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Estimating the Supply Response of Cured Tobacco at Barn Level in Khyber Pakhtunkhwa, Pakistan

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Contents

Abstract: Various aspects of tobacco have been examined through different studies. However, input demand and supply response of tobacco at the barn level remainsremains unknown. This study examines profitability, input demand, and supply response of tobacco in Khyber Pakhtunkhwa by employing a normalized restricted translog profit function. The findings indicate that tobacco production is profitable, and barn owners in the province are responsive to changes in output and input market prices. The use of labour and fuelwood in the processing of green leaves is very important in resource allocation decisions. The demand for labour and fuelwood increases as the price of tobacco output rises at the barn level. Furthermore, higher input prices have a negative effect on the province's tobacco supply. This study suggests that the government should seek an alternative to fuelwood that would not only help in reducing costs but also be beneficial to the environment and prevent deforestation.

Key Words: Tobacco barn; Supply Response, Translog profit function, Khyber Pakhtunkhwa

JEL Classification: E32.

Introduction

Tobacco production and its related industries are undeniably important to Pakistan's economy (PARC, 2012). Pakistan, one of the world's top ten countries for producing raw tobacco, was placed ninth in 2018 (FAOSTAT, 2020). The crop's most distinguishing feature is its linkage to the viable and efficient cigarette industry. Regardless of the fact that tobacco is only cultivated on about 0.25 per cent of total irrigated land, the crop contributes significantly to the country's economy by creating jobs and generating revenue from tobacco production and its related industries (National Bank of Pakistan, 2018; 2020). Despite being among the top producers of tobacco, the country's tobacco crops remain relatively small in terms of cultivated land and production value, accounting for only about 0.42 per cent of the total value of agricultural products. The area of land allocated for tobacco growing has not exceeded, over the past 20 years, more than 0.25 per cent of the total arable land (Saleem and Iqbal, 2020). The cigarette industry also does not contribute significantly to the

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manufacturing sector or GDP of the country. The importance of the tobacco industry in Pakistan may be evidenced by the fact that this sector contributes 2.2 per cent of the large-scale manufacturing sector as well as 0.5 per cent of the country's industrial employment. Furthermore, this sector contributes roughly 4 per cent of the federal government's indirect tax revenue, largely collected through federal excise duties (SPDC, 2018). The tobacco industry in Pakistan supports 1.2 million people's livelihoods, directly and indirectly, employs 350,000 people, and generates around Rs. 300 billion in annual revenue (Daily DAWN, 2016; Ali, 2020; PTB Website).

Many tobacco-producing countries in Africa and Asia are low-income, exporting the majority of their tobacco while consuming less than 20 per cent of it domestically. Among the developing countries that cultivate tobacco, India, Pakistan, Malawi, and Zimbabwe are the countries that are considered low-income food-deficit countries (LIFDCs) (Zafeiridou et al., 2018). Figure 1 of the study depicts the top ten tobacco producers in the world, with China leading the pack with an estimated annual production of 2241 thousand tonnes in 2018 (about 36.77 per cent of global annual tobacco production). After China, the other major producers of raw tobacco were Brazil, India, and the United States, which produced 762.27, 749.91, and 241.87 thousand tonnes, respectively. Brazil, the world's second-largest tobacco producer, produced 12.50 per cent of total tobacco, followed by India and the United States, which produced 12.30 and 3.97 per cent of total annual tobacco production, respectively. In 2018, Pakistan produced 106.73 thousand tonnes of raw tobacco, ranking ninth in the world and accounting for 1.75 per cent of global output (FAOSTAT, 2020).

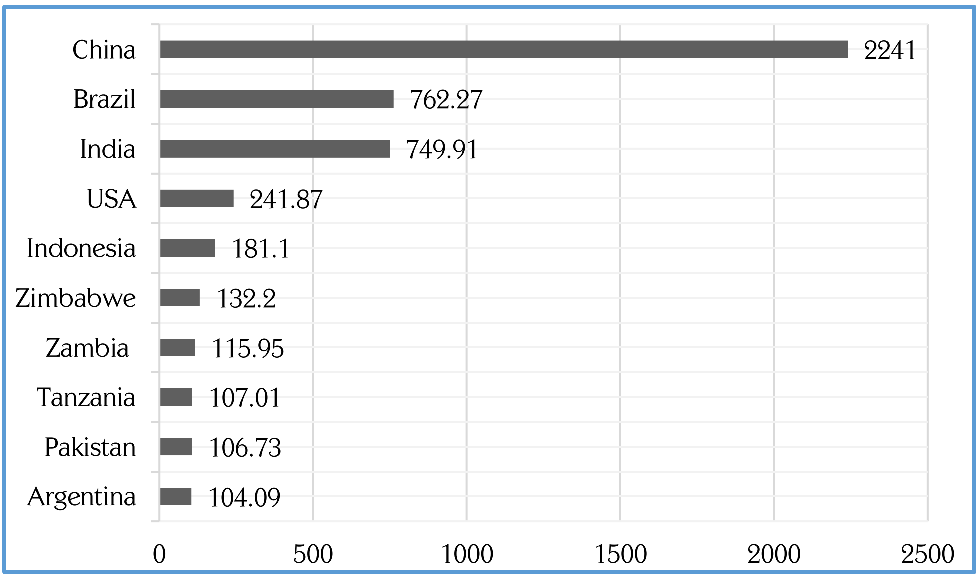

Figure 1: World leading tobacco producing countries in 2018 (Thousand Tonnes)
Data Source: FAOSTAT, 2020

Tobacco was not grown in Pakistan at the time of independence, so in order to meet the country's tobacco demand, the government imported tobacco (Ali et al., 2015). In 1948, Pakistan departed from being fully dependent on tobacco imports and achieved self-sufficiency in tobacco production in 1969 (Majid et al., 2017). Before 1968, the cultivated tobacco in the country was not up to the standard; thus, the government spent valuable foreign exchange reserves to import high-quality raw tobacco to meet the industry's demands (Ali et al., 2015). The federal government of Pakistan started considerable measures to help develop and improve the country's tobacco sector in 1968. In order to achieve these goals, the Pakistan Tobacco Board (PTB) was established in 1968 to promote and increase tobacco production as well as tobacco exports from the country. Since its inception in 1968, the PTB has worked to defend the rights of tobacco producers, purchasers, tobacco product manufacturers, and tobacco processing dealers. The quality and quantity of tobacco match the world's leading tobacco-growing countries due to PTB research and development activities in the country (Ali et al., 2015).

As shown in table 1, the average level of production of raw tobacco was slightly higher than 100 thousand tonnes during the period 2000-01 to 2017-18. The highest output of raw tobacco in the country (129.8 thousand tonnes) was reported in 2013-14, followed by a decreasing trend in production up to 2017-18. Likewise, the production of raw tobacco in KP was the maximum in the same year 2013-14 (100.8 thousand tonnes), and there was a decreasing pattern up to 2018. The declining trend in production can be attributed in part to the shrinking cultivation area. In 2009-10, the KP's share of total production was the highest, accounting for 78.88 per cent of total raw tobacco produced in the country. Tobacco exports and their products are earning valuable foreign exchange for the government. In 2000-01, 3.21 million kilograms of raw tobacco (unmanufactured tobacco) were exported to various countries of the world, and in the same year, 84.19 million cigarette sticks and 3.86 million cigar sticks were also exported, earning 284.41 million rupees. Tobacco and its products were exported in 2017-18 for a total of $25.75 million. In 2017-18, Phillip Morris (Pak) was Pakistan's largest exporter of raw tobacco, while Pak Hills Company became the second-largest exporter of tobacco (Pakistan Tobacco Board, 2019).

Table 1. Share of Khyber Pakhtunkhwa in Cultivated Area and Tobacco Production in Pakistan

Year	Area Under Tobacco Cultivation, ('000' Hectares)		Production of Tobacco ('000' Tonnes)		Yield in Kilograms per Hectare		Share of KP in total Production
	Pakistan	Pakhtunkhwa	Pakistan	Pakhtunkhwa	Pakistan	Pakhtunkhwa	%
2000-01	45.6	26.5	85.1	61.2	1866	2309	71.91
2001-02	49.4	29.8	94.5	69.9	1913	2346	73.97
2002-03	46.6	27.2	88.2	64.3	1893	2364	72.90
2003-04	45.6	27.0	86.2	62.9	1890	2330	72.97
2004-05	50.5	32.2	100.5	77.3	1990	2401	76.91
2005-06	56.4	36.5	112.6	87.9	1996	2408	78.06
2006-07	50.9	30.8	103.3	78.2	2029	2539	75.70
2007-08	51.4	32.7	107.8	84.9	2097	2596	78.76
2008-09	49.7	31.1	104.9	81.7	2111	2627	77.88
2009-10	55.8	36.2	119.3	94.1	2138	2599	78.88
2010-11	51.3	32.5	102.8	78.2	2004	2406	76.07
2011-12	45.8	28.8	97.9	75.1	2138	2608	76.71

Year	Area Under Tobacco Cultivation, ('000' Hectares)		Production of Tobacco ('000' Tonnes)		Yield in Kilograms per Hectare		Share of KP in total Production
	Pakistan	Pakhtunkhwa	Pakistan	Pakhtunkhwa	Pakistan	Pakhtunkhwa	%
2012-13	49.8	31.8	108.3	83.4	2173	2623	77.01
2013-14	49.1	30.1	129.9	100.8	2646	3349	77.60
2014-15	53.8	34.5	120.0	89.2	2229	2586	74.32
2015-16	50.0	30.5	118.8	85.2	2376	2793	71.72
2016-17	47.7	29.5	100.0	71.8	2377	2840	71.80
2017-18	46.3	25.0	106.8	71.0	2375	2840	66.48
2018-19	44.9	24.9	111.6	68.0	2325	2735	60.93
2019-20	50.8	28.1	113.6	71.4	2237	2541	62.85

Source: PBS 2009; Agriculture statistics of Pakistan 2018; PTB, 2021; Bureau of Statistics KP, 2021

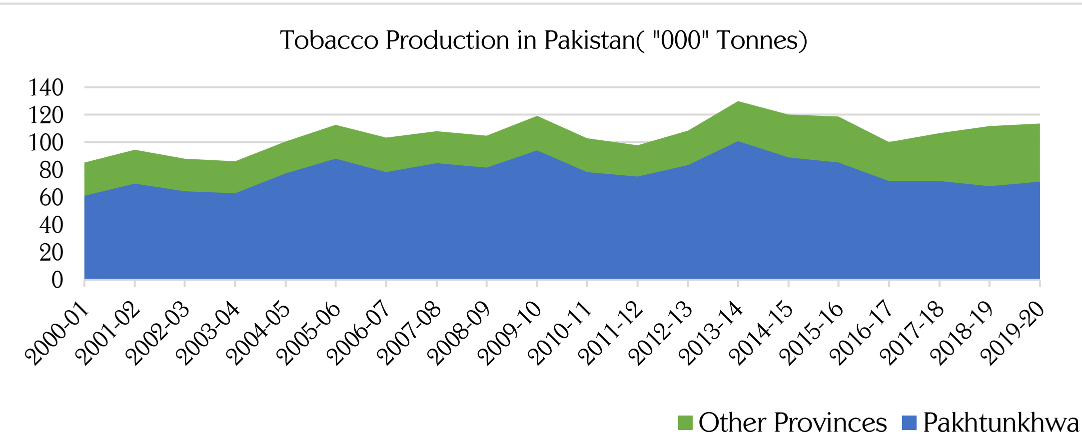

Figure 2: Share of KP in total tobacco production in Pakistan.

Currently, almost all tobacco crop varieties are produced in the country. In Pakistan, Flue Cured Virginia (FCV) is the most cultivated tobacco variety, and its popular name is Virginia, with its primary usage in cigarette manufacturing. The FCV is largely grown in the KP districts of Charsadda, Mardan, Swabi, Nowshera, Malakand, Buner and Mansehra. However, Dark Sun Cured Rustica, also known as Black Leaf, is the second most grown tobacco variety in Pakistan. Its popular name is Naswar tobacco or snuff tobacco. Dark Sun Cured Rustica is grown in the Attock, Vehari, Rajanpur, and DG Khan districts of Punjab Province. In addition, Dark Sun Cured Rustica is also cultivated in the Sindh Dadu district, as well as Balochistan's Pishin and Qila Saifullah districts. Other tobacco varieties grown in the country include Dark Air Cured Virginia (DAC) and Sun-Cured Rustica (White Patta) (Tobacco Statistical Bulletin (PTB), 2018; Pakistan Tobacco Board

Website, 2021). According to 2017 KP development statistics, in 2016, Khyber Pakhtunkhwa produced 75.83 per cent of total tobacco in the country. Pakistan has approximately 50,000 tobacco growers, with over 23,964 (or 47.93 per cent) located in KP, according to the Pakistan Tobacco Board. The districts of Swabi, Charsadda, Mardan, Buner, and Mansehra in KP province produce 98 per cent of the Flue Cured Virginia (FCV) tobacco, popularly known as cigarette tobacco. In 2019–20, FCV tobacco was grown on 27.04 thousand hectares of irrigated land in the major tobacco-producing district of KP. Every year, growers in these districts produce an average of 70-75 million kg of Flue Cured Virginia (FCV), which is the main ingredient in cigarettes (Pakistan Tobacco Board, 2021; 2022). In 2019–20, tobacco crops were grown on 50.80 thousand hectares in Pakistan, with 113.6 thousand tonnes of total production (PTB, 2021). According to the Khyber Pakhtunkhwa Bureau of Statistics, tobacco was planted on 28.09 thousand hectares, and total production was recorded at 71.38 thousand tonnes (KPBOS, 2021).

In the literature that is currently available, few studies have been conducted to examine tobacco supply response in their countries (Dean, 1966; Adesimi, 1970; Leaver, 2004; Pfumayaramba, 2011; Ndedzu et al., 2014; Ali et al., 2014; Verter and Gota, 2017; Shahzad et al., 2018; and Namome, 2018). Most of the above-mentioned studies used time series data for their analysis. There is no study in the existing literature that has examined input demand and supply response of tobacco at the barn level. This gap in the literature drew our attention, and we decided to investigate the cost of production, profitability, productivity, input demand, and supply response of tobacco in KP at the barn level.

Material and Methodology

Study Area

To achieve research objective, this study collected primary data from tobacco farmers and barn owners in KP. One advantage of collecting primary data is that researchers may collect information specifically for their study's main purpose. Khyber Pakhtunkhwa is Pakistan's smallest regional province and one of the country's four federating units. It is located along the international border with Afghanistan in the northwest region of the country. The total area of Khyber Pakhtunkhwa is 101741 km^2, with a population of 35.5 million, which is 17.09 per cent of the total population. The area and population also included the newly merged Federally Administered Tribal Area (FATA) in KP Province after the 25th constitutional amendment in Pakistan. According to 2017 KP development statistics, Khyber Pakhtunkhwa's share of tobacco production in 2016 was 75.83 per cent of the country's total tobacco produced. The report also showed that Buner, Charsadda, Mardan, Mansehra, Malakand, Nowshera, and Swabi were seven tobacco-producing districts in the province. The total area of seven tobacco-producing districts is 13315 square kilometres, with a total population of 10.30 million (PBS, 1998; 2017).

Collection of Data, Sampling, and Sample Size

Ideally, every researcher in his/her field of research wants to study the whole population. However, it's usually impossible to do this, so a researcher has to settle for a sample. This study used Pakistan Agricultural Research Council (PARC) sampling and sample size technique for data collection. In 2012, the PARC collected data from Swabi, Mardan, and Charsadda, which were the most prominent tobacco-growing districts in Khyber Pakhtunkhwa. The same respondents were again interviewed in Swabi, Mardan, and Charsadda districts in 2020.

The sample size for each district was calculated using the eminent Cochran (1977) formula.

$$n = \frac{(t)^2 * (s)^2}{(d)^2} \quad (1)$$

Where

t = value for a selected alpha level of 0.025 in each tail

s = estimate of standard deviation in the population.

d = acceptable margin of error for mean being estimated.

Bartlett, Kotrlik, and Higgins (2001) used the Cochran (1977) formula to develop a table for different population sizes, and that table was used to select the sample size for all the districts as follows:

Table 2. Sample Size for Collecting Data from Tobacco Growers and Barn Owners in KP

District name	Tobacco total area	Tobacco farm average size	The number of tobacco farmers (Approx.)	Sample size
Swabi	18214	2.03	8972	90 (65%)
Mardan	6071	1.29	4706	31 (22%)
Charsadda	3827	1.03	3716	19 (14%)
Total	28112		17394	140

Source: Pakistan Agricultural Research Council (PARC), Islamabad.

To choose tobacco growers from popular tobacco-growing villages/areas, the PARC used simple random sampling techniques. This study followed the same sample size and collected data from those respondents.

Methodology and Empirical Model

To estimate input demand, supply response, and the elasticities of fixed factors for tobacco production at the barn level in KP, this study used a normalized restricted translog profit function approach. A number of studies have used the translog profit function approach for estimating crop elasticities and supply response functions. Farooq et al. (2001), Junaid et al. (2014), Olwande et al. (2009), Rahman and Kazal (2016); Sidhu and Baanate (1981); Wijetunga (2016); and Sajjad et al. (2022), are some prominent studies that also employed the translog profit function to estimate elasticities.

The profit function was used in its translog functional form for barn-level supply analysis. The normalized restricted profit function as formulated by Diewert (1973) and Christenen et al. (1973), for a single output is given in translog form as:

$$ln\pi^* = \alpha_0 + \sum_{i=1}^{3} \alpha_i \, lnP_i^* + \frac{1}{2}\sum_{i=1}^{3}\sum_{j=1}^{3} \gamma_{ij} lnP_i^* \, lnP_j^* + \sum_{i}^{3}\sum_{k=1}^{3} \delta_{ik} \, lnP_i^* lnZ_k + \sum_{k=1}^{3} \beta_k \, lnZ_k + \frac{1}{2}\sum_{k=1}^{3}\sum_{h=1}^{3} \theta_{kh} \, lnZ_k lnZ_h + \varepsilon \qquad (2)$$

where:

π^* = represents the restricted profit (total revenue less total cost of variable inputs), normalized by the price of output (P_R).

P_i^* = price of the *i* th input (P_i) normalized by the output price (P_R).

i = 1, labor wage rate

= 2, fuelwood price

= 3, transport price

Z_k = represents fixed input quantity, k

k = 1, barn rent

= 2, curer and fireman cost

= 3, education of the barn holder

$\alpha_0, \alpha_i, \gamma_{ij}, \delta_{ik}, \beta_k, \theta_{kh}$ are the parameters in the equation to be estimated.

and *ln* = represents natural logarithm in the given equation.

The following are the corresponding share equations:

$$S_i = \frac{P_i X_i}{\pi} = -\frac{\partial ln\pi^*}{\partial lnP_i^*} = -\alpha_0 - -\sum_{k=1}^{4} \delta_{ik} \, lnZ_k \quad (3)$$

$$S_R = \frac{PX}{\pi} = 1 + \frac{\partial ln\pi^*}{\partial lnP} = 1 - \sum_{i=1}^{3} \alpha_i - \sum_{i=1}^{3}\sum_{j=1}^{3} \gamma_{ij} \, lnP_j^* - \sum_{i=1}^{3}\sum_{k=1}^{4} \delta_{ik} \, lnZ_k \qquad (4)$$

Where S_i in the restricted profit equation represents ith input share, S_R shows output share, while X_i denotes the quantity of *i*, and *X* is tobacco output at the barn level.

In order to overcome the issue, one of the share equations is omitted since the output, and input shares have come from a singular system of equations, and their summation is equal to one ($S_R - \sum S_i = 1$). Using Zellner's seemingly unrelated regressions (SURE), the profit function and factor demand equations are computed jointly for consistent and reliable estimates with Stata version 14 software (Zellner, 1962; StataCorp, 2015).

Equations Used for Estimating Tobacco Output Supply and Input Demand Elasticities

Equations Used for Input Demand Elasticities

The variable input $i(\eta_{ii})$ own price elasticity of demand is estimated as follows:

$$\eta_{ii} = -S_i - \gamma_{ii}/S_i - 1 \qquad (5)$$

In a similar way, the following expression is employed for estimating the cross-price elasticity of demand (η_{ij}):

$$\eta_{ij} = -S_i - \gamma_{ii}/S_i - 1 \quad for \quad i \neq j \qquad (6)$$

The following equation was used to obtain the elasticity of demand for variable input with respect to output price $P_R(\eta_{iR})$:

$$\eta_{iR} = S_R + \sum_{j}^{3} \gamma_{ij}/S_i \qquad (7)$$

Similarly, for variable input, the elasticity of demand with respect to the k[th] fixed factor can be obtained as follows:

$$\eta_{ik} = \beta_k + \delta_{ik} lnP_i^* + \theta_{kh} lnZ_h - \delta/S_R \qquad (8)$$

Estimation of Output Supply Elasticities

The following equation is used to estimate output supply elasticity in relation to the price of the *i*th variable input:

$$\epsilon\_Ri = -S\_i - \gamma\_ji/S\_R \qquad (9)$$

To estimate the own price elasticity(ϵ_{RR}): the following equation was used:

$$\epsilon_{RR} = \sum_{i=1}^{3} S_i + \gamma_{ji}/S_R \qquad (10)$$

The output supply elasticity in relation to fixed input $k(\epsilon_{Rk})$ was estimated as:

$$\epsilon_{Rk} = \beta_k + \sum_{i=1}^{3} \delta_{ik} lnP_i^* + \theta_{kh} lnZ_h + \sum_{i=1}^{3} \frac{\delta}{S_R} \qquad (11)$$

Results and Discussion

Region Wise Itemized Cost of Harvesting and Curing of Tobacco Crop in KP (Rs. /ha)

Table 3 shows the average cost of processing green tobacco leaves in the barn for three districts as well as in KP. Barn repair costs in Charsadda were much higher than in the Swabi and Mardan districts. Fuelwood is a significant component of the whole cost due to its scarcity and rising demand. On the basis of the cost structure, fuelwood accounts for Rs. 171233 (44.66%) of the overall cost of processing green tobacco leaves in the barn for Swabi, Rs. 167440 (43.66%) for Mardan, and Rs. 165918 (43.28%) for Charsadda. The majority of farmers purchase fuelwood from wood vendors and pay their bills after harvesting their crops, resulting in high fuelwood prices. Due to late payments, the wood seller always charges more than the market price for their fuelwood. Similarly, the cost of leaf harvesting, tying, and loading into the barn was also higher in Charsadda than in the other two districts. Due to labour scarcity in those areas during the tobacco harvesting season, the cost of leaf plucking, tying, and loading the barn was quite high. Charsadda district has the highest average cost of loading a barn at Rs. 75267 per hectare, followed by Swabi and Mardan districts, while in KP, the average cost for leaf picking, tying, and loading was estimated at Rs. 74899. The table shows that the average barn rent was higher for district Swabi as compared to the other districts. The average bundles of per hectare green leaf produced after processing in the barn by districts are estimated at Charsadda 69, Mardan 63, and Swabi 63, indicating that in 2020 the per hectare yields and bundles are more in weight and numbers. Similarly, the overall average cost of bailing material used in dry leaf bundles was almost different in all regions. The average cost of bailing material was estimated and found to be higher in Charsadda as compared to the other two regions. Curers and firemen, an important component in tobacco processing, cost Rs. 46378 in Charsadda, Rs. 42897 in Mardan, and Rs. 34413 in Swabi, indicating considerable variation in average costs among the three regions, notably in Charsadda. The average barn rent for one hectare of tobacco processing in Swabi, Charsadda, and Mardan was Rs. 38295, 34605, and 31935, respectively, in 2020. One thing worth noting was that the average cost of transportation to the depot in Charsadda was quite high, whereas the cost of green leaf transportation from the field to the barn premises in Swabi was very high. The average cost of processing green leaves per hectare in the Charsadda district was greater than the other two districts in the study, at Rs. 385838, compared to Rs. 374341 and Rs. 371160 in Swabi and Mardan districts, respectively.

Table 3 also presents all the costs incurred for processing and curing tobacco crops in KP. In the overall cost of barn repair category, central pipe replacement was reported as having the highest average cost in 2020. The clay for plastering has a small cost because most farmers have claimed that their barns are concreted and so do not require clay for plastering. Similarly, the pakka/concreted barn has reduced the demand for bhoosa, which was necessary for plastering. In comparison to other costs of harvesting and curing, the total average cost of barn repair is not as high as it should be, and the main reason for the low cost is the concrete barn. The total average cost of one barn repair was estimated at Rs. 9571 in 2020. Harvesting green leaves for processing in the barn is also a significant cost component in 2020, with an estimated average cost of Rs. 74899. The costliest component of curing costs was fuelwood, which accounted for Rs. 170001 in 2020. The curer and fireman's average costs were estimated to be Rs. 37966.57, accounting for 10 per cent of the cost of processing one hectare of green tobacco leaf. Other cost components in 2020 were unloading (Rs. 36917) and barn rent (Rs. 36358). The total average cost of one hectare of tobacco production at barn level was Rs. 378257 in 2020.

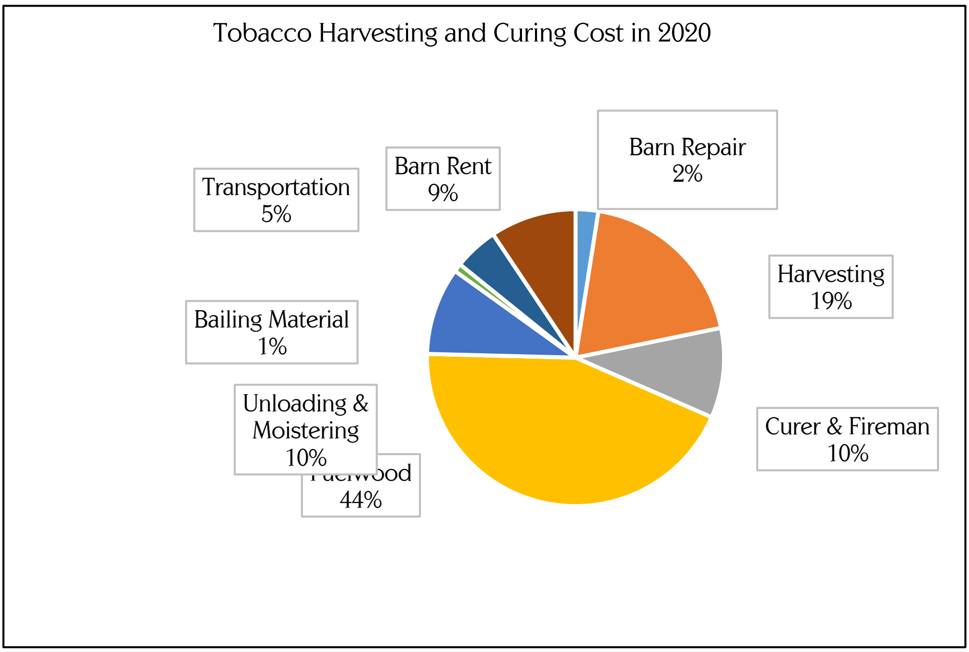

Figure 3: Harvesting and Curing Cost of Tobacco in Khyber Pakhtunkhwa in 2020

Table 3. Region Wise Itemized Cost of Harvesting and Curing of Tobacco Crop in Khyber Pakhtunkhwa (Rs. /Hectare)

Region/District. 2020		Swabi			Mardan			Charsadda			Pakhtunkhwa		
Particular	Unit	Quantity	Rate	Cost/ha	Quantity	Rate	Cost/ha	Quantity	Rate	Cost/ha	Quantity	Rate	Cost/ha
Clay for plastering/Lepai	Trolleys	0.6	1813.9	1251.6	0.7	1440.0	1022.4	0.7	1193.8	823.7	0.7	1594.1	1099.9
Wheat Bhoosa for Lepai	Mounds	0.4	788.8	378.6	0.8	913.3	812.8	1.2	864.3	1071.7	0.7	857.5	587.1
Labour charges for Lepai	MDs	2.0	612.1	1248.8	3.7	480.0	1795.2	5.8	492.0	2848.7	2.9	549.8	1616.6
Central Pipe Replacement	Rs.	1.0	2190.3	2190.3	1.0	2151.6	2151.6	1.0	2263.2	2263.2	1.0	2196.2	2196.2
Oven/Angheti Repair	Rs.	1.0	1135.8	1135.8	1.0	1009.7	1009.6	1.0	1057.9	1057.9	1.0	1096.7	1096.7
Seba/Sooter/Jute thread	Rs	---	---	1010.3	---	---	1213.7	---	---	994.6	---	---	1053.9
Stick Replacement	No	112.9	16.3	1844.9	171.3	13.0	2227.4	145.0	10.7	1547.5	130.5	14.7	1920.9
Total Cost of Barn Repair				9060.6			10232.9			10607.2			9571.3
Leaf Picking, Tying and Loading	MDs	120.3	612.2	73656.1	149.9	477.4	71579.5	174.4	431.6	75267.5	134.41	557.25	74899.9

Region/District. 2020		Swabi			Mardan			Charsadda			Pakhtunkhwa		
Particular	Unit	Quantity	Rate	Cost/ha	Quantity	Rate	Cost/ha	Quantity	Rate	Cost/ha	Quantity	Rate	Cost/ha
Transportation from Field to Barn	Rs.	---	---	14486.4	---	---	10374.8	---	---	10041.2	----	----	12950.8
Curer & Fireman Charges	Rs	---	---	34413.3	---	---	42897.6	---	---	46378.4		----	37966.6
Fuelwood (50 kg)	Mound	215.4	794.8	171233.2	201.6	830.0	167410.8	216.3	767.1	165918.2	212.47	800.12	170001.5
Cost of Unloading (untie, grad, bailing)	MDs	55.4	612.5	33944.7	79.6	477.4	38002.6	93.3	431.6	40270.7	66.07	557.25	36917.5
Cost of Bailing Material	Rs.	---	---	3150.9	---	---	3797.4	---	---	4292.8	----	----	3453.3
Cost of Transportation to Depot	Bundle	63.4	81.4	5161.2	63.5	84.4	5362.4	69.6	130.3	9064.1	64.28	88.81	5708.7
Barn's Rent	Rs	---	---	38295.4	---	---	31935.4	---	---	34605.3	----	----	36358.7
Total Cost of Harvesting and Curing	Rs.			374341.4			371160.8			385838.4			378257.1

Cost of Production, Productivity, Profitability and Benefit-Cost Ratio of Tobacco in KP

Table 4 shows the estimated average cost of tobacco production per hectare for the three districts as well as Khyber Pakhtunkhwa. To cultivate tobacco crops, nursery raising is the first and most important operation. The farmers in the Mardan district incurred the highest cost for nursery raising among the three districts in 2020. The estimated average total cost of nursery raising for tobacco growers in Mardan was 2.83 per cent, followed by Swabi at 2.80 per cent of the total cost incurred. Similarly, the estimated average nursery raising cost in KP was Rs. 19473, or 2.94 per cent of the total cost of growing tobacco per hectare. Furthermore, preparing land was the next activity for sowing tobacco plants, and farmers' costs for land preparation were also the highest in Mardan, at 3.72 per cent of the total incurred cost, followed by Charsadda (3.24 per cent). Chemical fertilizer and farmyard manure are two of the most important and effective cost components in tobacco production, with costs in the double digits in percentage terms. Farmers in Charsadda spent the highest average amount of Rs. 87145 (12.94 per cent) on manure and chemical fertilizers among the three districts, followed by the district's Swabi farmers, who spent Rs. 78294 (12.01 per cent). Tobacco is a labour-intensive crop, so labour costs were included in the overall cost of FYM and chemical fertilizer. The next phase after preparing the land and applying farmyard manure is sowing and transplantation, and in Swabi, the average cost of sowing was the highest at Rs. 10549, or 1.62 per cent of the per hectare total cost of tobacco production. Following planting, intercultural practices, plant protection measures, topping and de-suckering, and irrigation are the next phases in the production of tobacco.

Farmers also incurred various costs during harvesting and curing, such as barn repair, harvesting, curing, curer and fireman expenses, and transportation to the depot, among other costs. If the crop is ready for harvesting, before harvesting, the barn owners repair the barn for the processing of the green leaves to dry in it. The Charsadda district had the highest average barn repair costs, estimated at Rs. 10607, or 1.58 per cent of the total per hectare cost. Tobacco producers (barn owners) in Charsadda reported their average harvesting and curing costs at Rs. 385838, or 57.30 per cent of the total tobacco production cost per hectare, followed by tobacco producers in Swabi, with reported their harvesting and curing average costs at Rs. 374341. The cost of harvesting and curing tobacco per hectare was more than half of the total production costs in each of the three districts of KP. The cost of land leasing for the tobacco crop is also estimated, and farmers in the Mardan district will pay high land rent in 2020. Tobacco average per kilogram costs was also estimated for the three selected tobacco-producing districts and KP. Tobacco per kilogram cost was estimated by subtracting the value of tobacco bi-products from the total cost and then dividing the net total cost by the per hectare yield of tobacco. The average estimated cost of tobacco per kilogram for the three districts of Mardan, Swabi, and Charsadda was Rs. 179.37, 171.64, and 167.77, respectively. The average per kg cost of tobacco production was highest for producers in district Mardan at Rs. 179.37, followed by district Swabi with a cost of Rs. 171.64. The average per kg cost of tobacco production in KP province was similarly estimated at Rs. 174.18, which would be extremely beneficial to policymakers, farmers, and government officials not only in KP province but also in the federal government.

Despite the fact that production costs are local, profits from cash crops like tobacco are being squeezed by global commodity pricing (Ntibiyoboka, 2014). To better understand tobacco production and its profitability in the province, this study employed gross margin analysis to examine tobacco production gross returns in the three districts, namely Swabi, Mardan Charsadda, and KP. Several studies in the literature examined tobacco profitability in their respective countries using gross margin analysis. Using gross margin analysis, Ntibiyoboka (2014) examined tobacco profitability in Tanzania's Mpanda district.

Rweyemamu (2001) also conducted a study using the same methodology (gross margin analysis) to examine tobacco and maize crops' relative economic profitability, which were two competing crops. The profitability of tobacco producers in Khyber Pakhtunkhwa is depicted in Table 4 of the study. The gross margin in Charsadda was Rs. 223280 per hectare, indicating that tobacco production in Charsadda is more lucrative than in the other two districts of KP. Following Charsadda, district Swabi had the highest gross margin of Rs. 207188, showing that tobacco production in Swabi is also more profitable compared to tobacco producers in Mardan. The average cost of tobacco production in district Charsadda was estimated to be Rs. 673218 per hectare, the highest among the three major tobacco-producing districts in KP, with district Mardan placing second at Rs. 66462

0. Nursery raising costs, preparation of land for sowing, FYM, chemical fertilizers, sowing operations, intercultural practices, measures of plant protection, de-suckering and topping of tobacco plants, and irrigation costs are all included in the variable costs. Tobacco production in Charsadda, Swabi, and Mardan districts generated gross returns of Rs. 822990.24, 784121.46, and 764150.37 per hectare, respectively.

Furthermore, in order to determine if cultivating tobacco in the province is financially viable, the benefit-cost ratio is estimated for the three districts as well as KP. According to estimates, the benefit-cost ratio for growing tobacco crops is 1.22, 1.20, and 1.15 for Charsadda, Swabi, and Charsadda, respectively. This indicates that tobacco producers' investments were financially reasonable and that, on average, investing Rs. 1 in these districts returns Rs. 1.22, 1.20, and 1.15. Similarly, the gross margin for KP was estimated to be Rs. 197215, with a BCR of 1.18, suggesting that investing Rs. 1 in the province returns Rs. 1.18. The cost of production includes land lease and barn rent for those respondents who owned their land or had their own barn to dry the green leaf in. Furthermore, according to Johnson (1982), gross margin is the difference between an enterprise's total gross output and its variable production costs. Meskel and Gemechu (2017) also used total revenue and total variable cost to estimate the benefit-cost ratio in their studies. The benefit-cost ratio was also estimated using total revenue and total variable cost techniques. Charsadda has the highest benefit-cost ratio value of 1.37, followed by Swabi, which has a BCR of 1.36, suggesting that investing Rs. 1 in tobacco production returns Rs. 1.37 and 1.36, respectively. Similarly, the overall gross margin for tobacco producers in KP was Rs. 197215 per hectare, with a benefit-cost value of 1.34, showing that tobacco is a lucrative crop in the province, with an investment of Rs. 1 return Rs. 1.34 in the region.

Table 4. Region-wise Production Cost, Productivity and Profitability of Tobacco in KP (per/ha)

Region/ Production Cost in 2020	Swabi	Mardan	Charsadda	Pakhtunkhwa
Cost Component /ha	Cost in Rs.	Cost in Rs.	Cost in Rs.	Cost in Rs.
Nursery Raising	18225.43 (2.80)	18807.55 (2.83)	17424.55 (2.59)	19473.63 (2.94)
Land Preparation	20716.13 (3.18)	24700.45 (3.72)	21779.00 (3.24)	21912.09 (3.31)
Manure and Fertilizer Application	78294.45 (12.01)	79617.99 (11.98)	87145.73 (12.94)	80119.28 (12.09)
Sowing and Transplantation	10549.74	8474.20	6900.95	9609.53

Region/ Production Cost in 2020	Swabi	Mardan	Charsadda	Pakhtunkhwa
	(1.62)	(1.28)	(1.03)	(1.45)
Intercultural Practices	24237.39 (3.72)	23880.15 (3.59)	23129.84 (3.44)	24225.92 (3.66)
Plant Protection Measures	19027.06 (2.92)	26791.51 (4.03)	23109.34 (3.43)	21125.38 (3.19)
Topping & De-suckering	11408.91 (1.75)	12332.53 (1.86)	10419.01 (1.55)	11525.23 (1.74)
Irrigation (labour charges + water rates)	11072.15 (1.70)	12434.04 (1.87)	13355.51 (1.98)	11951.97 (1.80)
Barn Repair	9060.62 (1.39)	10232.90 (1.54)	10607.30 (1.58)	9571.32 (1.44)
Harvesting and Curing	374341.00 (57.43)	371161.00 (55.85)	385838.00 (57.31)	378257.1 (57.07)
Land Lease	74925.82 (11.49)	76188.17 (11.47)	73508.77 (10.92)	75013.62 (11.32)
Total Production Cost/ha	651859.10	664620.30	673218.40	662785.07
Value of Bi-products	20472.57	21854.25	35470.67	22847.90
Net total cost	631386.53	642766.05	637747.73	639937.2
Yields in Kilograms/ha	3678.49	3583.49	3801.29	3674.06
Tobacco Cost per Kilogram in Rs.	171.64	179.37	167.77	174.18
Gross Return (Rs/ha)	784121.46	764150.37	822990.24	784986.70
Total Variable Cost (Rs/ha)	576933.28	588432.13	599709.63	587771.45
Total Production Cost (Rs/ha)	651859.10	664620.30	673218.40	662785.07
Gross Margin (Rs/ha)	207188.2	175718.2	223280.6	197215.25
Net Return (Rs/ha)	132262.4	99530.07	149771.8	122201.6
Benefit-Cost Ratio = $\frac{\text{Total Revenue/ha}}{\text{Total Cost/ha}}$	1.20	1.15	1.22	1.18
Benefit Cost Ratio = $\frac{\text{Total Revenue}}{\text{Total Variable Cost}}$	1.36	1.30	1.37	1.34

Source: Author's own estimation based on 2020 survey data.

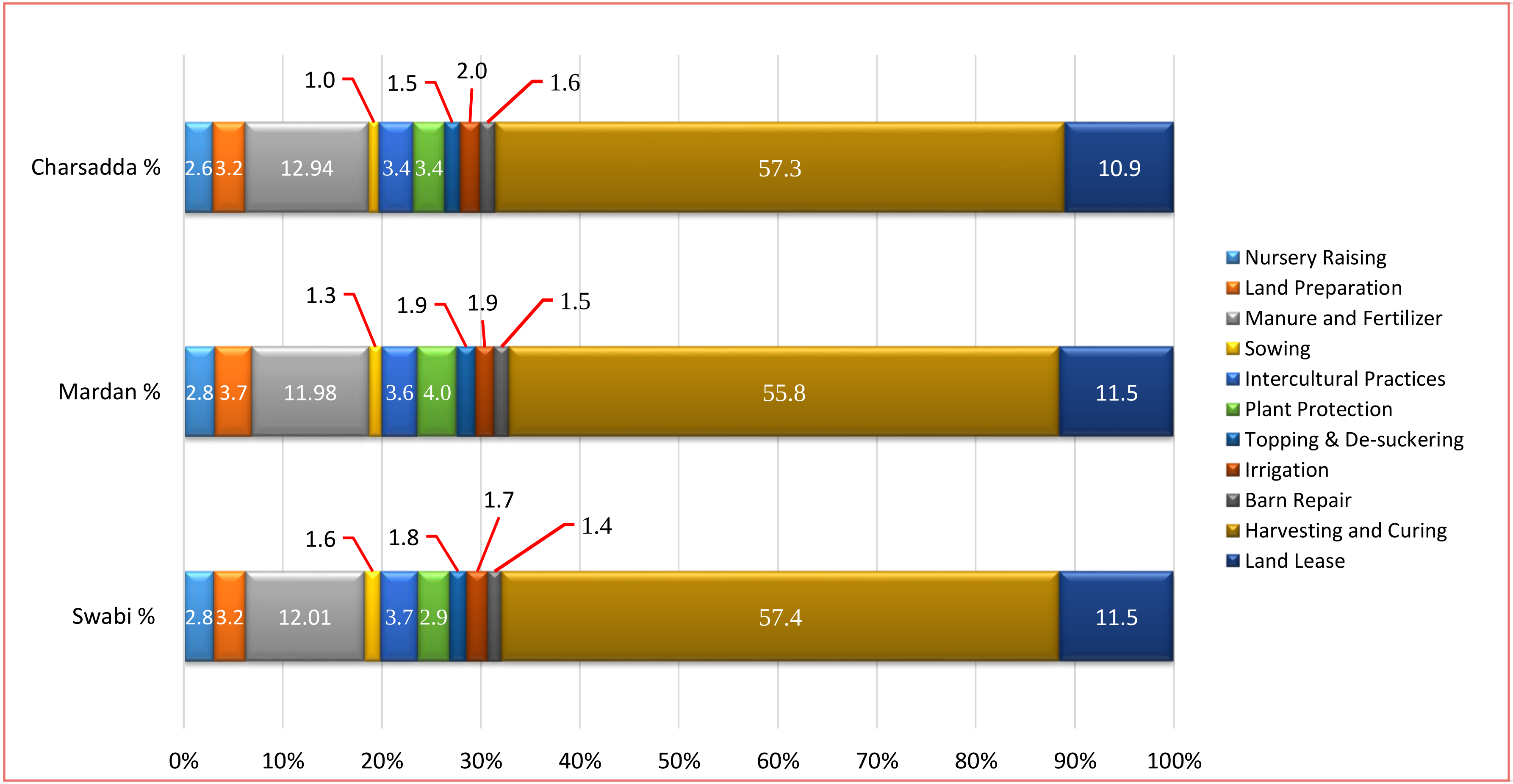

Figure 4: Region-wise summary of tobacco production cost in 2020 (per hectare). (Nursery, Farm and Barn level cost per hectare)

Tobacco Barn's Level Output Supply and Input Demand Elasticities

This study used a normalized restricted translog profit function to estimate tobacco supply response at the barn level in Khyber Pakhtunkhwa. Tobacco Barn level elasticities are estimated using profit function parameter estimates for output supply, variable input demand, and fixed factors. Tobacco barn level elasticities are depicted in Table 6 of the analysis. Overall, the supply of tobacco, as well as decisions about resource allocation, are affected by changes in input or output prices. The price elasticity of the tobacco supply is positive and significant, as expected, and is compatible with economic theory. With variable input prices and fixed factor quantities held constant, the estimated output supply elasticity is 0.31, indicating that a 1 per cent increase in tobacco prices would result in a 0.31 per cent increase in tobacco supply. The estimated own-price elasticities of the input variables labour, fuelwood, and transportation are statistically significant and have negative signs, according to the findings. Furthermore, with the exception of labour demand elasticity, which is elastic, all other own-price elasticities are inelastic. The estimated cross-price elasticities have mixed results, with some of the cross-price elasticities being complements and others substitutes. The own-price elasticity of labour demand is -1.11, suggesting that for every 1 per cent increase in wage rate, labour demand falls by 1.11 per cent. Fuel wood's own price elasticity is 0.77, indicating that a 1 per cent increase in fuelwood prices would lead to a 0.77 per cent decrease in fuelwood demand.

When tobacco prices increase, there is an immediate and significant increase in demand for the variable inputs that the owner of the barn needs to dry the green tobacco leaves. Labour demand would also change in response to a rise in tobacco prices, rising by 1.10 per cent for every 1 per cent increase in tobacco prices. Tobacco production is labour intensive at all stages, and this statement is validated by the magnitude of the elasticity of demand for labour. Fuelwood, a vital input in the processing of green leaves into dried leaves, is the most expensive cost component at the barn level. The estimated fuelwood demand elasticity is 0.91, indicating a 0.91 per cent increase in fuelwood demand with every 1 per cent increase in the price of tobacco in KP. The findings also revealed that changing input costs (an increase) at the barn level negatively affects tobacco production in the province. The production of tobacco would decrease by 0.18 per cent for every 1 per cent increase in labour cost, compared to a 0.10 per cent decrease for every 1 per cent increase in fuelwood prices. The labour demand elasticity with respect to fuelwood price is -0.19, which suggests that for every 1 per cent increase in fuelwood prices, labour demand declines by 0.19 per cent. Moreover, fuelwood demand elasticity is negative -0.13 with respect to labour wage elasticity, suggesting that fuelwood demand is reduced by 0.17 per cent for every 1 per cent increase in the wage rate. The negative signs and elasticities of fuelwood and wage rate indicate that these inputs are complementary, and their combined use increases tobacco production positively.

Table 5. Parameter estimates of the normalized translog profit function.

Variables	Parameters	Coefficients	t-ratio
Profit Function			
Constant	α_0	7.4682***	16.49
$ln\ P'_{Labor}$	α_W	-0.1107***	-2.90
$ln\ P'_{Fuelwood}$	α_F	-0.1551***	-2.81
$ln\ P'_{Transport}$	α_T	-0.0037	-0.51
½$(lnP'_{Labor}\ x\ lnP'_{Labor})$	γ_{WW}	-0.0120	-0.57

Variables	Parameters	Coefficients	t-ratio
½($lnP'_{Fuelwood}$ x $lnP'_{Fuelwood}$)	γ_{FF}	-0.2915***	-6.53
½($lnP'_{Transport}$ x $lnP'_{Transport}$)	γ_{TT}	-0.0080***	-4.87
$lnP'_{Fuelwood}$ x lnP'_{Labor}	γ_{FW}	-0.0458*	-1.89
$lnP'_{Transport}$ x lnP'_{Labor}	γ_{TW}	0.0039	0.96
$lnP'_{Transport}$ x $lnP'_{Fuelwood}$	γ_{TF}	-0.00004	-0.01
lnP'_{Labor} x $lnP'Z_{Barnrent}$	γ_{WB}	0.0490***	3.70
$lnP'_{Fuelwood}$ x $lnP'Z_{Barnrent}$	γ_{FB}	0.0731***	3.72
$lnP'_{Transport}$ x $lnP'Z_{Barnrent}$	γ_{TB}	0.0006	0.22
lnP'_{Labor} x $lnP'Z_{Curer\&Firman}$	γ_{WC}	-0.0419***	-4.14
$lnP'_{Fuelwood}$ x $lnP'Z_{Curer\&Firman}$	γ_{FC}	-0.0549***	-3.67
$lnP'_{Transport}$ x $lnP'Z_{Curer\&Firman}$	γ_{TC}	-0.0012	-0.65
lnP'_{Labor} x $lnP'Z_{Education}$	γ_{WE}	-0.0083**	-2.05
$lnP'_{Fuelwood}$ x $lnP'Z_{Education}$	γ_{FE}	0.0077	1.29
$lnP'_{Transport}$ x $lnP'Z_{Education}$	γ_{TE}	-0.0004	-0.52
$lnZ_{Barnrent}$	β_B	2.7685	0.79
$lnZ_{Curer\&Firman}$	β_C	-0.5399	-0.19
$lnZ_{Education}$	β_E	-0.1278	-0.47
½($lnZ_{Barnrent}$x $lnZ_{Barnrent}$)	θ_{BB}	0.0673	0.12
½($lnZ_{Curer\&Firman}$ x $lnZ_{Curer\&Firman}$)	θ_{CC}	0.1203	0.83
½($lnZ_{Education}$x $lnZ_{Education}$)	θ_{EE}	0.0516	0.75
$lnZ_{Barnrent}$ x $lnZ_{Curer\&Firman}$	θ_{BC}	-0.1729	-0.65
$lnZ_{Barnrent}$ x $lnZ_{Education}$	θ_{BE}	-0.0482	-0.83
$lnZ_{Education}$ x $lnZ_{Curer\&Firman}$	θ_{EC}	0.0194	0.44
Labor share equation			
Constant	α_W	-0.1107***	-2.90
lnP'_{Labor}	γ_{WW}	-0.0120	-0.57
$lnP'_{Fuelwood}$	γ_{WF}	-0.0458*	-1.89
$lnP'_{Transport}$	γ_{WT}	0.0039	0.96
$lnZ_{Barnrent}$	δ_{WB}	0.0490***	3.70
$lnZ_{Curer\&Firman}$	δ_{WC}	-0.0419***	-4.14
$lnZ_{Education}$	δ_{WE}	-0.0083**	-2.05
Fuelwood share equation			
Constant	α_F	-0.1551***	-2.81
lnP'_{Labor}	γ_{WF}	-0.0458*	-1.89
$lnP'_{Fuelwood}$	γ_{FF}	-0.2915***	-6.53
$lnP'_{Transport}$	γ_{FT}	-0.00004	-0.01
$lnZ_{Barnrent}$	δ_{FB}	0.0731***	3.72

Variables	Parameters	Coefficients	t-ratio
$lnZ_{Curer\&Firman}$	δ_{FC}	-0.05491***	-3.67
$lnZ_{Education}$	δ_{FE}	0.0077	1.29
Transport share equation			
Constant	α_T	-0.0037	-0.51
lnP'_{Labor}	γ_{WT}	0.0039	0.96
$lnP'_{Fuelwood}$	γ_{FT}	-0.00004	-0.01
$lnP'_{Transport}$	γ_{TT}	-0.0080***	-4.87
$lnZ_{Barnrent}$	δ_{TB}	0.0005	0.22
$lnZ_{Curer\&Firman}$	δ_{TC}	-0.0012	-0.65
$lnZ_{Education}$	δ_{TE}	-0.0004	-0.52
F-statistic		72.27***	
Observations		138	

Table 6. Estimated Elasticities of Translog Profit Function

	Tobacco Price	Labor wage	Wood price	Transport price	Barn rent	Curer & fireman	Education
Tobacco supply	0.312*** (5.37)	−0.177* (−5.61)	−0.105** (−2.19)	−0.009 (−1.32)	1.786 (0.56)	1.294 (0.43)	−0.073 (0.004)
Labor demand	1.109*** (5.49)	−1.111* (−9.77)	−0.193* (−1.76)	−0.062* (−1.78)	1.567 (0.51)	1.696 (0.50)	−0.027 (−0.15)
Fuelwood Demand	0.914** (2.24)	−0.132 (−1.03)	−0.772** (−2.85)	−0.009 (−0.39)	1.784 (0 .65)	1.346 (0.45)	−0.093 (−0.35)
Transport demand	1.475 (1.34)	−0.365* (−1.82)	−0.305 (−0.41)	−0.804* (−1.75)	1.866 (0.67)	1.243 (0.43)	−0.056 (0.08)

****, **, * indicates 1, 5, and 10 % level of significance. T-ratios are the figures in parentheses.*

Conclusions and Recommendations

Tobacco production and its related industries are undeniably important to Pakistan's economy. Overall, market prices of tobacco strongly influence tobacco barn owners' allocation decisions for input demand and output supply in the province. Results showed that production of tobacco is profitable in KP (BCR = 1.18, 1.34), with a gross margin of Rs. 197215. Tobacco's own price elasticity of supply is positive, as expected (but inelastic), and is consistent with economic theory. The inelastic own price elasticity of tobacco supply shows that producers are not very responsive to fluctuations in tobacco market prices. There are a few reasons for this inelastic price elasticity of the tobacco supply, which is why the influence of price isn't as strong as it should be. Tobacco purchases made under contract likely contribute to the inelastic elasticity of the tobacco supply. There are well-known barn owners in tobacco-producing districts who have been processing green leaves in their barns for decades. The majority of producers rely on tobacco for their revenue since it is the only crop that is consistently profitable in their districts. Many respondents said that they only have experience in tobacco production and have no experience in other businesses, leaving them with no choice other than to process green leaves in the barn.

Based on the estimates, and increased output price for the barn owner would increase tobacco supply to the industry, resulting in an increase in input demand. The elasticities of labour and fuelwood demand indicate the significance of these input variables for barn owners during green leaf processing. As the price of raw tobacco increases, demand for inputs, labour, and fuelwood will also increase. It was also concluded from the findings that tobacco output at the barn level in Khyber Pakhtunkhwa is also affected by input costs. Fuelwood and labour wages are essential inputs for tobacco production, and since they are complementary inputs with negative elasticities, employing them together would significantly increase tobacco output.

The findings of this study offer some policy implications for the tobacco sector in KP. As earlier indicated, tobacco prices positively affect tobacco supply; hence, increasing tobacco prices for the barn industry will boost tobacco supply and input demand, consequently benefiting tobacco processors, increasing green leaf demand, developing the tobacco industry, and particularly boosting the economy in KP. At the barn level, fuelwood is a costly component of the cost of production, and most barn owners borrow fuelwood from a wood vendor and pay more than the market price at the end of the season. To protect barn owners from the exploitation of wood vendors, it is suggested that loan facilities be made available to them through tobacco companies at affordable rates throughout the province. This study further suggests that the government should endeavour to find an alternative to fuelwood, which would not only help in reducing costs but also be beneficial for the environment and prevent deforestation in the country.

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