Global Scientific JOURNALS

GSJ: Volume 10, Issue 5, May 2022, Online: ISSN 2320-9186
www.globalscientificjournal.com

Valuation of Cost and Returns of Potato Crop with Projected Implications in Punjab province of Pakistan

Muhammad Tahir Latif[1*], Iftikhar Ahmad[1], Muzzammil Hussain[2], Muhammad Asghar[3], Majid Hamid[1] and Muhammad Hamid Rafiq[4]
[1]Adaptive Research Farm, Gujranwala 52200, Pakistan
[2]Directorate of Agriculture (FT & AR) Gujranwala 52200, Pakistan
[3]Directorate of Agriculture (IPM) Punjab, Lahore 55110, Pakistan
[4]Assistant Directorate office, Agricultural Extension Gujranwala 52200, Pakistan
[*]Corresponding author: tahirr.uaf@gmail.com

ABSTRACT

The study was conducted to estimate the costs and returns of potato production, to determine the factors affecting the production and to calculate the projected values of production to give some policy recommendations. The primary data was collected on production parameters with sample size of 100 and non-probability sampling technique from division Gujranwala of Punjab province during 2020-21. Economic parameters like operational cost of production, yield, net profit and Benefit Cost Ratio (BCR) were computed as Rs. 105947/acre, 290 mound/acre, Rs. 140553/acre and 2.33 respectively. Thus growing potato is profitable enterprise as returns are more than double against the cost incurred. Multiple regression analysis was employed to examine the factors affecting the production of potato. The results revealed that the education, experience of potato growing and land holding were contributing positively and significantly to potato production. However, owing the existence of fruits and vegetables market far away from farm showed a negative impact on yield. Variables like dummy extension services and dummy use of family labor were contributing positively but non-significantly. The value of R^2 implies that 58% of the variations in the dependent variable were explained by the independent variables. Based on above 25 years secondary data with time series analysis by adopting stochastic model of autoregressive integrated moving average (ARIMA) (2, 3, 1) at maximum probability of 95% confidence interval for Punjab province the potato production is predicted to increase (95.63 percent) from 7735.9 thousand ton in 2021 to 15134 thousand ton in 2030. Similarly, in district Sialkot area the potato production is predicted to increase (17.36 percent) from 110.4 thousand ton in 2021 to 129.56 thousand ton in 2030. However, in district Gujranwala area the potato production is predicted to decrease (-204 percent) from 7.5 thousand ton in 2021 to -7.8 thousand ton in 2030. Better stable market price, high yielding varieties and pure fertilizer at subsidized rates may be the factors to increase the potato production. Policy makers and extension workers should motivate the farmers to increase the acreage under cultivation of potato in division Gujranwala.

Keywords: Cost, Gujranwala, Potato, Production, Punjab, Returns

INTRODUCTION

Potato is one of the most important high-nutritive value crop grown in the world. It comes in the forefront of tuber-crops and occupies the fourth position after wheat, sorghum and rice, as an edible and consumed crop in the world. The majority of potato production comes from industrial countries; China, Russia, India, and United States of America with production 72, 63, 23 and 20 million tons/annum, respectively (FAO, 2007).

In Pakistan potato is the fourth most significant crop in terms of bulk production after wheat, rice and maize. Potato export value raised 9.8 percent to $87.39 million in 2020–21, up from $79.59 million the previous year. This value is expected to grow further in the current fiscal year. Total potato production recorded at 5.742 million tons in 2020–21, up from 4.428 million tons the previous year, representing a 29.67 percent increase. Punjab's potato yields were 5.682 million tons in 2020–21, accounting for 98.95 percent of total production in the country (Govt. of Pakistan, 2021). Potato is widely grown in different agro-climatic conditions of Pakistan and throughout the world. It is one of the four major staples which have a significant contribution to national domestic consumption and food needs. Despite the ease in cultivation and fewer labor requirements, potato productivity in Pakistan is not yet promising as compared to neighboring India and Bangladesh. Low productivity of the crop in Pakistan is due to several biotic, abiotic stresses and the relatively limited allocation of land. Pakistani vegetable

basket is incomplete without Potato. Potato is a nutritionally superior vegetable due to its edible energy and edible protein. It has become an integral part of breakfast, lunch and dinner among the larger population. Being a short duration crop, it produces more quantity of dry matter, edible energy and edible protein in lesser duration of time compared to cereals like rice and wheat. Hence, Potato is considered to be an important crop to achieve nutritional security of the nation (Ahmed et al. 2012).

Pakistan is blessed with vast agricultural resources on account of its fertile land, well-irrigated plains, extremes of weather, and centuries old tradition of farming. The prominent cropping pattern of the division Gujranwala included as Rice-Wheat, Rice-Berseem, Rice-Peas-Wheat, Sugarcane-Wheat, Fodder (pearl millet/sorghum)-Wheat, Maize-Berseem, Maize-Fodder-Potato, Maize-Rice-Potato, Maize-Wheat and Spring Maize-Autumn Maize-Wheat. It has been reported by Crop Reporting Service, Agriculture Department Punjab that the production of potato has been increasing from previous years in different areas particularly Noshehra Virkan and Daska of division Gujranwala; hence it was necessary to estimate the costs and returns of potato production, to determine the factors affecting the production and to calculate the projected values of production to give some policy recommendations.

MATERIAL AND METHODS

The study employed multistage sampling technique to collect primary data during 2020-21. In first stage Punjab province of Pakistan was selected. The Punjab has been divided into nine administrative divisions. Among those Gujranwala division was selected purposively, then based on the data set of crop reporting service, Punjab district Gujranwala and Sialkot were selected due to the higher area and production of potato among other districts of the division. Then convenience (non-probability) sampling method was employed from all the tehsils particularly from Noshehra Virkan and Daska with a total sample size of 100. A well-structured and pre- tested questionnaire was used to collect primary data. Descriptive Statistics and analytical framework was considered for the analysis of the data to fulfill the objectives of the study. The study used Younas et al. (2016) and Latif et al. (2017) methodology for estimating cost and returns. The operational cost of production (TC) per acre like land preparation, seed & sowing, fertilizer, insecticides and weedicide, irrigation, water charges (including *abiyana*), harvesting & marketing and labor use was computed. Total Revenue (TR) per acre earned from the sale of potato was calculated by multiplying the farmer's price received per mound with the total output produced (mound) in the season.

$TR = p \times y$

Total cost was subtracted from total revenue to estimate net profit earned per acre by the farmers.

$Net\ \pi = TR - TC$

Benefit Cost Ratio (BCR) was estimated by dividing total revenue with total cost.

$BCR = TR \div TC$

To quantify the factors affecting the production, Multiple Linear Regression Model was used as given below. Sher et al. (2015) employed the same method.

$y = a_0 + a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + a_5x_5 + a_6x_6 + \epsilon$

Where; y = Potato production per acre (mound), α_0 =Constant, x_1 = Education (year), x_2 = Experience of potato growing (year), x_3 = Land holding (acre), x_4 = Distance from farm to main market (km), x_5 = Dummy extension services (if yes =1; otherwise = 0),x_6 = Dummy useof family labor (if yes =1, otherwise = 0), α_1…… α_6 are parameters of the variables., ε = random error.

Time-series data for the period 1996-2020 was employed which was collected from Crop Reporting Service of Agriculture Department, Govt. of Punjab. The ARIMA model has chosen for analysis due to its suitability to our dataset and non-stationary nature of time series to be forecasted. The analytical software Statistix 16 was used for time series analysis by adopting stochastic model of autoregressive integrated moving average (ARIMA) (p,d,q) as given below. Latif et al. (2021) also adopted the same technique to forecast the time series data.

$\hat{Y}_t = \mu + \varphi_1 Y_{t-1} + \ldots + \varphi_p Y_{t-p} - \theta_1 e_{t-1} - \ldots - \theta_q e_{t-q}$

Where, φ = damping parameter, Y_t = observed value of the time series in period t, μ = constant, φk =AR coefficient at lag k, θk =MA coefficient at lag k

RESULTS AND DISCUSSION

The survey findings showed that average land holding size was about 8.50 acre. Average land rented in size was 5.75 acre with land rent of Rs 50 thousand Rs acre^{-1}. Mostly surveyed farmers were educated by luckily having average schooling years of 8.5 with above 15 years of farming experience. As far as land holding is concerned mostly surveyed farmers (48%) were having land more than 12.5 acres, 28% had 5-12.5 acre and 24% farmers had

below 5 acres of land. Regarding ownership of farm machinery 75 percent farmer had their own tractors for agriculture farming. The findings are in line with Latif et al. (2018).

Economic parameters like operational cost of production, yield, net profit and Benefit Cost Ratio (BCR) were computed as Rs. 105947/acre, 290 mound/acre, Rs. 140553/acre and 2.33 respectively. Thus growing potato is profitable enterprise as returns are more than double against the cost incurred (Table 1).

Table 1: Cost and Returns Estimation of Potato Production

No.	Operation / Inputs	Avg. No. of operation / Unit (/ Acre)	Percentage of usage (%)	Avg. cost per operation/ unit (Rs./acre)	Total weighted cost (Rs. /acre)
	Deep Ploughing	1.88	83%	1461	2280
	Ploughing	5.35	100%	792	4237
	Planking	2.55	100%	442	1127
	Leveling	1	80%	1520	1216
1	Cost of Land Preparation				8860
	Seed Quantity (kg)	1360	100%	26	35360
	Seed Drilling	1	40%	2130	852
	Seed Broadcasting	1	10%	3692	369
	Seed Treatment	1	45%	1093	492
	Bridging	1	74%	1770	1310
2	Cost of Seed & Sowing				38383
	Water No	10	100%	684	6840
	Water Labour	1	83%	140	116
	Canal Labour	1	12%	126	15
3	Cost of Water				6971
	Urea	3	100%	1775	5325
	DAP	2	100%	4550	9100
	Other Fertilizer	1	64%	4950	3168
	Fertilizer Labour	1	100%	300	300
	Fertilzer Transport	1	100%	186	186
4	Cost of Fertilizer				18079
	Dung trolly	3	15%	1156	520
	Dung Transport	1	15%	733	110
	Dung Labour	1	15%	910	137
5	Cost of Dung/FYM				767
	Spray Pesticides	4.25	100%	990	4208
	Spray Pest Labour	1	100%	200	200
6	Cost of Pesticides				4408
	Spray Weedicides	1.25	99%	942	1166
	Spray Weeds Labr	1	92%	189	174
7	Cost of Weedicides				1340
8	Cost of Harvesting	1	100%	7500	7500
9	Cost of Other Exp. (like admin)	1	35%	2600	910
	Transport Rent	1	96%	4500	4320
	Transport Labour	1	90%	3000	2700
	Bar Dana (Bags)	1	90%	12000	10800
10	Cost of Transport				18730
11	Operational cost of Production				105947
12	Avg. Yield	(40kg/acre)			290
13	Gross Revenue	Crop Price (Rs./40 kg)		850	246500
14	Net profit	Rs./acre			140553
15	BCR				2.33

The mean percent share distribution of factors of production in total operational cost of production was also estimated. Factors like Land Preparation, Seed & Sowing, Water/irrigation, Fertilizer, Dung/FYM, Pesticides, Weedicides, Harvesting and Transport & marketing were contributing as 8%, 36%, 7%, 17%, 1%, 4%, 1%, 7% and 18% respectively (Figure 1).

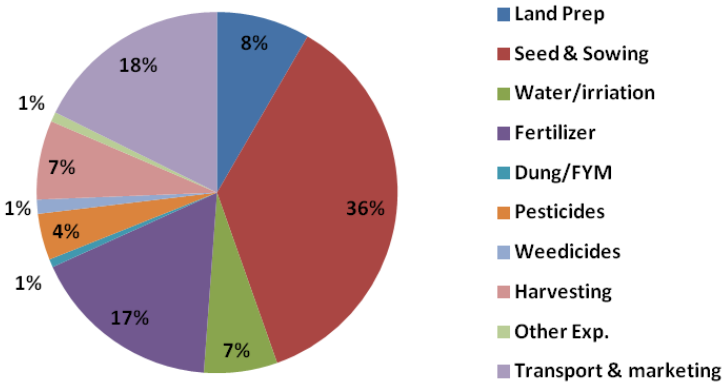

Figure 1: percent share distribution of factors of production in total operational cost of production

The results of multiple regression analysis purported that the years of schooling has positive and substantial effect on the dependent variable (yield). Education and training of the farmers can play a vital role in increasing the production efficiency of farmers (Tariq et al., 2018). Educated farmers have more skills and knowledge as compared to their counterpart who are less educated. They use the inputs more efficiently and can market their produce appropriately. The improvement in education of the farmers would generate a higher yield of potato at farm level (Fatima et al., 2016). The coefficient of experience in growing potato was positive and insignificant. The reason behind this was that the potato growers were less expert as compared to other traditional crops growers. The study of Khan (2003) concluded that there is fluctuation in yield due to variation in socioeconomic characteristic of farmers, where farmers with greater years of schooling and experience attained high yield as compared to their counterparts who are less trained and experienced.

It was observed that there is no established agricultural market in the study area and markets are situated at larger distance. The farmers had to travel about 25 km to sell their produce directly in the market. The variable of farm to market distance was negative and significant. There is a need of proper care while transporting potato to different markets as it was very delicate and had higher chances of deterioration (Amin, 1996).

Farm size has positive and significant impact on the potato yield. The farmer with larger land holdings has more resources as compared to their counterparts who have less acreage. The variable of total land holding was positive and had significant effect on the production of potato. According to Agir et al. (2015), farmers who had higher acreage under cultivation manage the production practices and farm risk more significantly as compared to their counterparts who have smaller acreage under potato.

Table 2: Estimated Result of Econometric Analysis.

Variable	Beta	t-value	Significance
Constant	38.450	34.543	0.000
Education (year)	0.210	2.180	0.004
Experience of potato growing (year)	0.101	2.071	0.009
Land holding (acre)	0.317	3.948	0.000
Distance from farm to main market (km)	-0.158	-2.032	0.005
Dummy extension services (if yes =1; otherwise = 0)	0.095	0.390	0.524
Dummy use of family labor (if yes =1, otherwise = 0)	0.083	2.045	0.362
R^2		0.580	
F-Value	24.54		

It was observed that mostly the hired labor is being used in the study area for the cultivation of potato. The hired labor has more technical skills and expertise for the management of crop. The dummy variable of family use was positive and had insignificant impact on yield of sampled farmers. Samtani et al. (2019) reported that scarcity of labor availability during the harvest period of potato have contributed to decline in yield.

It is also evident that provision of extension services to potato growers has positive but insignificant impact on yield. It has been observed during field visits that extension agents need updated trainings regarding potato cultivation.

For time series analysis ARIMA (2, 3, 1) was used for projected values. This confirms with the finding of a similar study by Latif et al. (2021). Employing 8 years projected forecasts of potato production and their 95 % confidence intervals are given in Table 3. At maximum probability of 95% confidence interval for Punjab province the potato production is predicted to increase from 851.6 thousand ton in 1995-96 to 15134 thousand ton in 2030. Similarly, in district Sialkot area the potato production is predicted to increase from 15.81 thousand ton in 1995-96 to 129.56 thousand ton in 2030. However, in district Gujranwala area the potato production is predicted to decrease (-121

percent) from 36.76 thousand ton in 1995-96 to -7.8 thousand ton in 2030. Better stable market price, high yielding varieties and pure fertilizer at subsidized rates may be the factors to increase the potato production. Policy makers and extension workers should motivate the farmers to increase the acreage under cultivation of potato in division Gujranwala. The detail is given in Table 3.

Table 3: Projected values of potato production (000 ton) using time series analysis

Model		2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Punjab-Model_1	Forecast	8122.52	9236.36	10476.41	11585.04	12491.81	13213.22	13795.57	14286.58	14724.25	15134.63
	UCL	9271.02	10695.87	12390.72	14161.17	15855.93	17413.68	18809.65	20046.07	21171.92	22233.53
	LCL	6974.03	7776.84	8562.10	9008.91	9127.69	9012.75	8781.49	8527.09	8276.57	8035.72
Gujrat-Model_2	Forecast	-2.20	-2.20	-0.57	-2.99	-1.50	-1.85	-2.90	-1.62	-2.77	-2.63
	UCL	4.31	6.39	11.03	9.93	13.05	14.33	14.30	17.00	16.93	18.07
	LCL	-8.71	-10.80	-12.16	-15.91	-16.05	-18.03	-20.09	-20.23	-22.48	-23.33
M.B.Din-Model_3	Forecast	4.07	4.64	5.80	5.40	4.08	3.08	2.60	2.20	1.61	0.90
	UCL	10.40	11.54	12.83	12.59	11.27	10.33	9.87	9.47	8.87	8.16
	LCL	-2.26	-2.26	-1.23	-1.80	-3.11	-4.17	-4.67	-5.07	-5.66	-6.37
Sialkot-Model_4	Forecast	109.08	112.12	117.07	118.69	118.52	120.84	124.78	126.89	127.56	129.56
	UCL	182.72	197.47	216.58	243.94	262.74	274.20	287.18	303.65	317.63	327.78
	LCL	35.45	26.77	17.56	-6.55	-25.70	-32.52	-37.62	-49.87	-62.51	-68.67
Narowal-Model_5	Forecast	1.70	1.59	1.36	0.39	-0.40	-1.13	-1.89	-2.66	-3.42	-4.18
	UCL	53.82	53.75	53.64	52.76	51.99	51.24	50.47	49.70	48.93	48.16
	LCL	-50.42	-50.56	-50.92	-51.98	-52.78	-53.49	-54.26	-55.02	-55.77	-56.53
Gujranwala-Model_6	Forecast	12.22	6.79	-2.31	-4.99	-0.48	2.99	-0.35	-7.09	-10.08	-7.80
	UCL	25.29	21.12	12.16	10.72	19.19	25.99	23.67	17.26	15.12	19.42
	LCL	-0.85	-7.54	-16.77	-20.69	-20.16	-20.00	-24.37	-31.44	-35.27	-35.02
Hafizabad-Model_7	Forecast	2.00	1.49	1.61	1.25	1.38	1.11	1.21	1.00	1.07	0.90
	UCL	3.74	3.48	3.77	3.46	3.63	3.37	3.48	3.27	3.35	3.18
	LCL	0.26	-0.51	-0.56	-0.95	-0.88	-1.15	-1.07	-1.28	-1.21	-1.38

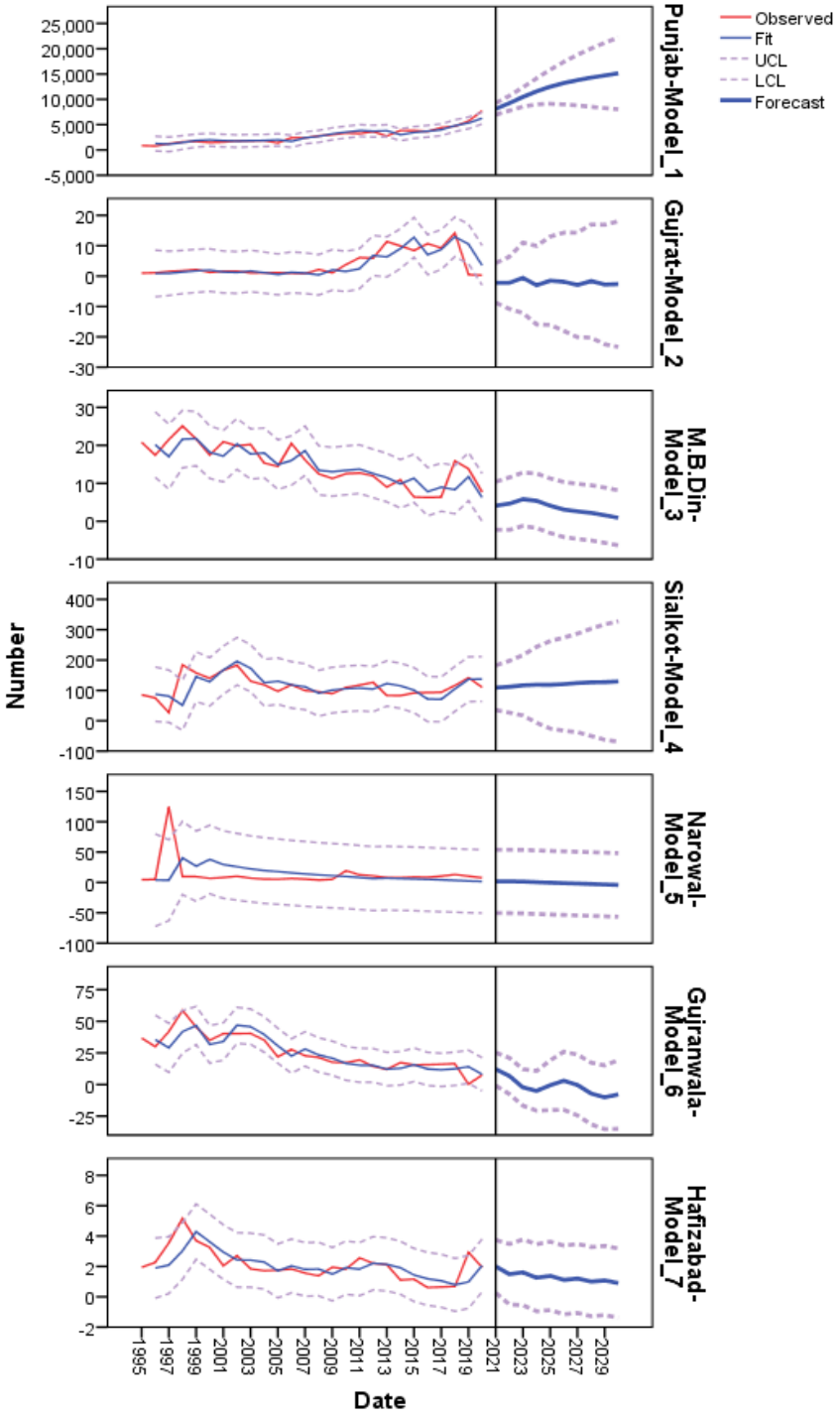

Figure 2: Projected values of potato production (000 ton) using time series analysis

CONCLUSION

Considering high value crop the study was conducted to estimate the costs and returns of potato production, to determine the factors affecting the production and to calculate the projected values of production. The results revealed that the education, experience of potato growing and land holding were contributing positively and significantly to potato production. However, owing the existence of fruits and vegetables market far away from farm showed a negative impact on yield. Dummy extension services and dummy use of family labor were contributing positively but non-significantly. The value of R^2 implies that 58% of the variations in the dependent variable were explained by the independent variables. Economic parameters like operational cost of production, yield, net profit and Benefit Cost Ratio (BCR) were computed as Rs. 105947/acre, 290 mound/acre, Rs. 140553/acre and 2.33 respectively. Thus growing potato is profitable enterprise as returns are more than double against the cost incurred. Based on time series analysis it is predicted to increase the Punjab potato production from 7735.9 thousand ton in 2021 to 15134 thousand ton in 2030. Similarly, in district Sialkot area the potato production is predicted to increase from 110.4 thousand ton in 2021 to 129.56 thousand ton in 2030. Price variation should also be avoided by

stabilizing marketing demand and supply across the location and time which may be accomplished through proper scientific based storage with the public-private venture.

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