

Estimation of Cost and Profit in Farming Some Major Crops During Last Two Decades in West Bengal: A Case Study in Birbhum District

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ABSTRACT

The growth of agriculture in West Bengal significantly contributes the food supply through nationwide since last few decades. The cost of farming specially seed cost, irrigation cost increases rapidly. Though modern mechanization has been introduced for few crops to reduce the animal and human labor cost yet an unregulated market structure overall cost of farming increased during last two decades. The present paper emphasises the growth of cost and profit in cultivation for last twenty years in West Bengal. With the help of secondary data it has been tried to measure

the cost and profit structure for seven major crops in West Bengal since 2001. The impact of various cost components on profit has also been derived with the help of a primary survey in the district of Birbhum.

Keywords Crop production, Cost of farming, Profitability, Irrigation, Production growth.

INTRODUCTION

West Bengal, a state of India, has a diverse and robust agricultural sector due to its favorable climate, fertile soil, and abundant water resources. Majority of Indian population always depends directly or indirectly on agriculture. The role of agriculture can never be undermined in the overall socio-economic aspects of India. Share of agriculture in state GDP of West Bengal has fallen from 30.06% in 1980-81 to 21% in 2019-20 (Govt of India, MOSPI, July 2020). The agricultural production of West Bengal has significant contributions to both local consumption and national food security. The state is one of the largest producers of rice in India. The “Golden Fiber,” jute is another significant crop of West Bengal, contributing substantially to the country’s overall production. West Bengal is a major producer of potatoes, particularly in the districts of Hooghly, Paschim Medinipur, and Bardhaman. West Bengal adopted Green Revolution technologies which significantly increased agricultural productivity through the use of high-yield variety (HYV) seeds, fertilizers, and modern irrigation techniques. West Bengal has a well-developed irrigation

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infrastructure, with canals, tanks, and tube wells being the primary sources. In West Bengal the cost of production and profitability in agriculture needs sincere and credible discussion.

In a study, Khatun and Roy (2012) pointed out the main constraints faced by the farmers in diversified area are poor asset, lack of credit facilities, lack of awareness and training facilities, lack of rural infrastructure, while the main constraints in less diversified area are poor transport facilities, poor asset, unfavorable agro-climate, lack of credit facilities, lack of awareness and training, and lack of basic infrastructure. Ghosh *et al.* (2014) used composite weather indices of rice yield forecasts along with observed yield in 2010 and 2011 for various districts of West Bengal. Maiti (2019) find out the efficiency and productivity of few crops and vegetables in the district of Purba Medinipur. He indicated that the changes in concentration and agricultural efficiency have been taken place among West Bengal districts which is not uniformly distributed within the states due to its physiographic as well as climatic variation. It is also concluded that food crops should be produced at a considerable rate compared to commercial crops. Chattopadhyay and Das (2000) measured growth rate of agricultural production crop wise and district wise and compare it between two periods, before and after left front government. They find out that due to successful land reform in West Bengal, a massive agricultural growth rate has been observed. Ali (2018) studied cropping pattern and irrigation intensity in Murshidabad district and observed that farmers changed their cropping pattern towards fruits and vegetables by adopting new planting technology and micro irrigation system. Das *et al.* (2019) measured total factor productivity and its sources of growth of rice cultivation in West Bengal for the period of 1994-95 to 2013-14. They revealed that there was a declination of area under rice cultivation. Share of human labor to total variable cost indicates rice cultivation was labor intensive. Fall of growth rate of bullock labor and sharp increase of machine labor showed the awakening of mechanization.

It has been observed from several studies that farmers of West Bengal are facing an increasing cost of production in the form of seed cost, fertiliser

and pesticide cost, irrigation cost, machinery cost and so on. Due to the growing cost of farming the profit of production decreases simultaneously which discourage traditional farming and force to diverse other production. The present paper tries to analyze the cost patterns for producing few major crops in West Bengal, output accrued from them and profits earned thereof for a period from 2001-02 to 2021-22. A micro level study has been conducted on a sample of 92 farming households in Birbhum district selected from 8 different sample villages spread over 5 different blocks of the district and over different size classes of farmer. With the help of primary data a statistical analysis has been performed to check the significance of study.

MATERIALS AND METHODS

Methodology and data collection

The paper was based on both secondary and primary data. Secondary data on cost of cultivation of major crops produced in West Bengal are collected from the Directorate of Economics and Statistics, Department of Agriculture, Co-operation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Govt of India for the period from 2001-02 to 2021-22. A detailed primary survey has been conducted in the district of Birbhum by taking 92 households selected from a total of 8 sample villages spread over 5 CD blocks with 2021-22 agricultural year as the reference year for survey. Sample villages were randomly selected in each block by using the method of Simple random sampling (without replacement) and selection of households for sample survey was done by following standard procedures of house listing and selection from 5 different stratified groups of the sample frame on the basis of the farmers' size classes (Marginal, Small, Semi-medium, Medium and Large) determined on the basis of their possessed land as done in official statistical surveys.

7 major crops have been considered namely Paddy, Wheat, Mustard, Masur (Lentil), Til (Sesame), Potato and Jute. The trend in the component wise cost of producing the crops in the state in the referred period is divided into two phases, Phase I (2001-02 to 2010-11) and Phase II (2011-12 to 2021-22). The

component wise average cost of production in two different phases has been considered both at current prices and real prices. Nominal values have been deflated to get the real values of the cost components for different years with consumer price index for agricultural laborers (with base 1986-87=100). In the secondary data, all components of operational cost are human labor, animal labor, machine labor, cost of seed, fertilizer and manures, insecticides, irrigation charges, interest on working capital and all other miscellaneous costs have been considered. Under fixed cost, the components are rental value of owned land, rent paid for leased-in land, all taxes and cess including land revenue, depreciation on implements and farm building and interest on fixed capital. The paid out cost calculation methodology is followed from the manual by the 'Foundation for Agrarian Studies, Calculation of Household Incomes - A Note on Methodology, 2015', where imputed rental value of owned land, imputed value of family labor and interest on fixed capital (excluding land) were deducted from the total cost to arrive at the paid out cost for each crop.

In this present work the impact of various cost

components on profit levels have been tested statistically to check the significance of the study. For the seven crops during the period 2001-02 to 2021-22 a multiple regression for individual crops is applied. The basic multiple regression framework is as:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_n X_n \quad (1)$$

In equation 1, Y is dependent variable, which is profit in the present work and X_i is the dependent variable, which is different types of cost, output level and other production related variables.

RESULTS AND DISCUSSION

Cost of cultivation

Table 1A and 1B show component wise average cost of production in two different phases respectively at current prices and at real prices. It has been observed that the cultivation of potato became the most expensive in both the phases and both in nominal as well as in real terms followed by jute. Total cost of cultivation (catch-all cost) of potato at current prices was found to be Rs 70779 per ha in Phase-I and it

Table 1A. Component wise average cost of cultivation (current prices) of major crops produced in West Bengal from 2001-02 to 2010-11 (Phase-I) and 2011-12 to 2021-22 (Phase-II).

Cost component	Average cost of cultivation of major crops in Phase-I						
	Paddy	Wheat	Mustard	Masur	Til	Potato	Jute
A: Operational cost	20448.89	20484.83	13436.43	12691.33	12112.33	52155.43	21045.93
seed	801.32	2106.29	267.29	1961.22	340.67	17764.91	542.78
Fertilizer and manures	2331.17	2716.00	1873.38	1020.31	832.52	10795.42	1742.46
Pesticides and insecticides	302.80	170.08	193.69	26.38	142.87	1213.02	228.02
Irrigation charges	1315.56	2612.36	1636.91	199.71	872.34	2925.84	824.34
Family labor (Human)	6238.56	4708.07	3969.06	3505.58	4230.81	6545.26	6631.64
Hired labor (Human)	5727.56	4130.80	2739.67	2877.09	3360.42	7614.89	8045.93
Animal labor (Owned + hired)	2340.52	2554.38	1860.19	1952.33	1333.92	1780.20	1987.13
Machine labor	933.91	1007.20	603.04	870.36	759.76	2068.81	589.49
Other expenses	457.48	479.67	293.22	278.36	239.03	1447.10	454.14
B: Fixed costs	8372.60	7401.12	6196.48	8055.29	5538.20	18623.66	9712.18
Total cost (Catch-all) (A+B)	28821.49	27885.94	19632.91	20746.62	17650.54	70779.10	30758.11
Paid out cost	15108.63	16219.64	9874.44	9494.87	8185.65	48023.64	14926.90
	Average cost of cultivation of major crops in Phase-II						
A: Operational cost	49215.98	35786.72	29660.30	23033.14	28517.53	106054.25	54474.79
Seed	1853.12	3650.12	562.08	2992.40	565.76	26817.11	872.24
Fertilizer and manures	5589.42	5820.10	4592.33	1773.79	2906.40	23042.18	4097.36
Pesticides and insecticides	1095.56	95.77	332.98	40.59	285.53	3266.91	417.23
Irrigation charges	2227.40	3262.62	2112.00	57.88	1388.44	4617.72	2290.28

Table 1A. Continued.

Cost component	Average cost of cultivation of major crops in Phase-I						
	Paddy	Wheat	Mustard	Masur	Til	Potato	Jute
Family labor (Human)	16233.87	7128.63	8881.38	6351.38	8469.59	18213.19	15515.22
Hired labor (Human)	15647.22	9026.12	8340.13	6279.47	9718.23	19781.90	25963.18
Animal labor (Owned + hired)	1908.30	1889.59	1524.52	1312.51	1401.27	2091.47	1638.55
Machine labor	3583.34	4043.83	2662.56	3716.48	2606.91	5075.45	2497.01
Other expenses	1077.75	869.95	652.32	508.64	1175.40	3148.33	1183.72
B: Fixed costs	16606.29	11249.61	12520.74	12676.83	9909.15	36462.55	21560.61
Total cost (Catch-all) (A+B)	65822.27	47036.33	42181.04	35709.98	38426.68	142516.80	76035.41
Paid out cost	34300.09	29112.51	21396.97	17468.00	20537.72	90305.69	39894.98

Source: Computed from the cost of cultivation/production and related data as published by the Directorate of Economics and Statistics, Department of Agriculture, Co-operation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Govt of India in the period from 2001-02 to 2021-22.

Table 1B. Component wise average cost of cultivation (real prices) of major crops produced in West Bengal from 2001-02 to 2010-11 (Phase-I) and from 2011-12 to 2021-22 (Phase-II).

Cost component	Average cost of Cultivation of major crops in Phase-I						
	Paddy	Wheat	Mustard	Masur	Til	Potato	Jute
A: Operational cost	5295.36	4707.93	3460.89	2530.95	2675.3	13579.22	543248
Seed	207.17	490.18	68.45	395.85	75.25	4572.5	138.32
Fertilizer and manures	601.43	630.2	488.68	205.22	189.17	2839.12	448.81
Pesticides and Insecticides	77.43	40.48	47.95	5.18	32.74	311.89	60.83
Irrigation charges	340.68	613.14	436.4	39.35	197.54	781.34	205.37
Family labor (Human)	1608.01	1043.7	997.7	690.13	935.59	1701.79	1711.21
Hired labor (Human)	1456.83	952.17	701.32	575.91	730.89	1978.48	2080.22
Animal labor (Owned + hired)	650.34	614.24	497.76	387	307.16	483.46	532.84
Machine labor	234.53	212.49	146.25	176.55	154.2	533.86	137.49
Other expenses	118.94	111.32	76.4	55.78	52.75	376.79	117.39
B: Fixed costs	2153.24	1724.49	1600.89	1623.92	1216.23	4827.97	2423.97
Total cost (Catch-all) (A+B)	7448.6	6432.42	5061.78	4154.87	3891.52	18407.19	7856.44
Paid out Cost	3903.85	3769.75	2565.23	1902.36	1808.74	12389.48	3853.38

Average cost of cultivation of major crops in Phase-II

A: Operational cost	6766.9	4954.51	4075.89	3165.19	3902.34	14624.2	7455.26
Seed	255.07	500.03	77.01	410.44	78.89	3687.27	121.28
Fertilizer and manures	768.35	810.2	635.3	253.92	399.04	3193.54	561.09
Pesticides and insecticides	148.45	14.74	45.48	5.66	38.51	449.3	57.12
Irrigation charges	308.91	452.92	289.46	8.75	189.62	656.51	315.56
Family labor (Human)	2219.6	982.41	1211.31	872.91	1144.27	2477.77	2136.6
Hired labor (Human)	2159.51	1260.13	1149.79	862.77	1344.82	2732.65	3535.18
Animal labor (Owned + hired)	269.75	264.55	213.46	179.34	196.35	298.36	229.63
Machine labor	489.04	548.94	364.33	501.45	355.81	695.64	337.18
Other expenses	148.22	120.6	89.75	69.94	155.02	433.17	161.62
B: Fixed costs	2286.59	1559.17	1728.17	1727.27	1356.4	5038.63	2950.88
Total cost (Catch-all) (A+B)	9053.49	6513.69	5804.06	4892.46	5258.73	19662.83	10406.14
Paid out cost	4730.93	4034.91	2948.45	2397.83	2824.23	12498.33	5445.21

Source: Computed from the cost of cultivation/production and related data as published by the Directorate of Economics and Statistics, Department of Agriculture, Co-operation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Govt. of India in the period from 2001-02 to 2021-22.

increased to Rs 142517 per ha in Phase-II. At real prices these values are Rs 18407 per ha and Rs 19663 per ha respectively in Phase-I and Phase-II at current prices), almost all the cost components like cost of seed, fertilizer, irrigation had the highest values for potato cultivation except human labor and animal labor in the category of operational cost structure as well as under fixed cost structure. The same trend was observed in case of potato cultivation when we compare the cost component values at real prices.

In both current and real prices, the cost of an-

imal labor for cultivating the crops has decreased significantly between the two phases (except Til and Potato) and an increase in the component of machine labor. It has been observed from Table 1C that except potato, all crops have more than 100% increase in the machine labor cost in real terms as well as in nominal terms.

The cost of seed and fertilizer at current prices has increased between the two periods for all the 7 crops. Cost of irrigation in real terms has decreased over the 2 phases for all the crops except jute implying

Table 1C. Component wise growth rates in average cost of cultivation (at both nominal and real prices) of major crops produced in West Bengal between the two phases.

Cost component	Growth rates in average cost of cultivation between the two phases							
	Paddy		Wheat		Mustard		Masur	
	Nominal	Real	Nominal	Real	Nominal	Real	Nominal	Real
A: Operational cost	140.68	27.79	74.7	5.24	120.75	17.77	81.49	25.06
Seed	131.26	23.12	73.3	2.01	110.29	12.51	52.58	3.69
Fertilizer and manures	139.77	27.75	114.29	28.56	145.14	30	73.85	23.73
Pesticides and insecticides	261.81	91.72	-43.69	-63.6	71.92	-5.14	53.84	9.38
Irrigation charges	69.31	-9.32	24.89	-26.13	29.02	-33.67	-71.02	-77.77
Family labor (Human)	160.22	38.03	51.41	-5.87	123.77	21.41	81.18	26.49
Hired labor (Human)	173.19	48.23	118.51	32.34	204.42	63.95	118.26	49.81
Animal labor (Owned + hired)	-18.47	-58.52	-26.03	-56.93	-18.05	-57.12	-32.77	-53.66
Machine labor	283.69	108.52	301.49	158.33	341.52	149.12	327.01	184.03
Other expenses	135.58	24.62	81.37	8.34	122.47	17.48	82.73	25.37
B: Fixed costs	98.34	6.19	52	-9.59	102.06	7.95	57.37	6.36
Total cost (Catch-all) (A+B)	128.38	21.55	68.67	1.26	114.85	14.66	72.12	17.75
Paid out cost	127.02	21.19	79.49	7.03	116.69	14.94	83.97	26.05

Cost component	Til		Potato		Jute	
	Normal	Real	Normal	Real	Normal	Real
A: Operational cost	135.44	45.87	103.34	7.7	158.84	37.24
Seed	66.08	4.83	50.96	-19.36	60.7	-12.32
Fertilizer and Manures	249.11	110.95	113.44	12.48	135.15	25.02
Pesticides and insecticides	99.85	17.62	169.32	44.06	82.98	-6.1
Irrigation charges	59.16	-4.01	57.83	-15.98	177.83	53.65
Family labor (Human)	100.19	22.3	178.27	45.6	133.96	24.86
Hired labor (Human)	189.2	84	159.78	38.12	222.69	69.94
Animal labor (Owned + hired)	5.05	-36.08	17.49	-38.29	-17.54	-56.9
Machine labor	243.12	130.75	145.33	30.3	323.59	145.25
Other expenses	391.73	193.86	117.56	14.96	160.65	37.68
B: Fixed costs	78.92	11.53	95.79	4.36	122	21.74
Total cost (Catch-all) (A+B)	117.71	35.13	101.35	6.82	147.2	32.45
Paid out cost	150.9	56.14	88.04	0.88	167.27	41.31

Source: Computed from the cost of cultivation/production and related data as published by the Directorate of Economics and Statistics, Department of Agriculture, Co-operation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Govt of India in the period from 2001-02 to 2021-22.

betterment in the irrigation infrastructure in the state and also possibly due to a better managed electricity distribution by the government for agriculture at affordable price in Phase-II.

The growth rate of paid out cost is lower than growth rate of total cost for potato both in nominal and real terms (Table 1C) than other cost. The cost components like imputed value for family labor, imputed rental value for owned land have grown at a much higher rate as compared to the actual expenses for hired labor and actual rent paid for leased-in land for potato cultivation. In case of all the other 6 crops, involvement of family labor in cultivation has substantially declined in the 2nd period but potato cultivation has needed more family labor with a noticeable growth in the 2nd phase as compared to that in the 1st phase. Cultivation of potato in owned land has also increased at a faster rate than that in the leased in land over the two phases.

The changes in the cost components of cultiva-

tion of various major crops in the state over the period of two decades decide the selection of crops produced by a farmer. Change in the cost of agricultural inputs over time determines the selection of crops for cultivation. The change in the components of cost of cultivation of various major crops has a direct effect on how much income the farmers earn at the end and how far the farmers manage to sustain the cultivation of crops which they are traditionally used to cultivate.

From the above Table 1D and the Figs. 1A and 1B below it is observed that potato cultivation has required one fourth of its cost of cultivation in seeds in the first phase which has declined to slightly less than one fifth in the 2nd phase. Seed cost share of masur and wheat in both the phases occupy 2nd and 3rd position. Therefore, it requires no special intuition to predict that farmers' profitability from potato cultivation can be enhanced with a cut in the seed cost of potato through Govt intervention or otherwise. Cost share of fertilizer was also found to be the highest for potato cultivation in both the phases followed by

Table 1D. Principal Component wise average percentage share of cost in total cost of Cultivation of major crops produced in West Bengal for the period from 2001-02 to 2021-22.

Cost Component	Phase-I (2001-02 to 2010-11)						
	Paddy	Wheat	Mustard	Masur	Til	Potato	Jute
Seed	2.78	7.64	1.35	9.54	1.94	24.85	1.75
Fertilizer and manures	8.08	9.79	9.69	4.94	4.87	15.32	5.74
Irrigation charges	4.56	9.54	8.59	0.94	5.06	4.26	2.6
Human labor (Own + Hired)	41.13	31.03	33.58	30.44	42.91	20.1	48.37
Animal labor (Owned + hired)	8.75	9.55	9.86	9.3	8.01	2.67	6.93
Machine labor	3.14	3.29	2.94	4.25	3.85	2.88	1.72
Land rent (Own + Leased in)	23.49	21.65	26.33	34.22	26.49	24.91	26.77
All other expenses	8.03	7.52	7.66	6.36	6.88	5.01	6.12
Total	100	100	100	100	100	100	100
Cost component	Phase-II (2011-12 to 2021-22)						
	Paddy	Wheat	Mustard	Masur	Til	Potato	Jute
Seed	2.82	7.71	1.32	8.35	1.55	18.79	1.18
Fertilizer and manures	8.49	12.47	10.97	5.38	7.73	16.31	5.43
Irrigation charges	3.4	6.95	4.98	0.2	3.52	3.37	3.1
Human labor (Own + Hired)	48.34	34.29	40.6	35.96	47.29	26.59	54.29
Animal labor (Owned + hired)	3.04	4.01	3.71	3.63	3.92	1.53	2.31
Machine labor	5.36	8.56	6.27	10.08	6.72	3.54	3.17
Land rent (Own + Leased in)	21.53	20.24	26.17	31.98	22.39	23.92	25.33
All other expenses	7.01	5.77	5.98	4.42	6.89	5.94	5.2
Total	100	100	100	100	100	100	100

Source: Computed from the cost of cultivation/production and related data as published by the Directorate of Economics and Statistics Department of Agriculture, Co-operation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Govt of India in the period from 2001-02 to 2021-22.

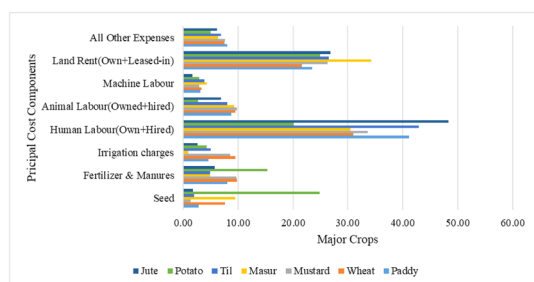


Fig. 1A. Average % share of cost in total cost of cultivation of major crops produced in West Bengal for the period from 2001-02 to 2010-11 (Phase-I).

wheat and mustard. Share of fertilizer cost in total cost of cultivation didn't grow substantially over the two phases in case of crops except for Wheat and Til. Cost share of animal labor has decreased and share of machine labor increased in the 2nd decade for all the major crops understandably due to the growth of mechanization in agriculture in the state,

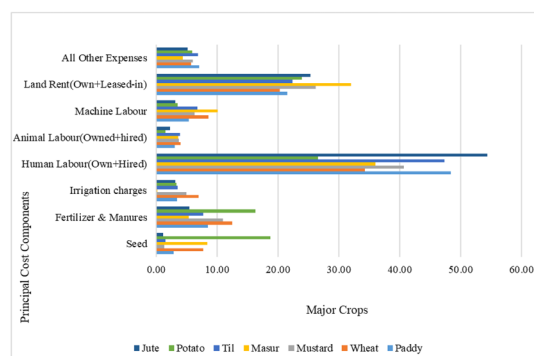


Fig. 1B. Average % share of cost in total cost of cultivation of major crops produced in West Bengal for the period from 2011-12 to 2021-22 (Phase-II).

Human labor cost has increased substantially for all crops during second phase. Jute Cultivation in Bengal was found to be highly labor intensive in both the decades with cost share of human labor being near 50% in first decade which jumped to 54%

Table 2A. Profitability of various major crops of West Bengal (measured over average Catch all costs) in the period from 2001-02 to 2021-22.

Name of the crop	Phase-I			Phase-II		
	Average output (in Rs/ha)	Average cost (in Rs/ha)	Net profit (in %)	Average output (in Rs/ha)	Average cost (in Rs/ha)	Net profit (in %)
Paddy	27358	28821	-6.35	56868	65822	-13.56
Wheat	24211	27886	-13.32	37985	47036	-19.08
Mustard	20790	19632	5.01	43705	42181	4.26
Masur (Lentil)	28168	20747	36.87	46280	35710	26.64
Til (Sesame)	19946	17651	12.59	34058	38427	-10.51
Potato	67200	70779	-5.13	143015	142517	-0.67
Jute	34294	30758	7.12	78191	76035	2.25

Source: Computed from the cost of cultivation/production and related data as published by the Directorate of Economics and Statistics, Department of Agriculture, Co-operation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Govt of India in the period from 2001-02 to 2021-22.

Table 2B. Profitability of various major crops of West Bengal (measured over average Paid-out costs) in the period from 2001-02 to 2021-22.

Name of the crop	Phase-I			Phase-II		
	Average output (in Rs/ha)	Average cost (in Rs/ha)	Net profit (in %)	Average output (in Rs/ha)	Average cost (in Rs/ha)	Net profit (in %)
Paddy	27358	14109	93.22	56868	34300	65.72
Wheat	24211	16220	48.23	37985	29113	32.15
Mustard	20790	9875	109.86	43705	21397	106
Masur (Lentil)	28168	9495	200.39	46280	17468	160.94
Til (Sesame)	19946	8186	142.67	34058	20538	66.11
Potato	67200	48024	44.57	143015	90306	60.76
Jute	34294	14927	119.94	78191	39895	96.34

Source: Computed from the cost of cultivation/production and related data as published by the Directorate of Economics and Statistics, Department of Agriculture, Co-operation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Govt of India in the period from 2001-02 to 2021-22.

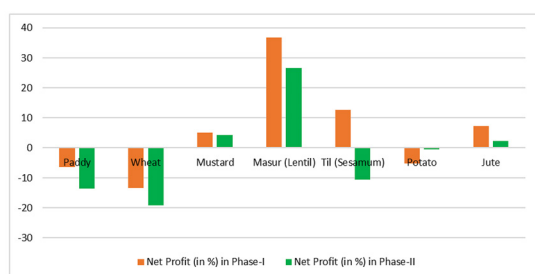


Fig. 2A. Profitability of various major crops of West Bengal (over average catch all costs) in the period from 2001-02 to 2021-22.

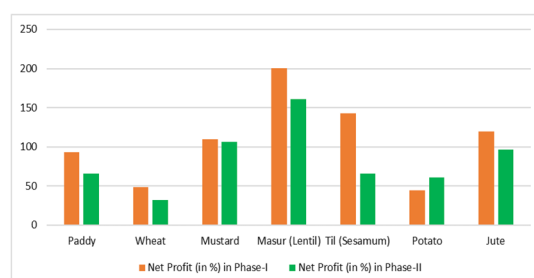


Fig. 2B. Profitability of various major crops of West Bengal (over average paid out costs) in the period from 2001-02 to 2021-22.

in the 2nd phase. Human labor cost of Til and Paddy in both the phases scored second and third place alternatively.

Profit of cultivation

In the following tables the output and profit generated

Table 3A. Profit from paddy production.

Profit paddy	Coefficient	Std error	t-ratio	p-value	
Const	55.4915	135.663	0.4090	0.6826	
Output	10.7700	0.500032	21.54	<0.0001	***
Area	25168.8	3519.60	7.151	<0.0001	***
Seed cost	2.75928	0.564270	4.890	<0.0001	
Ferti	0.411338	0.239469	1.718	0.0863	*
Pesti	-0.739358	1.14441	-0.6461	0.5184	
humanlab	-0.760230	0.147841	-5.142	<0.0001	***
Animallab	-5.67604	0.633894	-8.954	<0.0001	***
Irri	-7.45232	0.633423	-11.77	<0.0001	***
Loanrepay	-1.33319	0.247284	-5.391	<0.0001	***
Machinelab	-3.35054	0.355075	-9.436	<0.0001	***
Leasent	-1.24027	0.101032	-12.28	<0.0001	***
All_minorcost	-0.964564	0.0876202	-11.01	<0.0001	***

R-squared: 0.953454 Adjusted R-squared: 0.952708 P-value (F): 0.0000
Level of significance : * = 10% ** = 5% *** = 1%

Source: Statistical analysis of primary data.

Table 3B. Profit from til (sesame) production.

Profit til (Sesame)	Coefficient	Std Error	t-ratio	p-value	
Const	-1.66010	1.60988	-1.031	0.3028	
Area	59135.3	5794.67	10.21	<0.0001	***
Seed cost	5.14512	0.254802	20.19	<0.0001	
Ferti	1.90273	0.178049	10.69	<0.0001	***
Pesti	-1.89277	0.648555	-2.918	0.0036	***
Humanlab	-1.12357	0.127615	-8.804	<0.0001	***
Animallab	-13.1851	1.89693	-6.951	<0.0001	***
Irri	-1.43196	0.337943	-4.237	<0.0001	***
Machinlab	-6.15327	0.840863	-7.318	<0.0001	***
Output	63.5964	4.79740	13.26	<0.0001	***

R-squared: 0.796678 Adjusted R-squared: 0.794242 p-value (F): 0.0000
Level of significance : * = 10% ** = 5% *** = 1%

Source: Statistical analysis of primary data.

Table 3C. Profit from masur production.

Profit masur	Coefficient	Std error	t-ratio	p-value	
Const	-0.385628	3.88698	-0.09921	0.9210	
Area	10909.9	2369.58	4.604	<0.0001	***
Seed cost	-1.85764	0.263035	-7.062	<0.0001	***
Ferti	0.114427	0.318286	0.3595	0.7193	
Pesti	-12.5382	1.47708	-8.489	<0.0001	***
Humanlab	-0.932914	0.106738	-8.740	<0.0001	***
Animallab	2.80509	0.680244	4.124	<0.0001	***
Irri	4.49545	0.809655	5.552	<0.0001	***
Loanrepay	-2.56980	0.299229	-8.588	<0.0001	***
Machinlab	1.11397	0.336285	3.313	0.0010	***
Leasedrent	-0.897519	0.0514718	-17.44	<0.0001	***
All other cost	-0.437076	0.196243	-2.227	0.0262	**
Output	25.2911	1.92195	13.16	<0.0001	***

R-squared: 0.940200 Adjusted R-squared: 0.939241 p-value (F): 0.0000
Level of significance : * = 10% ** = 5% *** = 1%

Source: Statistical analysis of primary data.

from cultivation of various crops in West Bengal in both the phases has been discussed.

From Table 2A it is observed that average net profit rate over catch-all cost for paddy, wheat and potato are found to be negative in both Phase-I and II. Sesame has also negative profit during Phase II. But crops like Masur (36.87% and 26.64%), Mustard (5.01% and 4.26%) and Jute (7.12 % and 2.25%) registered positive net profits over catch-all cost in both the periods though the percentage of net profits

declined in Phase-II (Fig. 2A). In Table 2B, all crops in the two phases had registered a positive net profits rate over paid-out cost. Masur (Lentil) crop turned out the most profitable crop in both the phases. Wheat on the other hand was lowest net profit in both the phases. Mustard, Masur, Jute and Til had a more than 100% net profit over paid-out cost in phase-I which could be maintained by only Mustard and Masur in phase-II (Fig. 2B). However, we can see that net profits in both the profits for all the crops has decreased in the 2nd phase as compared to that in the 1st phase

Table 3D. Profit from wheat production.

Profit wheat	Coefficient	Std error	t-ratio	p-value	
Const	-0.136972	13.4150	-0.01021	0.9919	
Area	15003.8	1796.48	8.352	<0.0001	***
Seed cost	-4.90696	0.414151	-11.85	<0.0001	***
Ferti	-0.952624	0.121212	-7.859	<0.0001	***
Pesti	2.82033	0.482888	5.841	<0.0001	***
Humanlab	-1.41960	0.118011	-12.03	<0.0001	***
Animallab	-1.56919	0.400662	-3.916	<0.0001	***
Irri	-2.71070	0.323081	-8.390	<0.0001	***
Loanrepay	-0.506590	0.774399	-0.6542	0.5132	
Machinlab	-0.722606	0.148000	-4.882	<0.0001	***
Leasedrent	-0.542197	0.0359744	-15.07	<0.0001	***
All other cost	-1.29849	0.241567	-5.375	<0.0001	***
Output	6.56536	0.829825	7.912	<0.0001	***

R-squared: 0.939247 Adjusted R-squared: 0.938273 p-value (F): 0.0000
Level of significance : * = 10% ** = 5% *** = 1%

Source: Statistical analysis of primary data.

Table 3E. Profit from potato production.

Profit potato	Coefficient	Std error	t-ratio	p-value	
Const	58.8105	112.405	0.5232	0.6010	
Area	60408.6	7369.61	8.197	<0.0001	***
Seed cost	-15.0337	3.20869	4.685	<0.0001	***
Ferti	-1.78531	0.682949	-2.614	0.0091	***
Pesti	11.7554	4.47833	2.625	0.0088	***
Humanlab	-0.289191	0.424004	-0.6820	0.4954	
Animallab	-29.4624	2.67094	-11.03	<0.0001	***
Irri	-21.8330	2.19182	-9.961	<0.0001	***
Loanrep	-11.8642	1.90358	-6.233	<0.0001	***
Machinlab	-10.8254	1.27305	-8.503	<0.0001	***
Leasedrent	3.54934	0.199341	17.81	<0.0001	***
All other cost	-1.33572	0.235225	-5.678	<0.0001	***
Output	3.76161	0.372116	10.11	<0.0001	***

R-squared: 0.962911 Adjusted R-squared: 0.962316 p-value (F): 0.0000
level of significance : * = 10% ** = 5% *** = 1%

Source: Statistical analysis of primary data.

except potato where net profit rate has improved in both the cases.

Now, to find out which of the cost components impact the profitability in both the phases a multiple regression has been applied. Data are collected from primary survey of 92 household in different villages of Birbhum district. Volume of output and area of production of the crops are also considered as important criteria to the profitability of the crops. The

multiple regression with profitability of each of the crops as dependent variables and the cost components along with output of crops and irrigated area of each crop as the explanatory variables. The regressions have been run by considering all the values are in constant prices.

From the above six regression results (Table 3A to 3F) it has been observed that, profitability has positive relation with output and area of production.

Table 3F. Profit from mustard production.

Profit mustard	Coefficient	Std error	t-ratio	p-value	
Const	-0.592722	20.2028	-0.02934	0.9766	
Area	12365.8	1707.27	7.243	<0.0001	***
Seed cost	-5.55944	2.21757	-2.507	0.0124	**
Ferti	-0.467226	0.160107	-2.918	0.0036	***
Pesti	2.32147	0.668393	3.473	0.0005	***
Humanlab	-0.840774	0.111597	-7.534	<0.0001	***
Animallab	1.19382	0.542332	2.201	0.0280	**
Irri	-1.95528	0.408262	-4.789	<0.0001	***
Loanrep	-1.36458	0.207072	-6.590	<0.0001	***
Machinlab	0.0316003	0.239346	0.1320	0.8950	
Leasedrent	-0.865599	0.0759552	-11.40	<0.0001	***
All other cost	-0.957234	0.0695384	-13.77	<0.0001	***
Output	34.6191	1.61751	21.40	<0.0001	***

R-squared: 0.854696 Adjusted R-squared: 0.852365 p-value (F): 0.0000
level of significance : * = 10% ** = 5% *** = 1%

Source: Statistical analysis of primary data.

Ferti = Fertilizer cost, Pesti = Pesticide cost, Humanlab = Human labor cost, animallab = Animal labor cost, Machinlab = Machine labor cost, Irri = Irrigation cost, Loanrep = Loan repayment cost, Leasedrent = Rent of leased land, All other cost = Other expenses.

The seed cost has a significant negative impact on profitability for potato (Table 3E), mustard (Table 3F), wheat (Table 3D), and masur (Table 3C). After the increase of machine labor cost, animal labor cost, and irrigation cost, profit of paddy production decreases significantly (Table 3A). For potato loan repayment cost, irrigation cost, animal labor cost reduces the profitability drastically (Table 3E). For wheat, beside seed cost the cost of animal labor and human labor also has significant negative impact on profit. Irrigation cost and labor cost also decreasing the profit from mustard production. Since few years various types of machinery have been engaged in paddy cultivation. As a result machine cost has increased for paddy cultivation but simultaneously animal and labor cost also reduces profit due to the incomplete adoption of machinery and fragmented small land holding.

CONCLUSION

Agriculture in West Bengal is an essential part of the state's economy, providing livelihoods to a large portion of the population. Several times the state faced natural disasters such as floods and cyclones, which devastated crops and agricultural infrastructure. Small and fragmented landholding reduces volume and efficiency in farming units. Farmers often face challenges related to market access and fluctuating prices for their produce, impacting their income stability. Despite facing several challenges, the sector continues to succeed due to the rich natural resources, supportive policies, and adoption of modern farming practices in West Bengal. The government has implemented various schemes, subsidies, insurance to support the agricultural sector. The malfunctioning of proper distribution of government supports and market control may worsen the growth of agriculture. Government should take more initiative to control the agricultural

input prices such that the cost of production does not outweigh the profitability of production.

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