

PROFITABILITY OF WHEAT CROP CULTIVATION IN SUGAR CROP DOMINATED AREA: ECONOMIC AND CLIMATIC STUDY

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Abstract

Recently, sugarcane largely introduced in "Dera Ismail Khan" (D.I.Khan) Khyber Pakhtunkhwa Province, Pakistan, especially during the summer season. The current study was conducted at Arid Zone Research Centre (AZRC), Dera Ismail Khan (D.I.Khan) to evaluate cost and benefit, as well as climatic profile suitability for wheat cultivation, during 2014/2015 and 2015/2016 seasons. A sample of 200 respondents from 10 major wheat growing villages of the respective areas of the district was interviewed through pre-tested questionnaire. The study revealed that the cost of wheat production was Rs. 35,680 per acres, whereas output comes 1680 kg per acre (42 mounds) amounting Rs. 63,600 per acres. Farmers' margin also rises by adding the value of family labor and owned land, which is sufficient to sustain a normal family. Moreover, positive influence between return price and output of wheat was concluded from the study, whereas negative effect of cost was also observed. The output elasticity of Land preparation (LP), Seed and Sowing (SS), Farm inputs (FI), Irrigation (Irr), Pesticides / insecticides (Pest) and Harvester threshing (HT) are 0.124587, 0.31244, 0.5874, 0.55461, 0.08248 and 0.65743, respectively. From climatic point of view, calculated accumulated growing degree days all over the studied seasons at the studied district were about 2663.5 degree days two seasons average. This is sufficient for the used type of wheat at this area to push the different growing stages and present economic crop yield.

Key Words: Wheat, Cost, Return, Profit, climatic profile, growing degree days, Cobb-Douglas, Arid Zone, D.I. Khan, Pakistan

INTRODUCTION

In Pakistan, wheat is the leading food grain and staple diet of the people, which occupies the largest agriculture area of the country. Wheat contributes up to 9.9 percent to the value added in agriculture and 2% to the GDP. Area under wheat cultivation, during 2015-2016, has increased to 9260 thousand hectares from last year's area of 9204 thousand hectares, which shows an increase of 0.6 %. However, production of wheat stood at 25.482 million tons during 2015-2016, showing an increase of 1.6% over the last year's production of 25.086 million tons. The production increased as crop was sown at appropriate time and available

moisture and availability of use of inputs remained adequate. It is grown in almost all provinces including Khyber Paktoon Khawa Province (KPK) (Economic Survey of Pakistan 2015-16).

In D.I.Khan district, wide variety of crops ranging from arid to humid is cultivated. Among these, the most important are wheat, rice, sugarcane, cotton, maize, millet, sorghum, pulses, oilseed, vegetables and fruits. Prior to the inception of "Chashma Right Bank Canal" (CRBC), D.I.Khan, sorghum and millet were the major crops grown in the area. However, after CRBC, sugarcane, rice and orchards took the lead and were largely introduced in the summer season. The area under sugarcane crop has been increased to 15.5 million acres in D.I.Khan, which is the largest in Khyber Pakhtunkhwa province. D.I.Khan is the only district in Pakistan having four Sugar Mills (Chashma¹, Chashma², Tandlian Wala Sugar Mills Extension Miran and Al-Moiz) in working condition while two new Sugar Mills "Al-Mughni" and "Alman Sayyam" are under construction. The present shift of area to sugarcane crop needs to be rationalized in order to meet food requirements of the local masses and maintain production equilibrium in food and industrial crops. Although the area has potential to produce important winter crops (wheat, barley, pulse, oilseed, and fruits), yet there has been constant increase in summer and winter acreage of sugarcane particularly after the commencement of CRBC. Tripathi (1993) analyzed the economics of high yielding wheat variety cultivation for three farm size groups for middle hill and valley farms in Tehri Garhwal district, Uttar Pradesh, India. Data were collected from a sample of 120 farms for 1987/88. The average operational cost was Rs 2431/ha for middle hills farms and Rs 2506/ha on valley farms. Bullock labor accounted for the highest percentage of operational cost followed by manure, fertilizer and seeds. Ahmed *et al.* (2011) concluded that wheat production contribute significantly to farm sustainability and contribute to alleviation of malnutrition in the State. The actual production constraints restrict the sustainability of this important crop. Soni (2000) conducted a study of the impact of improved wheat production technology, including high yielding varieties with cultural practices and comparing yield, input level and net returns. Farmers adopting advanced technology had 61.92%-76.07% higher yield as compared to the traditional system.

Air temperature is among the most important environmental factors that control plant development, growth and yield. It is a major environmental factor that determines the rate of plant growth and development. All biological processes respond to temperature, and all responses can be summarized in terms of three cardinal temperatures, namely the base or minimum (T_{min}), the optimum (T_{opt}), and the maximum (T_{max}) temperatures. The nature of the response to temperature between

these cardinal points, which is important for calculating the phenology, adaptation and yield of various crops (Shaykewich, 1995). The most common temperature index used to estimate plant development is growing degree days (GDD), or heat unit (HU). The accumulation of GDD determines the time of developmental events, maturity of the crop and yield.

The current investigation aimed to:

- Study the climatic conditions suitability and profitability of wheat crop in the studied area to focus the ever growing food demand of inhabitants of D.I.Khan and rest of the KPK where land availability is much limited.
- To formulate new economically viable cropping pattern having diverse crop rotations.

MATERIALS AND METHOD

The study was conducted at Arid Zone Research Centre, D.I.Khan, KPK, Pakistan during seasons of 2014/2015 and 2015/2016. For data collection, ten (10) villages were selected randomly, which includes "Himat", "Mandaran", "Ketch", "Lar", "DhapShumali", "Shorkot", "DarabanKalan", "Parova", "LundaSharif" and "Ramak falls" under the command area of Chashma Right Bank Canal (CRBC), D.I.Khan. The analysis is based on the primary data, 200 farmers out of major wheat growers of these areas were considered as samples for study. Necessary information from farmers was collected at their field or home by using pre-tested questionnaire to get the actual data. It included maximum information such as land holding, total cultivated area, area under wheat cultivation etc. However, main focus was on various inputs used in wheat crop production.

Growing degree day's calculations:

Daily maximum and minimum air temperature were collected from the weather station in Arid Zone Research Centre (AZRC), Dera Ismail Khan during the period from October to April of both studied seasons of 2014/2015 and 2015/2016. Phenological stages as well as number of days between each stage were recorded and GDD was also calculated for every stage using climatology data with the following equation.

Growing degree days (GDD) calculation:

$$GDD = \sum((T_{max} + T_{min})/2) - T_{base}$$

Where

T_{max} = daily maximum air temperature

T_{min} = daily minimum air temperature

T_{base} = base temperature (5.5°C according to Maynard and Hochmuth, 2007).

Statistical Analysis:

Econometric view (E-Views)/SPSS package was used to analyze data. The detail is given below: Cost and benefit of wheat will be compared through "Benefit Cost Ratios" (BCR) Samiullah *et al.* (2014) and Elahi *et al.* (2015):

$$\text{Benefit cost ratio of wheat} = \frac{TR}{TC} \dots\dots\dots(1)$$

Whereas,

TR (Total Revenue) is the per acre total benefit generated from wheat production

TC (Total Cost) is the per acre total cost of wheat cultivation.

Profit Function:

$$\Pi = TR - TC \dots\dots\dots(2)$$

Where,

$$TR = P * Q \quad (P = \text{Price of output and } Q = \text{Output})$$

$$TC = V * X \quad (V = \text{Input price and } X = \text{Input purchased})$$

Therefore,

$$\Pi = PQ - VC \dots\dots\dots (3)$$

Model of profit function

Empirical model of crop profit function in econometric form is given as:

$$\Pi = \alpha + \beta_1 P + \beta_2 Q + \beta_3 C \dots\dots\dots (4)$$

The above model described that " Π " is determined by the three major factors, which are as under:

$$P = \text{Output Price}$$

$$Q = \text{Output Produced}$$

$$C = \text{Output Cost}$$

Equations (2), (3) are used to generate equation (4) above. It indicates that profit (Π) depends on output price (P), total output (Q) and cost per unit (C) of output produced. β_s are the parameters to be estimated and measure the change in (Π) with a unit change in the variables on right hand side as the case unit changes (Debertin, 2012; Anwar, 2013; Samiullah *et al.*, 2014 and Elahi *et al.*, 2015).

To show the input-output relationship, log linear "Cobb Douglas" production function has been used (Haq *et al.*, 2002 and Hussain and Khattak, 2011).

However, due to some additional variables used in the present study, accordingly it was modified. The following log linear Cobb-Douglas production function was applied, using the least square method:

$$\ln P = \ln a_0 + a_1 \ln Area + a_2 \ln LP + a_3 \ln SS + a_4 \ln FI + a_5 \ln Irr + a_6 \ln Pest + a_7 \ln HT + ei \dots\dots\dots(5)$$

The above model was then converted into the following general form:

$$Pw = a_0' Area^{a_1'} LP^{a_2'} SS^{a_3'} FI^{a_4'} Irr^{a_5'} Pest^{a_6'} HT^{a_7'} ei \dots\dots\dots(6)$$

Whereas,

P	=	Total wheat production (kg per acre)
Area	=	Area under wheat crop
LP	=	Land preparation
SS	=	Seed and sowing
FI	=	Farm inputs
Irr	=	Irrigation
Pest	=	Pesticides / insecticides
HT	=	Harvester threshing

a_0 = Shows the impact of innovations or technology.

$a_1, a_2, a_3, a_4, a_5, a_6$ and a_7 are the Output elasticities of Area, LP, SS, FI, Irr, Pest and HT, respectively.

e_i = Residual term (to include effect of omitted variables).

RESULTS AND DISCUSSION

Climatic circumstances:

Data in Figures (1 & 2) indicated that, highest average maximum temperature, during both studied seasons, was 36.1°C, recorded in 21 of April and 30 of April of both studied seasons of 2014/2015 and 2015/2016, respectively. Whereas, the lowest observed average maximum temperature was 11.5°C, recorded in 21 of January and 31 of January of both studied seasons, respectively.

On the other hand, the highest observed average minimum temperature was 22.2°C, recorded in 11 of October and 20 of October of both studied seasons of 2014/2015 and 2015/2016, respectively. On the contrary, the lowest average minimum temperature recorded was 3°C, it was found in 21 of January and 31 of January of both studied seasons, respectively.

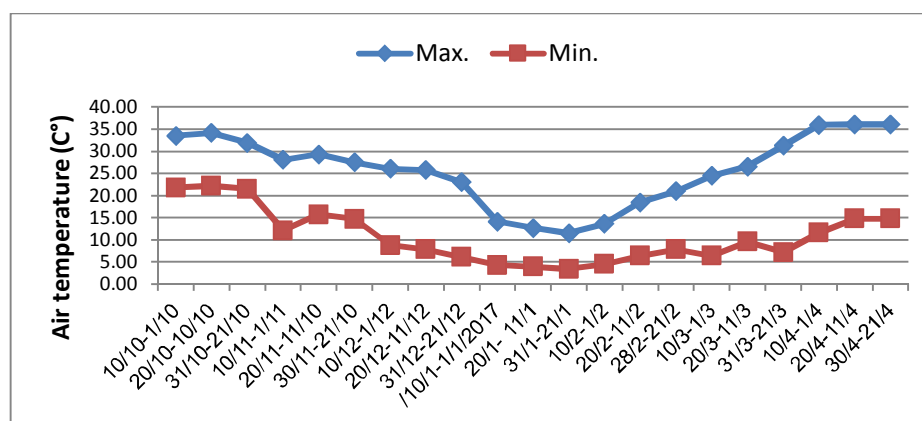


Fig. 1. Maximum and minimum air temperature during seasons of 2014/2015.

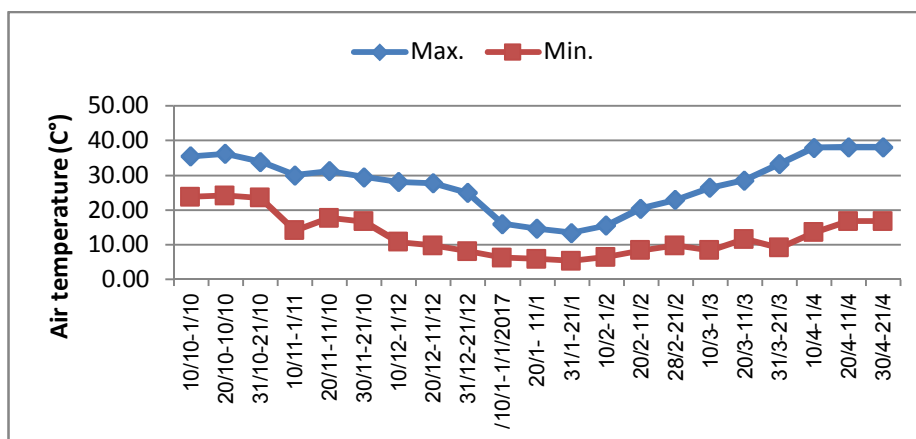


Fig. 2. Maximum and minimum air temperature during seasons of 2015/2016.

Growing degree days:

Data in Table (1) shown average maximum and minimum air temperature and the monthly accumulative growing degree-days for wheat plants during the growing seasons.

The highest accumulative growing degree days (681.5) was detected during October in both studied seasons. However, accumulation of growing degree-days reduced in November to record 472.0. Contrary, the lowest accumulated growing degree days was found on January (86.5) followed by those accumulated in February (179.5).

All over the growing seasons 2663.5 degree days were accumulated. This number reflected the required degree days for the optimum wheat crop production.

Table 1. Maximum and minimum air temperature and the accumulative growing degree days during wheat growing seasons.

Days	Max. temperature (C°)	Min. temperature (C°)	GDD
October	33	22	681.5
November	28	14	472.0
December	27	07	331.5
January	13	14	86.5
February	17	06	179.5
March	27	09	392.5
April	34	11	520
Total			2663.5

Profitability study:

To compare the cost and revenue of wheat, Benefit Cost Ratio (BCR) was calculated by using equation number "1":

$$\text{BCR for Wheat} = \frac{\text{TR}}{\text{TC}} = \frac{63,600}{35,680}$$

$$\text{BCR for Wheat} = 1.78$$

The calculated value of BCR clearly indicates that the wheat cultivation is profitable.

By using equation number "2", net return is calculated as:

$$\text{Net Return} = \text{TR} - \text{TC} = 63,600 - 35,680$$

Net Return = 27,920

Estimated model as per equation number "4":

$$\Pi = -0.0052 + 0.831P + 0.072Q + 0.53C$$

Standard Error = {0.004} {6.12 E⁰⁵} {0.07} {1.03 E⁻⁰⁸}

t-ratio = {-1.69} {1548.13} {0.75} {-753562}

R² = 0.82,

R² (adjusted) = 0.68

F = 6.39 E²⁰

F-test determines the overall goodness of fit/significance of the model. It is clear from the above model that the value of f-test is very high.

$F_{\text{calculated}} = 6.39 E^{20} > F_{\text{tabulated}} = 3.12$

i.e Calculated value of f-statistic is greater than tabulated value of f-statistic.

Thus the model shows overall significance.

The co-efficient of determination (R²), signify that the 82% deviation in the dependent variable has been explained by the independent variables. The sign of independent variables shows that effects of explanatory variables are according to the theory. Whereas, $t_{\text{calculated}} > t_{\text{tabulated}} = 1.895$, indicates that t-ratios of the factors confirms that, profit of the wheat production (π) is significantly determined by the three already mentioned factors of the model keeping all the other inputs constant. Thus, a unit increase in per acre cost of wheat, profits will rise by Rs. 0.83, producing another kg of output (Q) will increase the profit by Rs 0.72 while each additional unit of per kg cost (C) will decrease the profit by Rs. 53. The estimation of the profit function revealed that profit is significantly affected by the above three mentioned factors. However, the effect of cost is higher than the effect of price and output of wheat.

At the end, Cobb Douglas Production Function is calculated through equaton"5" given as under:

$$\ln P = 3.51008 + 0.64123 \ln \text{Area} + 0.124587 \ln LP + 0.31244 \ln SS + 0.5874 \ln FI + 0.55461 \ln IRR + 0.08248 \ln \text{Pest} + 0.65743 \ln HT \dots \dots \dots (7)$$

Or in general form is given as:

$$\ln P = 33.54094375 + \text{Area}^{0.64123} + LP^{0.124587} + SS^{0.31244} + FI^{0.5874} + Irr^{0.55461} + Pest^{0.08248} + HT^{0.65743} \dots \dots \dots (8)$$

It is concluded that Area, LP, SS, FI, Irr, Pest and Hrvt are statistically significant. As per equation 7 & 8, the calculated value of wheat area elasticity of production (0.64123) indicates that if wheat area increase by 1% and all other inputs remain unchanged, production will increase by 0.64%. Similarly, the output elasticity of LP, SS, FI, Irr, Pest and HT are 0.124587, 0.31244, 0.5874, 0.55461, 0.08248 and 0.65743, respectively, which can be interpreted in the same way.

Table 2. Average Cost of Production of Wheat Cultivation in D.I.Khan

S.#	Item/ Inputs	Unit	Quantity	Rate (Rs.)/unit	Total expenditure
1.1	Tractor hours	Hours/Acre	2	800	1,600
1.2	Labor	Man Days	1	400	400
2	Land Preparation	Rs.	-	-	2,000
2.1	Seed of Wheat	Kg	40	90	1,920
2.2	Labor (from sowing)	Man days	1	400	400
3	Seed & sowing	Rs.	-	-	2,320
3.1	Diammonium phosphate (DAP)	Rs.	1	3480	3,480
3.2	Urea	Rs.	2	2020	4,040
3.3	Transportation Cost	Rs.	3	100	300
3.4	Application (Labor)	Man Days	1	400	400
4	Farm Inputs	Rs.	-	-	8,220
4.1	Canal	Seasonal	1	800	800
4.2	Labor	Man Days	4	400	1,600
5	Irrigation	Rs.	-	-	2,400
5.1	Insecticide / Pesticides	Ks.	-	-	1600
5.2	Spray pumps (Rent)	Per day	1	200	200
5.3	Application (Labor)	Man Days	1	400	400
6	Pesticides	Rs.	-	-	2,200
6.1	Harvesting	Per acre	1	1,500	1,500
6.2	Threshing	Mounds	40	120	4,800
6.3	Empty bags	Per bags	20	12	240
7	Harvesting / Threshing	Rs.	-	-	6,540
8	Land Rent	Kanal	8	1500	12,000
Total Cost					35,680

Table 3. Average Total and Net benefit of Wheat

Item	Quantity (maund*)	Rate (Rs/maund*)	Total Amount (Rs.)
Produce	42	1400	58,000
Stalk	-	4200	4800
Total Revenue	-	-	63,600
Net Revenue	-	-	

* Maund = 40 kg

Table 4. Economics of sugarcane production on per acre basis

S.#	Cost Incurring Items acre	Cost in Rs./acre
1	Land preparation (Ploughing+ harrowing+ ridge making+ plotting)	2000+1800+600+400=4800
2	Seed (setts) (2.5 tons)	2.5×4250=10625 (Rs.170/maund)
3	Sowing (read as planting)	1000
4	Fertilizers (3 urea bags+ 2 DAP bags)	8000
5	Irrigations (70% canal irrigations excluding)	10000
6	IPM	3000
7	Harvesting (1000 kg/person/day)	8000
8	Transportation	7000
9	Other	5000
10	Total expenditure	57425
11	Gross income (yield 56 t/ha)	567× 170=96390 (Rs.170/maund)
12	Net income	96390-57425=38965

Illustrated data in Table (4) showed the economics of sugarcane production, which obtained benefit cost ratio (BCR) as follow: TR = 96,390 and TC = 57,425, so, net income = 38,965.

In addition, if a farmer owns his own land, then he is in a position to earn above Rs.39000 per acre (Table 4). To be realistic, this is a meager margin earned by a farmer after caring the sugarcane field for 12-14 months. The fact of matter is that rising prices of fertilizers and irrigation costs are responsible for increasing the cost of production. To make the matter even worse, farmers are deprived of timely payment of their dues by different sugar mills (Iqbal and Iqbal, 2014).

Moreover, from Table (2) and Table (4), noticed that,

Seasonal total investment = net return/total cost

For wheat = $27,920 \div 35,680 = 0.783$ R.s.

When, for sugarcane = $38,965 \div 96,390 = 0.404$ R.s.

On the other hand, monthly net return for wheat = net return/growing season (months) For wheat = $27,920 \div 7 = 3,988.5$ R.s/month,

While for sugarcane = $38,965 \div 12 = 3,247.08$ R.s/month.

From mentioned before, found that, seasonal total investment and monthly net return had greater economic potential for wheat production more than sugarcane production. Whereas, grower cultivated a wheat crop had advanced chance to cultivate other crops through 5 months to complete the year, this lead to increase the net income for grower.

CONCLUSION

The results indicate that the average cost per acre was Rs. 35,680 and average production (output) of wheat was estimated to be 1650 kg per acre. Therefore, the gross return of wheat production was Rs. 63,600 per acre. According to this result, the BCR was calculated as 1.78. Moreover, positive influence between return price and output of wheat was concluded from the study whereas negative effect of cost on the other hand was observed in wheat production. It is concluded that Area, LP, SS, FI, Irr, Pest and HT are statistically significant variables. As per equation 7 & 8, the calculated value of output elasticities of Area, LP, SS, FI, Irr, Pest and HT are 0.64123, 0.124587, 0.31244, 0.5874, 0.55461, 0.08248 and 0.65743, respectively.

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جدوي زراعة القمح في مناطق زراعة المحاصيل السكرية : مفهوم إقتصادي ومناخي

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أجريت هذه الدراسة في مركز بحوث المناطق القاحلة، ديرة إسماعيل خان (ديخان) - باكستان بهدف تقييم إنتاج القمح ضمن زمام منطقة تشتهر بزراعة المحاصيل السكرية. تم التقييم من ناحيتي مدي ملائمة الظروف المناخية من جهة ودراسة التكلفة والمنفعة في منطقة ديرا إسماعيل خان، مقاطعة خيبر باختونخوافي باكستان خلال موسمي ٢٠١٤/٢٠١٥ و ٢٠١٥/٢٠١٦. وكان الافتراض الأساسي للتحليل الإقتصادي لإنتاج القمح هو تقييم التأثير المالي والعائد من زراعة القمح علي المزارعين. تم إجراء مقابلة مع عينة من ٢٠٠ مشارك من ١٠ قرى رئيسية لزراعة القمح في المناطق محل الدراسة من خلال استبيان تم اختياره مسبقاً.

كشفت الدراسة أن تكلفة إنتاج القمح كانت ٣٥,٦٨٠ روبية/لأيكرو من إجمالي إنتاج قدرة ١٦٨٠ كجم للأيكرو. كما يرتفع هامش الربح المتوقع للمزارعين بسبب إضافة قيمة العمل الأسري والأراضي المملوكة لهؤلاء المزارعين. وعلاوة على ذلك، تم التوصل إلى تأثير إيجابي لسعر القمح. وقد حققت مقاييس مرونة الإنتاج الأتية "إعداد الأرض للزراعة" 0.124587 (LP) و"البذور والزراعة" (SS) 0.31244 و"المدخلات المزرعية" 0.5874 (FI) و"الري" 0.55461 (Irr) و"الأفات والمبيدات" 0.08248 و الحصاد 0.65743 .

من وجهه النظر المناخية، تراوحت درجات الحرارة المتجمعة طوال كل موسم من موسمي الزراعة في المنطقة المدروسة حوالي ٢٦٦٣,٥ و حده حرارية متجمعة والذي يعتبر كافي لإنتاج المحاصيل بالكم الأمثل من المحصول.