_{xi} = b_i \frac{\bar{Y}}{\bar{X}_i}(P_Y)$$

where,

MPP_{xi} = Marginal physical product of i^{th} input

P_y = Price of output per unit (Rs.)

$\bar{Y}$ = Geometric mean of output

$\bar{x}_i$ = Geometric mean of i^{th} input

b_i = Regression co-efficient of i^{th} input (i = 1, 2, 3,……, 6)

The marginal input cost was worked out by taking unit charges of the respective resource.

$$MIC_{xi} = P_{xi}$$

where,

MIC_{xi} = Marginal input cost of i^{th} input

P_{xi} = Unit price of i^{th} input

The marginal value product (MVP) and marginal input cost (MIC) for each input were compared and the difference of two was tested by computing the 't' statistics, using the following formula:

$$t = \frac{MVP_{xi} - MIC_{xi}}{SE \text{ of } MVP_{xi}}$$

where,

$$SE \text{ of } MVP_{xi} = \sqrt{AVP.V(b_i)}$$

$$V(bi) = \text{Variance of } i^{th} \text{ co - efficient} = \frac{\sum (x - \bar{x})^2}{n - 1}$$

RESULTS AND DATA ANALYSIS :

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Cost and returns from hybrid rice seed cultivation:

The objective of farmer is to secure the highest net

returns. This objective can be achieved by reducing cost by manipulating the input mix and/or by enlarging revenue the by increasing quantity of produce and/or selling the produce at higher price. In this context estimation of costs and returns assumes a great importance. The costs involved in hybrid rice seed cultivation and returns received from same have been presented in Table 1.

Operational costs:

A glance on Table 1 reveals that operational cost (Rs.90540 per ha) was the most important item of cost of hybrid rice cultivation, which occupied about 61 per cent of total cost (cost C_3). Further, the expenditure on human labour (Rs.75190 per ha) was the single largest item of cost of cultivation amongst all items, alone occupied more than half (50.38%) of cost C_3. This high magnitude of expenditure on human labour was due to the fact that most of the operations in hybrid rice seed cultivation are performed manually; therefore, human labour plays an important role. The expenditure on machine power was another item of operational cost, stood at Rs.15249 per ha (10.29% of total cost).

Material cost:

It is evident from Table 1 that material cost (Rs.28232 per ha) *i.e.* the expenditure on purchase of production inputs also occupied an important part of cost hybrid rice cultivation (18.92%). The most important item of material cost noticed was manures and fertilizers, which was estimated to Rs.10870 per ha (7.28% of total cost). The expenditure on plant protection chemicals and growth regulator (Gibberellic acid) were other items of material cost, stood at Rs.6496 and Rs.4947 per ha, respectively, accounted for 4.35 per cent and 3.32 per cent of total cost, respectively. From expenditure point of view seed was not an important item. The expenditure on purchase of female and male line seeds together accounted for 1.97 per cent of total cost (Rs.2944 per ha). This is important to note that the contract firms supply female and male line seeds to the farmers on credit, which is not an open market price of seed.

Table 1: Cost of cultivation in hybrid rice seed production

Sr. No.	Particulars	Cost (Rs./ha)	Proportion of total cost (%)
	Operational cost		
1.	Human labour		
	Hired labour	56440	37.82
	Family labour	18749	12.57
	Sub total (a+b)	75190	50.39
2.	Machine power	15249	10.29
	Sub total (1+2)	90540	60.68
	Material cost		
1.	Seed	2944	1.97
2.	Manures and fertilizers	10870	7.28
3.	Plant protection chemicals	6496	4.35
4.	Gibberellic acid	4947	3.32
5.	Irrigation charges	2975	1.99
	Sub total (1+2+3)	28232	18.92
	Fixed costs		
1.	Interest on total working capital	3354	2.24
2.	Rental value of owned land	16241	10.87
3.	Land revenue	500	0.32
4.	Depreciation	2822	1.86
5.	Interest on the value of fixed assets	3290	2.19
	Sub total (1+2+3+4+5)	26126	17.50
	Grand total (A+B+C)	144599	96.90
	Cost C_3	149220	100.00

Other costs:

Other costs consisted of interest on working capital, rental value of own land, depreciation and interest on value of own capital assets. A perusal of the table indicates that the rental value of land was most important item of other cost, stood at Rs. 16241 per ha, constituted 10.87 per cent of total cost. The interest on value of own capital assets was noticed to be another important item of other costs with a magnitude of Rs.3289 per ha, which constituted 2.19 per cent of total cost. The depreciation of capital assets was estimated at Rs.2822 per ha, constituted only 1.86 per cent of the total cost of cultivation.

It can be concluded that human labour in hybrid rice seed cultivation was most important item of expenditure followed by rental value of land and machine power.

Cost concept – wise cost of hybrid rice seed cultivation:

The comparison of returns to various costs (CACP cost concepts) has been presented in Table 2. A perusal of the table indicates that cost A_1, which included expenditure on hired labour, seed, manures and fertilizers, depreciation on farm building and capital assets, interest on working capital, stood at Rs.97455 per ha. No case of leased in land was noticed in the study area, therefore, cost A_2 was equal to A_1. Further, cost B_1 was estimated to be Rs.100744 per ha, while cost C_1, which included cost B_1 and imputed value of family labour, was found to be Rs.119494 per ha. Cost C_2* was found to be equal to

Table 2: Cost concept –wise cost and returns over various costs in hybrid rice seed cultivation

Sr. No.	Particulars	Cost (Rs./ha)
	Cost concept –wise costs in hybrid rice seed cultivation	
1.	Cost A_1	97455
2.	Cost A_2	97455
3.	Cost B_1	100744
4.	Cost B_2	116985
5.	Cost C_1	119494
6.	Cost C_2	135735
7.	Cost C_2*	135735
8.	Cost C_3	149300
9.	Cost of production (Rs./Qt.)	7175
Returns from hybrid rice seed cultivation		
1.	Yield of main product (Qt./ha)	19.15
2.	Yield of by- product (bundles/ha)	199.88
3.	Price of main product (Rs./ Qt.)	10234.41
4.	Price of by- product (Rs./bundle)	96.81
5.	value form main product (Rs./ha)	195989
6.	Value from by product (Rs./ha)	19273
	Gross returns (Rs./ha)	215262
Net return over various cost from hybrid rice seed cultivation		
1.	Cost A_1	117807
2.	Cost A_2	117807
3.	Cost B_1	114518
4.	Cost B_2	98277
5.	Cost C_1	95768
6.	Cost C_2	79527
7.	Cost C_2*	79527
8.	Cost C_3	65962
9.	Net return per one rupee expenditure	0.44

cost C_2 in the study area because the actual wage rate prevailed in the study area (at which the various costs were estimated) was higher than minimum wage rate. Total cost of cultivation *i.e.* cost C_3 was estimated to be Rs.149300 per ha.

Table 2 shows that average yield of hybrid rice seed was 19.15 quintal per ha. The average price received by the farmers for hybrid rice seed was worked to be Rs.10234 per quintal. Thus, gross returns received in cultivation of hybrid rice seed was recorded to be Rs.215261 per ha. And the average cost of production for hybrid rice seed alone turned to be Rs.7175 per quintal.

Analysis of the Table 2 also indicates that a gross income of Rs.215261 per ha was received from hybrid rice seed cultivation, while the net return over total cost (cost C_3) was found to be Rs.65962. Further, returns over direct cost (cost A_1) was found to be Rs.117807 per ha. The returns over cost B_1 and cost C_2 were estimated to be Rs.114518 and Rs.79527 per ha, respectively. The gross return over one rupee expenditure was worked out to be 1.44. This magnitude of gross return over one rupee expenditure implies that a net profit of Rs.0.44 for every one rupee spent in hybrid rice seed cultivation was realized by farmers.

The F_1 seed production is highly profitable for seed producers (Mohanty *et al.*, 2017). The magnitudes of returns over various costs and return over one rupee expenditure in hybrid rice seed production in the present case verify the notion.

Resource use efficiency in hybrid rice seed production:

In order to obtain the highest returns from crop production the farmer co-ordinates and manipulates the farm resources so as to increase returns and reduce costs. In this context, the study of resource use efficiency assumes a great importance. The production function analysis offers a powerful tool in resource allocation under different economic, social and cultural conditions in the farm plant and helps in reallocation of farm resources (Patil and Gaddi, 1997).

To estimate the resource use efficiency in hybrid rice seed cultivation, Cobb-Douglas production function as hypothesized in methodology was fitted. Before fitting the production function to the data, the data was put to test problem of multicollinearity. The correlation co-efficients through zero order pair-wise correlation matrices indicate that there was no problem of multicollinearity between any pair of explanatory variables.

Elasticity of production of inputs and co-efficient of multiple determination (R^2) for hybrid rice seed production:

The details of production function estimates, standard errors of co-efficients and co-efficients of multiple determination (R^2) are given in Table 3. It is evident from table that except machine power and number of irrigations, the regression co-efficients of all variables included in the model were positive.

The regression co-efficients of seed, expenditure on manures and fertilizers, expenditure on plant protection chemicals and growth regulator and human labour were found to be significant. The regression co-efficient of seed indicates that one per cent increase in the use of seed is expected to increase the productivity of hybrid rice seed by 0.1005 per cent.

The regression co-efficient of expenditure on manures and fertilizers and expenditure on plant protection chemicals and growth regulator were found to be positive, the production elasticity of above variables indicate that one per cent increase in expenditure on

Table 3: Estimated production function for hybrid rice seed production

Sr. No.	Variables	Regression co-efficient	Standard error
1.	Constant	–1.7567	0.305
2.	Seed (kg/ha)	0.1005*	0.029
3.	Expenditure on manures and fertilizers (Rs./ha)	0.2048*	0.043
4.	Expenditure on plant protection and plant regulators (Rs./ha)	0.2185*	0.044
5.	Human labour (man days/ha)	0.1396**	0.054
6.	Machine power (hours/ha)	–0.0894*	0.027
7.	Irrigation (No.)	–0.0003	0.019
	R^2 =0.84		

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

manures and fertilizers and plant protection chemicals and growth regulator will lead an increase in hybrid rice seed yield by 0.2048 per cent and 0.2185 per cent, respectively.

The regression co-efficient of human labour was also found to be positive and significant; the production elasticity of human labour indicates that one per cent increase in use of human labour is expected to increase the hybrid rice seed yield by 0.1396 per cent.

Table also indicates that the regression co-efficient of machine power was found to be negative and significant and production elasticity of the same indicates that one per cent increase in machine power is expected to decrease the yield of hybrid rice seed by 0.0894 per cent. However, the regression co-efficient of irrigation was found to be negative, but was non-significant.

The sum of significant co-efficients with less than unity indicates that the resources were being used in the rational stage of production, showing diminishing marginal productivity in respective cases. Based on the co-efficients of multiple determinations (R^2) it may be inferred that the explanatory variables included in the regression model are responsible for 84 per cent variation in yield per ha.

Marginal value productivity of resources in hybrid rice seed production :

The marginal value product of various inputs at their geometric mean levels holding other variables constant, in hybrid rice seed production have been presented in Table 4. The marginal value productivities of only those resources have been discussed, whose co-efficients were found to be influencing the hybrid rice seed yield significantly.

A perusal of the Table 4 reveals that marginal productivity of seed, which exercised a positive impact on yield hybrid rice seed, was as high as Rs.963.59 and a comparison of price of seed (acquisition cost) with its marginal value product shows that the marginal value product of seed was significantly higher than its acquisition cost, implying that the input seed was sub-optimally used and yield of hybrid rice seed can be increased by increasing the level of seed.

The marginal value productivity of expenditure on manures and fertilizers, expenditure on plant protection chemicals and growth regulator were found to be Rs.3.38 and Rs.3.5, respectively and a comparison of marginal value products of expenditure on manures and fertilizers and plant protection chemicals and growth regulator with their respective acquisition costs indicates that the marginal value products of the same were significantly higher than their respective acquisition costs, indicating that there is scope to increase hybrid rice seed yield by increasing the expenditure on manures and fertilizers expenditure on plant protection chemicals and growth regulator; alternatively implying that these inputs were used less than their optimal levels. However, marginal value productivity of human labour was less than its price *i.e.* wage rate.

Further, the marginal value productivity of machine power was found to be Rs. –1249.83, which was significantly lower than its acquisition cost, implying that the machine power in hybrid rice seed production was in excessive use and a comparison of marginal value product of the variable suggests that the yield of hybrid rice can be increased by decreasing the use machine power.

Conclusion:

On the basis of above it can be concluded that operating cost in hybrid rice seed cultivation under contract farming constituted a loin share followed by material costs and other costs. Total cost and returns over various costs in hybrid rice seed cultivation were very high, indicating that this venture in the study area was very remunerative. In hybrid rice seed cultivation the inputs seed, manures and fertilizers, plant protection chemicals and growth regulator were used below their optimum levels, while the machine power was over its

Table 4: Marginal value productivities of inputs in hybrid rice seed production

Sr. No.	Variable	MVP	MIC
1.	Seed (kg/ha)	963.59*	105
2.	Expenditure on manures and fertilizers (Rs./ha)	3.38**	1
3.	Expenditure on plant protection and plant regulators (Rs./ha)	3.59**	1
4.	Human labour (man days/ha)	101.60*	275
5.	Machine power (hours/ha)	–1249.83*	910

*and ** = difference between MVP and MIC significant at 1 per cent; and 5 per cent level of significance, respectively

optimum level and hybrid rice seed yield can be increased by increasing the levels of sub-optimally used inputs and decreasing the use of over-optimally used input. There is a need to educate the farmers on the optimum use of the resources and hybridization skills. There is need to evolve a package of practices of crop operations based on mechanical techniques to reduce dependence on human labour and to reduce unit cost of seed production.

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