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Economics of Potato Seed Production– an Analytical Study from Terai Zone of West Bengal

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Abstract

The study was conducted to analyze the economics of cultivation of potato seed in respect of technical efficiency and allocative efficiency in Terai zone of West Bengal, India based on primary data collected during September 2018 to March, 2019. The multistage sampling technique was used to select 80 potato seed grower as respondent. Total variable cost of cultivation (₹ acre^{-1}) was 47662.70 and 46098.94, respectively for seed and conventional production. Net return (GI-Cost C_3) in seed production revealed ₹ 29931.67 acre^{-1} which was 53.13% higher than conventional potato production. The input-output ratio (based on Cost C_3) for seed production was examined as 1:1.51. The contribution of different used resources to the variation of income (yield) was found 90% (R^2=0.900). The factors *viz*., seed and organic fertilizers found significant at 5% and human labour at 1% level. Low price of output, diseases and pest attack, high price of inputs, shortage of labour and irrigation were major problems in potato seed production. Hence, to increase production potential of potato seed at the farmers level, the availability of quality seed is to be ensured along with proper infrastructure, guidance and training facilities.

Keywords: Allocative efficiency, marketing efficiency, net return, technical efficiency

1. Introduction

Potato is one of the most widely cultivated horticultural and important vegetable crops originated in the high hills of Peru and Bolivia of South Africa, where it was domesticated approximately 7,000 to 10,000 years ago (Patel et al., 2019). Being the second largest producer, India occupies a prominent position on global potato map (Scott and Suarez, 2011; Rana, 2015). India produced 45.34 million tonnes potatoes (12.32% of world production) against 95.99 million tonnes by China (24.17% of world production) while Russian Federation, third largest producer of potatoes, produced 30.20 million tonnes (8.20% of world production) in 2013 (Anonymous, 2015). Despite the significant progress in Potato R&D, the national average yield (from 2011-12 to 2013-14) revealed 22.48 t ha^{-1} which was almost half of productivity as compared to the developed countries *viz*., USA (46.53 (t ha^{-1}), Netherland (44.83 t ha^{-1}), France (44.16 t ha^{-1}) and Germany (44.00 t ha^{-1}). Although on an average, India's land productivity in respect of potato was better than Asia's, an important reason for the yield gap is the dearth of quality planting material (Jain and Kumar, 1998).

Within India, potato production is highly concentrated in Gangetic plains as three largest potato producing states *viz*., Uttar Pradesh (32.38% of national production), West Bengal (26.94% of national production) and Bihar (14.56% of national production); collectively contribute about 74% to the national production (Rana and Anwer, 2018). But in terms of productivity, Uttar Pradesh, West Bengal and Bihar ranked 4th, 8th and 7th position over the country and even the productivity of West Bengal and Bihar found to be lower than national average productivity and Gujarat was the leading state in terms of productivity (31.58 mt ha^{-1}) although, its contribution to the total production was only 8.18% during FY 2015-16 (Horticulture Statistics at a glance, 2017). Therefore, India has to increase the potato productivity and that could be achieved through supply of good quality hybrid seed of suitable variety. But farmers used maximum quantity (about 91%) of self-retained seed from the previous autumn crop for potato cultivation and there is no standard seed supply system (Sidhu et al., 1997), thus majority (91.3%) of the growers purchase seed from open market with a limited supply from the Ministry of Agriculture (Ghebreslassie et al., 2014). Farmers who store seed potato without renewing the seed from a reliable source and use it for several consecutive cultivation seasons will face reduction in quality and performance (Gildemacher, 2012) and potato seed tubers supplied by local and informal systems are poor in terms of health, physiological, physical and genetic features (Gildemacher et al., 2009). This has been associated with the failure of the formal seed sector to multiply sufficient quantities of the new varieties and make it available to the farming communities (Rubyogo et al., 2010). There is also a

shortage of certified seed or quality seed of desirable crop varieties and the cost of certified seed of certain crops is very high, particularly for potato and jute. Therefore, there is urgent need to set up informal seed production system involving local farmers (Roy, 2014). Further, the main components of a seed production system are: 1) seed production and storage, 2) seed tubers quality, 3) seed availability and distribution, and 4) the flow of knowledge (Hirpa et al., 2012). Thus to fulfil the farmers expectation of higher yield, timely availability of viable seed along with adequate storage facility and capacity building of seed growers is paramount important.

With the above context, assessing the economics in potato seed production assumes paramount important. Hence the study was conducted for evaluating the cost of cultivation, technical efficiency and allocative efficiency of input factors and also to examine marketing efficiency of seed production of potato at farm level.

2. Materials and Methods

2.1. Study area

The study was conducted in Cooch Behar and Jalpaiguri districts of Terai zone in West Bengal during September 2018 to March, 2019. Both the districts were selected purposively based on maximum number of potato seed growers. One block from each district Sitalkuchi (latitude 26.160412 and longitude 89.18654) from Cooch Behar and Maynaguri (latitude 26.573830 and longitude 88.821495) from Jalpaiguri, having maximum area under potato seed production were selected. From each block, four villages were selected purposively based on maximum number of potato seed growers. From each village, 10 number of potato seed growers were selected randomly. Thus, a total number of 80 potato seed growers were taken as respondent for the study. The primary data was collected with the developed schedule from respondents through personal interview method.

2.2. Cost and return analysis

Descriptive statistical analysis such as mean, percentage etc. was carried to compute cost of cultivation. The farm management analysis and related farm income measures at Cost A_1, Cost A_2, Cost B_1, Cost B_2, Cost C_1, Cost C_2 and Cost C_3 were done. The efficiency measures were also carried out to examine the resource productivity in potato seed production.

In order to study the resource productivity and resource use efficiency among different types of production function, Cobb-Douglas production function in logarithmic form was used as given below:

$$Y=aX_1^{b1}X_2^{b2}X_3^{b3}X_4^{b4}X_5^{b5}X_6^{b6}X_7^{b7}U_1$$

The Cobb-Douglas production function was transformed into the following double log or log linear form so that it could be solved by the least square method:

$$\text{Log } Y=\text{Log } a+b_1 \text{ Log } X_1+b_2\text{Log}X_2+b_3\text{Log}X_3+b_4\text{Log}X_4+b_5\text{Log}X_5+b_6\text{Log}X_6+b_7\text{Log}X_7+Ui$$

Where, Y=production (₹ acre^{-1}), X_1=Human labour (₹ acre^{-1}), X_2=Seeds (₹ acre^{-1}), X_3=Organic fertilizers (₹ acre^{-1}), X_4=Inorganic Fertilizer (₹ acre^{-1}), X_5=Agro-chemical (₹ acre^{-1}), X_6=Irrigation (₹ acre^{-1}), X_7=Micronutrient (₹ acre^{-1}), a=constant and U_i=Error-term

The estimated coefficients of independent variables were used to compute the marginal value products (MVP) and the resources-use efficiency (RUE) was worked out using following formula. MVP was estimated at their respective geometric mean level and MFC was taken as unit price of the factor.

RUE =MVP/MFC

Where, $MVPi = \beta_i \frac{\overline{Y}}{\overline{X}_i} Py$

Where,

MVPi=Marginal value product of the i^{th} input,

$\overline{Y}$=Geometric mean of value of output

$\overline{X}_i$=Geometric mean of i^{th} input.

β_i=Estimated partial elasticity co-efficient of the i^{th} input, and

P_y=Price of output

2.3. Marketing margin

Marketing margin of the middleman was calculated as the difference between the total payment (marketing cost+purchase price) and receipts (sale price) of the middleman and calculated as:

Ami=Pri-(Ppi+Cmi)

Where, Ami=Absolute marketing margin of i^{th} middleman

Pri=Sale price unit^{-1}

Ppi=Purchase price unit^{-1}

Cmi=Cost incurred on marketing unit^{-1}

2.4. Marketing efficiency

Marketing efficiency is the ratio of market output to marketing inputs. An increase in this ratio represents improved efficiency and decrease denotes reduced efficiency. Marketing efficiency was calculated by using Acharya's index of marketing efficiency:

ME=FP/(MC+MM)

Where,

ME=Index of marketing efficiency

FP=Price received by the farmer

MC=Total marketing cost

MM=Marketing margins

2.5. Constrains in potato seed production

The Garrett's ranking technique was used to study the opinion of farmers regarding the constraints faced by them in cultivation and marketing of potato seed. The present position of each rank was converted into scores by referring table given by Garrett and Woolworth (1969). The constraint with the highest mean value was considered as the most important one

and the others followed in that order. The percent position of each rank was found out by the following equation:

Present position=(100(Rij-0.5))/Nij

Where,

R_{ij} = Rank given for the i^{th} constraint by j^{th} individual

N_{ij} =Number of constraints ranked by the j^{th} individual

3. Results and Discussion

3.1. Social and economic profile of seed growers

Input use and the corresponding efficiency as well as participation and decision making of the farming folk depend to a large extent on the socio-techno-economic features of them. Therefore, it necessitates having a brief sketch about the social and economic profile of seed growers in the selected study areas. The average age of the seed growers was found 42.69 years with an average family size of 4.81 indicated that young and middle aged farmers were more interested in potato seed production (Table 1). Nearly 70% of the seed growers had educational level from secondary onwards that led them to scientifically understand the potato seed production technology. The average annual income of the seed grower revealed ₹ 197803.73. The farming folk were mostly marginal in nature having average land holding to the tune of 5.12 acre and the net cropped area was 4.60 acre of which 42.93% (1.97 acre) was used for seed production purpose. It was investigated that the varieties like Kufri Jyoti, Kufri Arun and Kufri Sundari were used for potato seed production.

Table 1: Socio-economic attributes of sample seed growers

Particular	Value
1. Average age	42.69 year
2. Family size	4.81
3. Educational level	
Non-educated	6.25%
Upto class VIII	25.00%
Secondary	37.50%
Higher secondary and above	31.25%
4. Average family income (annual)	₹ 197803.73
5. Average family expenditure (annual)	₹ 165920.70
6. Average land holding	5.12 acre
7. Average agricultural land holding	4.81 acre
8. Average net crop area	4.60 acre (100)
9. Average seed crop area	1.97 acre (42.93%)

3.2. Cost and return analysis

On the basis of standard cost concepts, a comparative cost and return analysis between seed production and conventional production practices of potato was carried out and presented in Table 2. The average total variable cost of cultivation estimated in seed production was 3.87% than conventional production system. But, expenditure on various items of cost was almost same in both production systems. Only expenditure for purchase of seed was 8.59% higher in seed production practice than in conventional practice. The reason might be due to the use of lower quality seed in conventional production practice and higher quality seed in seed production practice. The study revealed that seed was the second costliest input accounting 35.54% of expenditure. The finding is also synonymous with the study of Ashu et al. (2018) and Kushwah and Singh (2011). The other cost items were expenditure on organic fertilizers, inorganic fertilizers, micro-nutrient, irrigation, application of agro-chemicals. Here agro-chemical includes pesticides, herbicides, insecticides, fungicides and chemicals for seed treatment. Share of own family labour with respect to total human labour was around 55% in both the production process. Per acre fixed cost of cultivation in both processes was found same (₹ 6295.06). Subsequently, the average total cost of cultivation per acre was estimated as ₹ 53957.76 in seed production and ₹ 52,394.00 in conventional production process. The average gross return from one acre of land was ₹ 89127.00 in seed production which is 16.07% higher than the gross return fetched from conventional production practice. This was might be due to the variation (12.50%) in output or yield between two production processes as well as market price.

3.3. Cost of cultivation and related income measures

The cost of cultivation and related income measures on potato production was calculated and shown in Table 3. The per acre average Cost A_1, Cost A_2, Cost B_1, Cost B_2, Cost C_1, Cost C_2 and Cost C_3 were estimated as ₹ 37797.70, ₹ 38263.94, ₹ 43708.94, ₹ 48368.94, ₹ 53813.94 and ₹ 59195.33, respectively in seed production whereas in conventional production, the above costs were ₹ 36024.99, ₹ 36491.23, ₹ 41936.23, ₹ 46596.23, ₹ 52041.23 and ₹ 57245.35, respectively. Family Labour Income (FLI), Farm Business Income (FBI) and Net Income were estimated to be ₹ 45418.06, ₹ 51329.30 and ₹ 29931.67 in seed production while in conventional production process; these were ₹ 34855.77, ₹ 40767.01 and ₹ 19546.65, respectively. From the cost analysis, it was observed that the net profit based on Cost C_3 in seed production was 53.05% higher than conventional method of production. The reason might be the higher level of productivity in seed production practice. The gross return was estimated as ₹ 89127.00 $acre^{-1}$ in potato seed multiplication and ₹ 76792.00 in conventional potato production. However, production cost $acre^{-1}$ was ₹ 597.75 in seed multiplication and ₹ 596.37 in conventional potato production. The results are also in conformity with the study of Sable et al. (2017) and Ashu et al. (2018). It is to note here that 10% cost of Cost C_2 was considered as managerial costs for accounting the net income (Cost C_3). Another important finding from cost and return analysis revealed that the overall technical efficiency (input-output ratio) based on Cost C_3 and

Table 2: Analysis of cost of cultivation of potato (size of farm: 1 acre)

Sl. No.	Item	Seed production			Conventional production		
		Amount / number	Rate (₹ unit^{-1})	Total (₹ acre^{-1})	Amount /number	Rate (₹ unit^{-1})	Total (₹ acre^{-1})
1.	Seed	484 kg	35	16940 (35.54)	520 kg	30	15600.00 (33.99)
2.	Family labour	43	235*	10105 (21.20)	43	235*	10105 (22.02)
3.	Hired labour	34.33	235*	8067.55 (16.93)	34.33	235*	8067.55 (17.58)
4.	Organic fertilizers	12.80 qtls	161.52	2067.46 (4.34)	11.14 q	161.52	1799.33 (3.92)
5.	Inorganic fertilizer 10:26:26 (Urea MOP)	45.35 kg 55.95 kg 14.16 kg	26 7 12	1740.67 (3.65)	45.35 kg 55.95 kg 14.16 kg	26 7 12	1740.67 (3.79)
6.	Micro-nutrient	16.58 g	80	1326.4 (2.78)	14.08 g	80	1126.40 (2.45)
7.	Plant Protection (Agro chemicals)	946 ml	1.20	1135.20 (2.38)	975 ml	1.20	1170.00 (2.55)
8.	Irrigation	12.39 hrs	155	1920.45 (4.03)	12.60 hrs	155	1953.00 (4.26)
9.	Machinery labour/ charges	-	-	3422.50 (7.18)	-	-	3422.50 (7.46)
10.	Interest on working capital @ 8 annum^{-1}	-	-	937.47 (1.97)	-	-	905.54 (1.97)
Total variable cost				47662.7 (100)			46098.94 (100)
1.	Rental value of own land	-	-	5445.00	-	-	5445.00
2.	Land revenue	-	-	143.82	-	-	143.82
3.	Depreciation	-	-	240.00	-	-	240.00
4.	Interest on fixed capital	-	-	466.24	-	-	466.24
Total fixed cost				6295.06			6295.06
Total cost				54166.71			52394.00
Yield (Gross return)		9903 kg	9	89127.00	9599	8	76792.00

*235 is the average market wage rate (actual wage rate going in the study area) of male and female labour

Table 3: Cost of cultivation and related income measures

Particulars	Seed Production (₹ acre^{-1})	Conventional Production (₹ acre^{-1})	Particulars	Seed Production (₹ acre^{-1})	Conventional Production (₹ acre^{-1})
Cost A_1	37797.70	36024.99	Farm Investment Income	41224.30	30662.01
Cost A_2	37797.70	36024.99			
Cost B_1	38263.94	36491.23	Net Income (GI-Cost C_3)	29931.67	19546.65
Cost B_2	43708.94	41936.23			
Cost C_1	48368.94	46596.23	Input Output Relationship		
Cost C_2	53813.94	52041.23	On the basis of Cost C_2	1.66	1.48
Cost C_3	59195.33	57245.35	On the basis of Cost C_3	1.51	1.34
Gross Income	89127.00	76792.00	On the basis of TVC	1.87	1.67
Farm Business Income	51329.30	40767.01	On the basis of TC	1.65	1.47
Family Labour Income	45418.06	34855.77	Cost of production based on Cost C_3 (₹ q^{-1})	597.75	596.37

total cost was 1.51:1 and 1.65:1 in seed production and 1.34:1 and 1.47:1 under conventional production process.

3.4. Regression coefficients of different inputs

Data presented in Table 4 revealed that the independent

Table 4: Production elasticity of input factors

Sl. No.	Particulars	Coefficients	t-Stat	Significance
1.	Log a	6.969135***	4.862143	0.0013
2.	X_1 (Human labour)	0.685538***	4.553562	0.0019
3.	X_2 (Seed)	-0.40722**	-2.73345	0.0257
4.	X_3 (Organic fertilizer)	0.308036**	2.873055	0.0207
5.	X_4 (Inorganic fertilizer)	-0.04718	-0.81616	0.4380
6.	X_5 (Agro-chemicals)	-0.0262	-0.37467	0.7176
7.	X_6 (Irrigation)	0.000307	0.006442	0.9950
8.	X_7 (Micro-nutrient)	-0.04316	-1.37707	0.2058
9.	R^2	0.900		

a- dependent variable-Income, ***: Significant at (p=0.01) level, **: Significant at (p=0.05) level

variable human labour was positively significant at 1% level while other variables *viz*., seed and organic manures were significant at 5% level each. The coefficient of seed (X_2), inorganic fertilizers (X_4), agro-chemical (X_5) and micro-nutrient (X_7) were negative and non-significant indicating that these factors were not utilized optimally. The co-efficient of irrigation (X_6) was found positive but non-significant. Further, the elasticity of each independent variable was less than unity in each input implying decreasing marginal productivity to each. The coefficient of multiple determinants (R^2) was 0.900 indicating that the model could explain 90% variation of income in potato seed production.

3.5. Allocative efficiency

Table 5 shows the allocative efficiencies of resources used in multiplication of potato seed. To examine the efficiency of resource use, the MVP of each factor was compared with its acquisition cost. The RUE ratio indicates the potential for further use of input. The resource is said to be allocated efficiently or optimally if RUE=1 or MVP=MFC. The MVP and RUE for three factors *viz*., human labour, organic fertilizer and irrigation was positive implying the positive impact towards income. But for rest other variables *viz*., seed, inorganic fertilizer, agro-chemical and micro-nutrient it was negative indicating overuse of above inputs. There was no further scope to increase output of potato seed production through use of the said factors unless change in the production technology. The MVP of three inputs *viz*., X_1, X_3 and X_6 were found to be greater than zero revealing that further increase in use of these factors would result into an increase in potato seed production and that should be coupled with change in production technology. The MVP was observed positive and highest for the input organic fertilizer (₹ 1360.11) followed by human labour (₹ 719.29) and irrigation (₹ 2.09). But RUE was examined 8.42 for organic fertilizer and 3.06 for irrigation inferring that by one unit extra use these inputs, the quantity of output would be added by 8.42 and 3.06 units, respectively.

3.6. Marketing margin and marketing efficiency of marketing channels

In marketing of output of seed growers, only two channels were identified as follows:

Channel I: Seed grower → RSPG → Wholesaler → Retailer → Consumer

Chunnel II: Seed grower → RSPG → Consumer

The seed producer used to sell their total output to existed Registered Seed Producer Group (RSGP) who took the responsibility to perform the activities like cleaning, grading and all the procedures and formalities for certification of seed bought from the seed growers.

The estimated net marketing margin at different stages of marketing channel of potato seed is presented in Table 6. Net marketing margin for per kg of output was highest for RSGP (₹ 4.50) followed by wholesaler (₹ 3.00) and retailer (₹ 1.50) for marketing channel I. While for marketing channel II, RSGP was the only middleman and they received a net marketing margin of ₹ 7.50. Further, the marketing cost was highest for RSGP (₹ 6.50 kg^{-1}) in both channels. The reason behind it might be that the RSGP did most of the post-harvest operations and formalities to get the certification. The marketing efficiency as well as producer's share in consumer rupee of channel II found higher than channel I. The marketing efficiency of channel I

Table 5: Allocative efficiency of different resources (variables) used in potato seed production

Particular	X_1 (Human labour)	X_2 (Seed)	X_3 (Organic fertilizer)	X_4 (Inorganic fertilizer)	X_5 (Agro-chemicals)	X_6 (Irrigation)	X7 (Micro-nutrient)
GM (₹)	18117.99	18865.69	2959.175	1755.079	1127.244	1840.072	1271.342
Byx	0.685538	-0.40722	0.308036	-0.04718	-0.0262	0.000307	-0.04316
Price (₹ $unit^{-1}$)	235	32	161.52	15.08*	120	155	80
MVP (₹)	719.29	-55.88	1360.11	-30.44	-225.61	2.09	-219.70
RUE	3.06	-1.75	8.42	-2.01	-1.88	0.01	-2.75

Table 6: Marketing margin and marketing efficiency of marketing channels

Channel	Marketing participants	MC (₹ kg^{-1})	Sale price (₹ kg^{-1})	Purchase price (₹ kg^{-1})	Net price (₹ kg^{-1})	Net marketing margin (₹ kg^{-1})	PSCR (%)	ME (%)
I	Seed grower	0	9	-	9	0	32.14	47.37
	RSPG	6.5	20	9	13.50	4.5		
	Wholesaler	2	25	20	23.00	3		
	Retailer	1.5	28	25	26.50	1.5		
	Total	10.00	-	-	-	9.00		
II	Seed grower	-	9	-	9	-	39.13	64.29
	RSPG	6.5	23	9	16.50	7.5		

MC: Marketing cost; ME: Marketing efficiency; PSCR: Producer share in consumer rupee

was less than 50% and the producer's share in consumer rupee in both channels was less than 40% which is contradictory to the findings of Balaji et al. (2010).

3.7. Constrains in potato seed production

A total twelve important problems *viz*., unavailability of quality seed, weed problem, unavailability of quality fertilizers, technological problem, irrigation problems, disease and pest attack, shortage of labour, low price of output, high price of input, small holding of seed growers, availability of credit and storage facility for output were identified. Garrett's ranking technique was used to rank the above said constraints. Among twelve, first five important constraints were low price of output, disease pest attack, high price of input, shortage of labour and irrigation for potato seed production (Table 7) that hindered the adoption and expansion of seed cultivation at farmer's level. The result is also in conformity with the study of Pandit et al. (2006). The maximum net marketing profit taken by the middlemen in marketing channels might be one of the important reasons of low price of output and the high humid condition and prevailing of mostly acidic soil might be reason of high weed infestation as well as diseases and pest attack. While the migration of unemployed youths for searching of employment in expectation of fetching higher income from the other region of the country might be the reason of shortage of labour. The highly acidic loamy porous soil, very scanty rainfall and unavailability of mini and deep irrigation system are augmenting the irrigation problem in the study area.

Table 7: Constraint analysis of potato seed production (N= 80)

Sl. No.	Constraints	Total score	Mean score	Ranking
1.	Unavailability of quality seed	3835	47.94	12
2.	Weed problem	4100	51.25	7
3.	Unavailability of quality fertilizers	3960	49.50	11
4.	Technological problem	4015	50.19	10
5.	Irrigation problems	4385	54.81	5
6.	Disease and pest attack	4535	56.69	2
7.	Shortage of labour	4400	55.00	4
8.	Low price of output	4650	58.13	1
9.	High price of input	4510	56.38	3
10.	Small holding	4095	51.19	8
11.	Availability of credit	4355	54.44	6
12.	Storage facility	4090	51.13	9

4. Conclusion

The net return in potato seed production was around 50% higher than conventional production practice. Although the inputs caused 90% variation in output but the resources were not utilized optimally. The producer's share in consumer rupee and marketing efficiency could be increased by eliminating middlemen. Hence, development of storage, grading facilities, processing centre, institutional and technical support are crucial for success of potato seed production at farmer's level.

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