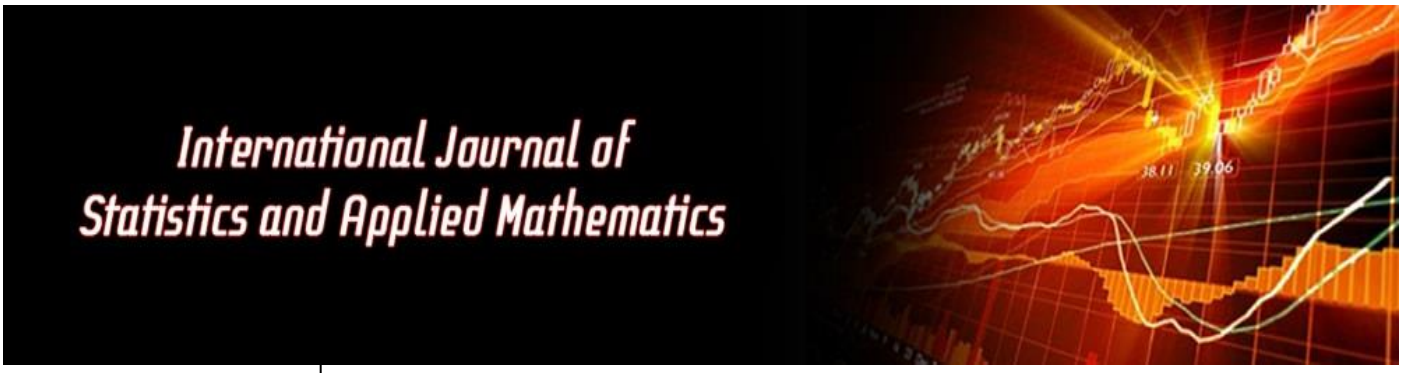
International Journal of Statistics and Applied Mathematics 2023; SP-8 (6): 835-843



ISSN: 2456-1452
Maths 2023; SP-8 (6): 835-843

https://www.mathsjournal.com
Received: 19-10-2023
Accepted: 22-11-2023

Jayaprada Y
Research Scholar,
Department of Agricultural Economics, PJTSAU,
Hyderabad, Telangana, India

PA Lakshmi Prasanna
Senior Scientist,
Agricultural Economics,
ICAR-Indian Institute of Rice Research, Hyderabad,
Telangana, India

T Lavanya
Professor, Department of Agriculture Economics, College of Agriculture, PJTSAU,
Hyderabad, Telangana, India

Santhosha Rathod
Scientist, Department of Agricultural Statistics, ICAR-Indian Institute of Rice Research, Hyderabad,
Telangana, India

Corresponding Author:
Jayaprada Y
Research Scholar, Department of Agricultural Economics, PJTSAU, Hyderabad,
Telangana, India

A comparative economic analysis of seed and grain production of paddy in Karimnagar district of Telangana state

Jayaprada Y, PA Lakshmi Prasanna, T Lavanya and Santhosha Rathod

DOI: https://dx.doi.org/10.22271/maths.2023.v8.i6Sk.1474

Abstract
The present study was conducted in Karimnagar district of Telangana to analyze comparative economics of seed and grain production of paddy. From this district three mandals i.e Vinavanka mandal, Manakondur mandal and Shankarpatnam mandal, were selected randomly among seed growing mandals for collecting primary data. Three villages were selected, one from each selected mandal.60 farmers were selected from each selected village, 20 grain producers, 20 hybrid seed producers and 20 OPV seed producers of paddy representing different farm sizes that is marginal, small, and others. The analysis of data revealed that the total costs in hybrid seed production per hectare was highest at Rs 115181.38, followed by paddy OPV seed production (Rs 93000.14) and general grain production (Rs 90,581.39 per hectare). The gross income for paddy hybrid seed production was Rs 200279.98/ha, followed by paddy OPV seed production at Rs138613.3 /ha and paddy grain production at Rs 133499.50/ha. The benefit-cost ratio for hybrid paddy seed production was 1.74, outperforming both OPV paddy seed production (1.49) and paddy grain production (1.47). These findings revealed superior performance of hybrid paddy seed production in terms of profitability compared to the other two alternatives.

Keywords: Hybrid paddy, OPV paddy, grain, seed, labor, economics

Introduction
Agriculture is the backbone of the Indian economy. Rice is grown in around 46.38 million hectares area in India with a production of 130.29 million tonnes and an average yield of 2.809 tons per hectare during 2021-22. (Agricultural statistics at a glance 2022). Paddy is the principal food crop cultivated throughout the Telangana state providing food for its population, fodder to the cattle and employment to the rural masses. Any decline in its area and production will have a perceivable impact on the state's economy and food security. In Telangana paddy is the major food crop grown in 3.65 million hectares producing 12.3 million tons in both *kharif* and *rabi* seasons with an average productivity of 3.366 tons / ha during 2020-21 (4th advance estimates). Telangana is contributing 9.44 percent of national paddy production with 7.88 percent of national paddy area. (source: Agricultural Statistics at a Glance 2022).
Typically, following the rice harvest, farmers set aside a portion of the collected grain to serve as seed for the next planting season. To these farmers, there exists no distinction between grain and seed. Nevertheless, in reality, grain primarily serves as our food source, and we generally do not concern ourselves with its germination potential. Conversely, a seed is a living grain with the capability to give rise to a living plant, and it is reserved for the specific purpose of crop cultivation. Consequently, considerable attention is placed on factors such as its physical purity, germination capacity, seed moisture content, and genetic integrity. It is underscored that "every seed is a grain, but not every grain is a seed."
Telangana state is involved in production and supply of good quality seed to farmers all over India and also to other countries (Radha & Choudary, 2005) [6]. Telangana state is considered as seed capital of India, with the presence of about 400 seed companies including major Multi-National Companies (MNCs) and 3.0 lakh farmers engaged in seed production for different seed agencies.

It is estimated that about 80 percent of hybrid rice seed requirement of the country is being met from production in Telangana state. Both public and private sectors are involved in seed production through contractual agreements with the farmers in the selected areas. Therefore, this paper attempted to study the actual cost of cultivation in both grain and seed production incurred by paddy farmers.

Materials and Methods

The research was conducted in the Karimnagar district of Telangana using a multistage sampling approach. Initially, Karimnagar was chosen as the study area. In the subsequent stage, three mandals were randomly selected from seed growing villages to gather primary data. Within each mandal, one village was chosen, namely Elbaka village (Veenavanka Mandal), Utoor village (Mankondur mandal), and Kannapur village (Shankarpatnam mandal).

Selection of Sample farmers

Any part of plant, which is used for commercial production, is called seed. But which is used for consumption purpose, is called grain. Accordingly, farmers were categorized as seed producing farmers and grain producing farmers based on purpose for which they were taking paddy production. In seed production adequate care is given from the purchase of seeds up to harvest adopting proper seed and crop management techniques. Within category of seed producers two types of seed producers namely open pollinated seed producers and hybrid seed producers were included in the study.

Open-pollinated seed vs hybrid seeds

Open-pollinated seeds are the result of natural cross-pollination or self-pollination between two plants of the same variety. They are true to type. On the other hand, a hybrid is the first-generation offspring of a cross between two genetically diverse parents**.** Rice hybrid is the F1 cross of two genetically distant pureline genotypes, having ability to produce 20-30% more yield than High Yielding Varieties (HYVs).

From each selected village, 60 farmers were sampled so as to have.

1. 20 farmers producing Hybrid paddy seed.
2. 20 farmers producing OPV paddy seed.
3. 20 farmers producing paddy grain.

Thus, the overall sample was 180 farmers spread across three villages as presented in the table. 1. It was ensured that all farm size categories representation was there in the sample (table. 2).

Table 1: Overall sampling framework adopted in the study

Category of farmers	Village No. 1 (Elbaka) Veenavanka mandal	Village No.2 (Utoor) Manakondur mandal	Village No. 3 (Kannapur) Shankar patnammandal	All three villages
	Number of farmers			
Hybrid paddy seed producers	20	20	20	60
OPV Seed producers	20	20	20	60
Paddy grain producers	20	20	20	60
Total	60	60	60	180

Table 2: Distribution of Farmers according to Agricultural Farm Size (Ha) categories

Hybrid paddy seed producers			
Particulars	**No of respondents**	**Area**	**Average farm Size**
Marginal	41 (68.33)	26.54 (42.53)	0.65
Small	16 (26.67)	21.28 (34.10)	1.33
Others	3 (5)	14.57 (23.35)	4.86
Total	60 (100)	62.399 (100)	1.04
OPV paddy seed producers			
Particulars	**No of respondents**	**Area**	**Average farm Size**
Marginal	32 (53.33)	18.62 (22.90)	0.58
Small	19 (31.67)	24.93 (30.67)	1.31
Others	9 (15)	37.74 (46.43)	4.19
Total	60 (100)	81.29 (100)	1.35
Paddy Grain producers			
Particulars	**No of respondents**	**Area**	**Average farm Size**
Marginal	33 (55)	20.05 (30.14)	0.60
Small	18 (30)	24.40 (36.68)	1.36
Others	9 (15)	22.07 (33.18)	2.45
Total	60 (100)	66.52 (100)	1.11

Among Hybrid paddy seed producers, 41 respondents represented marginal farmers with an average farm size of 0.65 hectares, 16 respondents represented small farmers with an average farm size of 1.33 hectares, and

3 respondents represented others with an average farm size of 4.86 hectares. In the case of OPV paddy seed producers, 32 marginal farmers had an average farm size of 0.58 hectares, 19 small farmers had an average farm size of 1.31 hectares, and 9 others had an average farm size of 4.19 hectares. Lastly, in paddy grain producers, 33 were marginal farmers, had an average farm size of 0.60 hectares, 18 small farmers had an average farm size of 1.36 hectares, and 9 others had an average farm size of 2.45 hectares. These figures emphasize the diverse range of farm sizes within each category, underlining the need for tailored support and interventions catering to the specific challenges faced by farmers with varying landholdings.

Methodology followed in analysis of data

Tabular analysis was used to estimate various cost concepts and income measures.

Cost of cultivation

The cost of cultivation is categorized broadly into variable and fixed costs, with variable costs encompassing expenses incurred on various inputs that fluctuate based on the scale of production, and fixed costs remaining constant regardless of the production quantity. The fixed costs include depreciation, land revenue/cess and other taxes, rental value of land, and interest on fixed capital

The cost concepts classification adopted by CACP (Commission for Agricultural Costs and Prices) New Delhi, was used in the present study as detailed below.

Cost concepts

Cost A1 = All the variable costs excluding family labour cost and including interest on working capital

Cost B 1 = Cost A 1 + interest on value of owned fixed capital (other than land)

Cost B2 = Cost B 1 + rental value of owned land + rent paid for leased-in land.

Cost C1 = Cost *B* 1 + imputed value of family labour.

Cost C2 = Cost B2+ imputed value of family labour,

Cost C3 = Cost C2 +10 percent of Cost C2 to account for the value of management input of the farmer.

Farm income measures

Total income received by the farmers from the sale of paddy seed in the case of seed farms and grain in the case of grain farms, including byproduct was considered to arrive at gross income. Net return is obtained by subtracting the total cost from gross returns

Farm business income

This is the return to the farm operator and his family labour and investment on owned land and owned fixed capital.

Farm business income= Gross income - cost A1

Family labour income

It is a measure of returns from paddy seed and grain farms to the family labour.

Family labour income= Gross income – cost B2

Farm investment income

This indicates the returns to the capital invested in paddy seed and grain farms.

Farm investment income = Farm business income - imputed value of family labour

Benefit - cost ratio

(Return per rupee spent) = Gross return/Total cost of cultivation

Cobb-Douglas production function

For estimating the effect of different factors in grain production and seed production the Cobb-Douglas production function was used. Yield in quintal per farm in grain production (Y_1) were taken as dependant variable. Similarly Yield in quintal per farm in seed production (Y_2) were taken as dependant variable

$$Y_{1i} = aX_1^{b1}X_2^{b2}X_3^{b3} \ldots\ldots X_n^{bn}$$

To linearise the equation, we took log on both sides.

Accordingly, Production function for paddy grain production can be written as

$$\text{Log } Y_{1i} = \text{Log } b_0 + b_i \sum \text{Log } X_{1i} + U_{1i} \quad (1)$$

where,

Y_{1i} = yield in quintals per farm in paddy grain production.

X_{1i} are independent variables,

b_o is scale parameter,

bi are input coefficients and

U_{1i} = residual

Likewise, per farm production function for paddy seed production can be written as

$$\text{Log } Y_{2i} = \text{Log } b_0 + b_i \sum \text{Log } X_{2i} + U_{2i} \quad (2)$$

The values of individual regression coefficients and R^2 values were estimated for paddy grain as well as seed producers sampled.

Results and Discussion

Table 3: Item wise cost of cultivation of Paddy farmers in sample area (Rs/ha)

Particulars	Paddy type		
	Hybrid paddy seed production	OPV paddy seed production	Paddy grain production
A. Variable costs			
Seeds	3765.35 (3.27)	2485.71 (2.67)	2556.68 (2.82)
Labour	58959.09 (51.19)	44652.65 (48.01)	40207.70 (44.38)
a) Human labour	39547.32 (34.33)	28182.65 (30.30)	22532.10 (24.87)
1) Hired human labour	30295.73 (26.30)	21697.37 (23.33)	15809.41 (17.45)
2) Family labour	9251.59 (8.03)	6485.28 (6.97)	6722.68 (7.42)
b) Machine labour	19411.764 (16.85)	16470 (17.70)	17675.59 (19.51)
Plant protection chemicals	7369.58 (6.40)	5462.86 (5.87)	6009.98 (6.63)
GA3	3672.43 (3.19)		
Fertilizers	12087.56 (10.49)	11636.68 (12.51)	12119.81 (13.38)
Interest on working capital	1974.66 (1.71)	1477.47 (1.58)	1400.56 (1.54)
Total variable cost	87828.69 (76.25)	65715.37 (70.66)	62294.76 (68.77)
B. Fixed costs			
Depreciation	726.97 (0.63)	621.28 (0.66)	698.96 (0.77)
Rental value of own land /Rent paid for leased in land	25323.20 (21.99))	25364.18 (27.27)	26240.68 (28.96)
Interest on Fixed capital	1302.50 (1.13)	1299.27 (1.39)	1346.98 (1.48)
Total Fixed cost	27352.69 (23.75)	27284.73 (29.33)	28286.63 (31.22)
C. Total cost (A+B)			
Total cost (A+B)	115181.38 (100)	93000.14 (100)	90581.39 (100)

(Note: Figures in Parentheses indicate percentages to total costs)

In table. 3, details of cost of cultivation for hybrid seed production, paddy OPV (Open-Pollinated Variety) seed production, and general grain production are presented. Out of the total costs, variable costs accounted for major share ranging from 68.77 percent (Rs. 62294.76) in paddy grain production to 76.25 percent (Rs. 87828.69) in hybrid seed production. Among the variable costs, human labor cost, both hired and family labour, constituted major share ranging from for 24.87 percent (Rs. 22532.1) in grain production to 34.33 percent (Rs. 39547.32) in hybrid seed production indicating the labor-intensive nature of hybrid seed production. Machine labor also contributed significantly to the total cost of cultivation, ranging from 16.85 percent (Rs. 19411.76) in hybrid seed production to 19.51percent (Rs. 17675.59) in grain production. Seeds contributed relatively less to total cost of cultivation, 2.82 percent (Rs.2556.68) in grain production to 3.27 percent (Rs.3765.35) in hybrid seed production. Fertilizers costs ranged from 10.49 percent (Rs. 12087.56) in hybrid seed production to 13.38 percent (Rs.12119.81) in grain production. The costs of plant protection chemicals contributed ranging from 5.87 percent (Rs. 5462.86) of total costs in OPV seed production to 6.63 percent (Rs 6009.98) in case of grain production. Gibberellic acid application accounts for 3.19 percent (Rs 3672.43) of total costs for hybrid seed production and this was not used by both OPV seed and grain producing farmers. The fixed costs accounted for 23.75 percent (Rs. 27352.69) of total costs in hybrid seed production followed by 29.33 percent (Rs. 27284.73) in OPV seed production and 31.22 percent (Rs. 28286.63) in grain production. Thus, the total costs per hectare of hybrid seed production worked out to Rs 115181.38 followed by Rs 93000.14 in Paddy OPV seed production and Rs 90581.40 in general grain production. Among the three different types of paddy production, cost incurred in hybrid seed production were found high compared to OPV seed production and grain production. This result corroborates with findings of Kumar *et al.* (2017) [4] and Pal *et al.* (2019) [5].

Table 4: Operation wise comparative human labour utilization in paddy seed and grain production (Man days/ha)

Operations	Hybrid paddy seed production	OPV paddy seed production	paddy grain production
Seeds and sowing	2	1	1
Transplanting	36	29	26
Weeding	7	15	10
Fertilizer in nursery	1	1	1
Fertilizer in main field	3	4	2
Supplementary pollination	29	0	0
Rouging	8	11	0
GA3	3	0	0
plant protection chemicals	4	4	3
Irrigation	5	5	8
Harvesting	6	0	0
Total man days	104	70	52

The analysis results presented in Table. 4 yield key insights regarding the operation-wise comparative human labor utilization in hybrid paddy seed production, OPV paddy seed production, and paddy grain production, measured in the number of man-days per hectare. First key insight is the labor-intensive nature of hybrid paddy seed production.

Secondly, transplanting operation stood out as a significant contributor to labor requirements in hybrid paddy seed production, with 36 man-days per hectare, surpassing the labor needed for both OPV paddy seed production (29 man-days/ha) and paddy grain production (26 man-days/ha). This in turn is due to reason that the transplanting process in hybrid paddy seed production was more intricate and resource-intensive because both male and female plants planted separately. Further, operations like supplementary pollination and rouging and GA3 applications were exclusive to hybrid paddy seed production, demanding 29, 8 and 3 man-days per hectare, respectively. On the other hand, OPV paddy seed production required 11 man-days labor for rouging, and paddy grain production demanded no labor for both supplementary pollination and rouging. Human labor utilization in weeding was higher in OPV seed production (15 man-days/ha) compared to 10 man-days in grain production and 7 man-days/ha in hybrid seed production. This divergence highlighted the unique challenges and labor requirements associated with hybrid and OPV seed production in paddy.

In conclusion, the comprehensive comparison revealed that hybrid paddy seed production involved higher human labor inputs across various operations, making it a more labor-intensive process compared to OPV paddy seed production and paddy grain production.

Table 5: Costs and Returns of paddy seed & grain farmers in sample area (Rs/ha)

Particulars	Hybrid paddy seed production	OPV paddy seed production	Paddy grain production
Total costs (Rs/ha)	115181.38	93000.14	90581.39
Total Average production (Qt)	24.64	66.38	64
Total Average Price (Rs/qt)	7085	2051	2060
Total Average returns from Byproduct	25704.59	2458.44	1709.2
Gross Income	200279.98	138613.3	133499.5
Net Income	85098.6	45613.2	42918.1
Benefit - cost ratio	1.74	1.49	1.47

Analysis results given in Table 5 reveal notable distinctions among the three production processes. The highest total costs of Rs 115181.38 per hectare was incurred in hybrid paddy seed production surpassing both OPV paddy seed production (Rs 93000.14/ha) and paddy grain production (Rs 90581.39/ha). The average yield of paddy per hectare was 24.64 quintals in hybrid seed production, 66.38 quintals in OPV paddy seed production and 64 quintals in paddy grain production. The average yield was found to be highest in OPV seed production followed by grain and hybrid seed production. The average sale price per quintal was RS.7085 for hybrid seed and Rs 2060 for grain and Rs 2051 for OPV seed. The total gross returns include returns from main product and byproduct was found higher in hybrid seed production (Rs 200279.98) followed by OPV seed (Rs138613.3) and grain production (Rs. 133499.5).

The return per rupee investment observed was 1.74 for hybrid seed production outperforming both OPV paddy seed production (1.49) and paddy grain production (1.47). It is pertinent to note here, that average sale price of OPV seed was lower than average sale price in the case of paddy grain. Hence it is the higher output quantity per hectare in the case of OPV seed production that has led to higher net income, when compared to net income in paddy grain production.

Thus, comparison of costs and returns of three types of paddy production revealed that hybrid seed production emerged as financially lucrative option due to high net income (86.57% more than OPV seed production and 98.28% more than grain production) and high returns per rupee investment compared other two types of paddy production. These results are similar to the findings of Wagan *et al.* (2015) [8] and Bhuker *et al.* (2018) [1]. Net income from OPV seed production was 6.28% more than paddy grain production

Table 6: Cost concepts

Particulars	Paddy Hybrid seed production	Paddy OPV seed production	Paddy grain production
Cost A1	79304.08 (62.59)	59851.40 (58.50)	56271.03 (56.47)
Cost A2	79304.08 (62.59)	59851.40 (58.50)	56271.03 (56.47)
Cost B1	80606.58 (63.62)	61150.67 (59.77)	57618.02 (57.82)
Cost B2	105929.79 (83.60)	86514.85 (84.56)	83858.70 (84.16)
Cost C1	88555.67 (69.89)	67635.96 (66.11)	64340.71 (64.57)
Cost C2	115181.38 (90.90)	93000.14 (90.90)	90581.39 (90.90)
Cost C3	126699.52 (100.00)	102300.16 (100.00)	99639.53 (100.00)

Note: Figures in Parentheses indicate percentages to total costs

***Source*:** computed from primary data

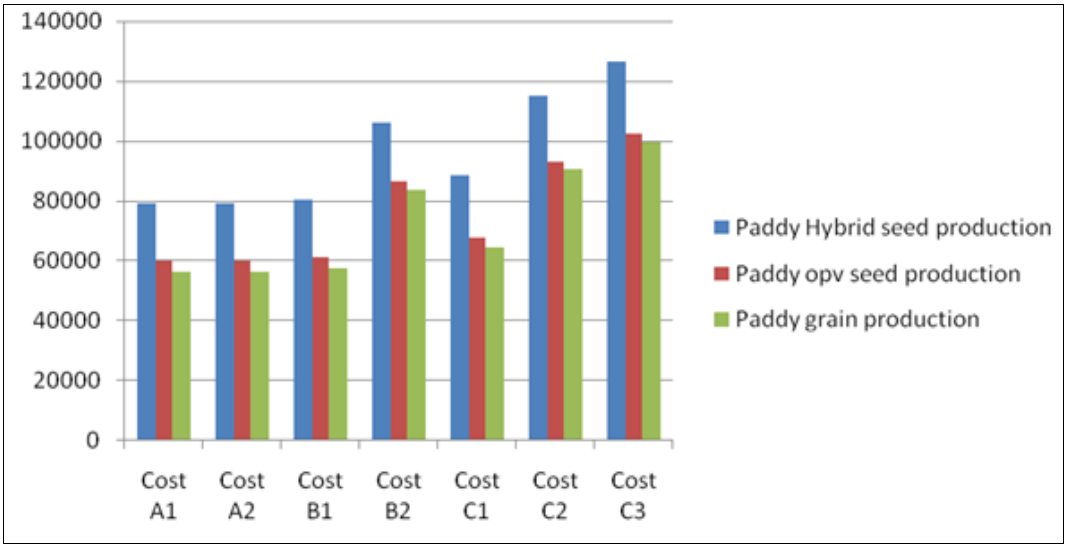


Fig 1: Comparative cost concepts

The analysis results presented in table 6 revealed that the cost A1 of paddy Hybrid seed production on the sample farms was Rs 79304.08, Rs 59851.40 for OPV seed production and Rs 56271.03 for grain production per hectare. The cost A2 was same as cost A1 as there no taxes incurred on land. The Cost B1 (which includes interest on fixed capital) was Rs 80606.58 for hybrid seed production followed by OPV seed production Rs 61150.67 and grain production Rs. 57618.02.

The Cost C1 revealed hidden costs associated with family labor contributions. The cost C1 for hybrid seed production was Rs 88555.67 followed by OPV seed production (Rs 67635.96). In paddy grain production relatively lower family labor involvement, led to its lower C1 cost Rs 64340.71. Similarly Cost C2 (which includes rental value of land and imputed value of family labour) and Cost C3 (including 10 percent contingency) represented the final total costs for three types of paddy production. The Cost C2 for Hybrid seed production was high Rs115181.38 followed by Rs 93000.14, Rs 90581.39 OPV seed production and grain production respectively.

Table 7: Measures of Farm income (Rs/ ha)

Particulars	Paddy hybrid seed production	Paddy OP Vseed production	Paddy grain production
Gross income	200279	138613.3	133499.5
Net income	85098.6	45613.2	42918.1
Farm business income	120975.9	78761.9	77228.5
Family labour income	94350.2	52098.4	49640.8
Farm investment income	111724.3	72276.6	70505.8
Benefit - cost ratio (Return per rupee spent)	1.74	1.49	1.47

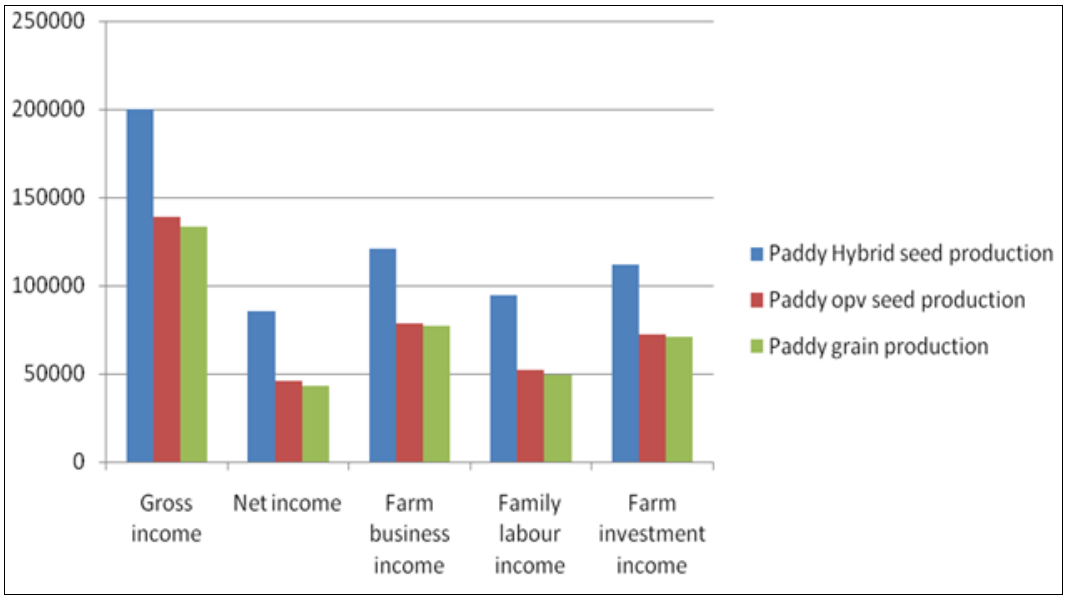


Fig 2: measures of Farm income

The results in Table 7 revealed that the farm business income (gross income - cost A1) was higher for paddy hybrid seed production (Rs 120,975.90/ha) compared to paddy OPV seed production (Rs 78761.9/ha) and paddy grain production (Rs 77228.5/ha). Family labor income was higher in paddy Hybrid seed production (Rs 94,350.18/ha), surpassing paddy OPV seed production (Rs 52098.4/ha) and paddy grain production (Rs 49640.8/ha). Similar trend was observed in the case of farm investment income also.

In summation, paddy Hybrid seed production was outscoring in its profitability relative to paddy OPV seed production and paddy grain production.

Production function analysis

To identify the factors influencing the yield of paddy seed production and grain production, Cobb-Douglas production function was employed. The results thus obtained are presented in tables 8 to 10 and discussed in this section.

The results of the analysis of factors influencing hybrid seed productivity (table. 8) indicated that total human labour (man days), machine labour (hours) were the major contributing factors to total yield. The elasticity co-efficient of total human labour, machine hours were found to be significant and positive, indicating that under ceteris paribus condition everyone percent increase in human labour, machine (hours) would increase the yield by 0.5 and 0.91 percent respectively. The returns to scale was 1.15 which was the sum of elasticities as shown in table 8. This value being greater than unity (1) means that, the farmers are operating in the region of increasing returns to scale. This implies that if all explanatory variables are simultaneously increased by one percent, the total yield of the hybrid paddy seed production will increase by 1.15 percent. Thus the analysis showed that resources were under-utilized hence there is a scope for reorganization of inputs such as total human labour (man days), machine (hours) / farm to increase yield.

Table 8: Factors influencing hybrid paddy seed production

Particulars	Coefficients	Std. Error	P-value
Intercept	-3.12	4.23	0.46
Area (ha)	-0.56	0.43	0.20
Total human labour (man days)	0.50	0.20	0.02**
Pesticide cost (Rs)	0.00	0.06	0.94
Machine (hrs)/Farm	0.91	0.41	0.03**
Seed cost (Rs)	0.37	0.61	0.55
Fertilizer cost (Rs)	-0.08	0.12	0.48
GA3 cost (Rs)	0.02	0.12	0.84
R^2	0.96		
Returns to scale	1.15		

** Significant at 5% level

Table 9: Factors influencing open pollinated variety seed production

Particulars	Coefficients	Std. Error	P-value
Intercept	4.31	1.62	0.01**
Area (ha)	0.55	0.13	9.04E-05***
Total human labour (man days)	-0.53	0.38	0.17
Pesticide cost	0.11	0.04	0.01**
Machine (hrs)/Farm	1.03	0.42	0.02**
N Qty (Kg /Farm)	0.07	0.08	0.37
P Qty (Kg /Farm)	-0.26	0.10	0.01**
K Qty (Kg /Farm)	0.01	0.02	0.65
Seed cost (Rs)	0.03	0.15	0.85
R^2	0.96		
Returns to scale	1.02		

*** significant at 1% level

The results of the analysis of factors influencing production on OPV seed producing farms (table. 9) indicated that area(ha), pesticide cost (Rs), machine (hours)/ farm, total P quantity(kg/farm) as major contributing factors to total production in OPV seed production. The elasticity co-efficient of area(ha), pesticide cost (Rs) and machine hours/farm were found to be positively significant, indicating that under ceteris paribus condition everyone percent increase in expenditure on pesticide cost and one percent increase in area would increase the yield (qtls) by 0.11, 0.55,1.03 percent respectively. The elasticity co-efficient of human labour, total P quantity(kg/farm) were found to be negatively significant, indicating that everyone percent increase in P quantity(kg/farm) and one percent increase in human labour under ceteris paribus condition would decrease the production by 0.26, 0.53 percent respectively. The returns to scale was 1.02 which was the sum of elasticities as shown in table 9.

Table 10: Factors influencing paddy grain production

Particulars	Coefficients	Std. Error	P-value
Intercept	-3.54	2.55	0.17
Area (ha)	0.2	0.1	0.04**
Total human labour (man days)	5.01	1.29	0.0003***
Pesticide cost	0.3	0.13	0.03**
Machine (hrs)/Farm	-2.72	1.09	0.02**
N Qty (Kg /Farm)	-0.5	0.22	0.03**
P Qty (Kg /Farm)	0.01	0.04	0.86
K Qty (Kg /Farm)	0.03	0.03	0.21
Seed cost (Rs)	-0.98	0.21	1.86E-05***
R^2	0.94		
Returns to scale	1.34		

*** significant at 1% level

The results of the analysis presented in the table 10 indicated that area(ha), total human labour(man days),pesticide cost(Rs),machine (hours)/ farm, total N quantity(kg/farm), seed cost(Rs) are major contributing factors to total yield(qtls) in grain production.

The elasticity co-efficient indicated that area, total human labour, pesticide cost were found to be significant positively indicating that under ceteris paribus condition everyone percent increase on each of the item would increase the total yield by 0.2,5.01, and 0.3 percent respectively. Machine labour, total N quantity (kg/farm), seed cost (Rs) were negatively significant.

The returns to scale were 1.34 which was the sum of elasticities as shown in table 10.

Sikdar *et al*. (2008) [7], Kea *et al*. (2016) [3], Elvina *et al*. (2023) [2], reported similar findings.

Conclusion

In conclusion, the analysis of data across three different types of paddy production revealed that the gross income from paddy hybrid seed production was Rs 200,279.98/ha, followed by paddy OPV seed production (Rs138613.3 /ha) and paddy grain production (Rs 133499.5/ha). When considering the total costs, the highest cost of Rs 115,181.39 per hectare was incurred in hybrid seed production, followed by paddy OPV seed production (Rs 93,000.14 per hectare) and general grain production (Rs 90,581.40 per hectare). The benefit-cost ratio reinforced this trend, with hybrid paddy seed production showing a ratio of 1.74, outperforming both OPV paddy seed production (1.49) and paddy grain production (1.47). These findings indicate the economic viability of hybrid paddy seed production and also its superior performance in terms of profitability compared to the other alternatives. Human labour cost constituted the largest part of total costs on both types of seed farms and grain farms of the paddy crop. Operational costs were accounted for more than 65 percent of the total cost in both seed production and commercial production of paddy. Though the total cost of production was higher in seed farms, it fetched higher net income to the seed growers, when compared to farmers of commercial production, owing to the higher market price of the seed. Cobb douglas production function analysis revealed that human labour (man days), machine (hrs), N (kg), pesticide costs were the significant predictors. Farmers need to be educated regarding optimum resource use. Policymakers and stakeholders can leverage these insights to tailor support programs, focusing on enhancing labor efficiency, promoting eco-friendly pest management techniques to further empower farmers.

References

1. Bhuker A, Bhatia J, Dhillon A, Kumar A. Comparative economics of seed production vis-à-vis commercial grain production in cluster bean in Haryana. Forage Res. 2018;43(4):327-329.
2. Elvina TS, Siregar A, Ginting R. Analysis of Factors Influencing Rice Production in Labuhan Batu District. J Soc Res. 2023;2(9):3305-3317.
3. Kea S, Li H, Pich L. Technical Efficiency and Its Determinants of Rice Production in Cambodia. Economies. 2016;4(4):1-17.
4. Kumar A, Singh RKP, Singh K, Mishra JS. Economics of paddy (*Oryza sativa*) production: A comparative study of Bihar and Punjab. Indian J Agric. Sci. 2017;88:314-319.
5. Pal Govind, Bhaskar UK, Kumar JSP, Sripathy KV, Ramesh KV, Agarwal DK, *et al*. Management, Socio-economic Dynamics of Farmers and Economics of Certified Seed Production of Paddy in Karimnagar District, Telangana. J Econ Manag Trade. 2019;23(6):1-9.
6. Radha Y, Chowry KR. Comparative economics of seed production vis-à-vis commercial production of cotton in Andhra Pradesh. Indian J Agric. Econ. 2005;60(1):94-102.
7. Sikdar MMH, Alam MA, Hossain MI. Factors affecting the technical efficiency of Boro rice production in Bangladesh a Cobb-Douglas stochastic frontier analysis. J Bangladesh Agric. Univ. 2008;6:215-226.
8. Wagan SA, Noonari S, Memon SMIN, Bhatti AM, Kalwar GY, Sethar AA, *et al*. Comparative Economic Analysis of Hybrid Rice v/s Conventional Rice Production in District Badin Sindh Province Pakistan. J Environ Earth Sci. 2015;5(3):ISSN 2224-3216 (Paper).

9. Agricultural Statistics at a Glance. Government of India, Ministry of Agriculture & Farmers Welfare, Department of Agriculture & Farmers Welfare Economics & Statistics Division; c2022.