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Determinants of Cherry Production and Marketing in Pakistan: A Propensity Score Matching Approach

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Abstract
In the current study determinants of cherry production and marketing in Pakistan are estimated. For the study cross sectional data set of 60 cherry producers was collected from Kalat and Ziarat districts of the Balochistan province. The analysis was carried out by employing a number of different econometric models and techniques like poison regression model was employed for estimating number of hectares under cherry orchard while logit model was employed for farmers' decision making like selling at farm gate or taking the commodity to the market. Propensity score matching technique was employed for estimating the cherry net returns and cherry yield. The empirical results indicate that farmers selling cherry at market are obtaining higher net returns.

Key words: *cherry, market participation, production, propensity score matching, Balochistan, Pakistan.*

Introduction

In developing countries, the marginal fruits mostly receive less attention as compared to main fruits. Pakistan is one of the few countries of the world having four seasons and the rich soil for all kinds of fruits. More than 28 types of fruits are grown throughout the year. The country has also got the position both geographically and strategically to enhance its fresh fruit production for export to the traditional markets like Middle East, Afghanistan, Iran and the emerging markets like China, Central Asian Republics along with the highly competitive but lucrative markets of Europe and Far East. The prominent fruit crops are mangoes, citrus (kino, oranges etc), dates and apples having vast local consumption as well as exports (Ali et al., 2003-04).

Cherry[1] (Prunus avium L.) is a marginal fruit of temperate zone in Pakistan. There

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[1] Cherry originated from the region between Caspian and Black Seas. Cherry has been in existence as a cultivated fruit since the dawn of civilization, but little was accomplished in improving it until the sixteenth and seventeenth centuries.

are two main types of cherries, the sweet[2] (desert) and the sour. Cool climate with good winter rains and dry cool summers are alike ideal weather for the good quality cherry production (Tareen and Tareen, 2006). Cherry trees do not thrive on heavy or poorly drained soils but it does well on sandy loam soil. Cherry needs chilling requirements ranging from 500-1300 hours (Children, 1983). Cherries are used for frozen pies and pie filling and for canning, bakeries, ice cream, sauces, preserves and other deserts (Children, 1983). In Pakistan Quetta, Pishin, Kalat, Zhob, Mastung, Loralai and Swat are ideal temperate zones for commercial cherry growing. In Balochistan cherry is grown on about 897 hectares on commercial basis with an annual production of about 1,507 tones[3] (Government of Balochistan, 2002-03).

In Balochistan many fruits are gown like apple, cherry, plum, peach, apricot etc. Although cherry is an important fruit, but it has been neglected for the last many years. The climatic conditions of Balochistan are suitable for the production of cherry (Government of Balochistan, 1991-92). Cherry has many advantages as compared to competing fruits. The cherry has great advantages like less water requirement, short production duration and high value in the market. In addition the cherry fruit is also affected by the multiple constraints like perishable nature, poor physical and institutional infrastructure, non availability of timely inputs. Cherry got popularity in the area due to its high return. Its importance can be judged from the fact that farmers had replaced apricot, pear and even apple with cherry plants (Ali et al., 2003-04).

In Balochistan British army introduced cherry first time in the 19th century. They grow cherry to meet their food requirements. In Balochistan Cherry is cultivated mainly in Quetta, Ziarat and Kalat districts. The Ziarat cherry is famous throughout Pakistan (Ali et al., 2003-04).

As cherry is a marginalized fruit in Pakistan so there is drought of research work regarding production and marketing of cherry in Pakistan. According to best of our knowledge no study in the past has estimated the cherry production and marketing practices in Pakistan. As cherry has not been given much importance in the past, hence the purpose of the current study is to estimate the determinants of cherry production. The second most important aspect to be studied is to estimate the determinants of cherry farmers market participation i.e. how the farmers make market participation decision. Most importantly in the current study the benefits of cherry farmers' market participation are studied on net returns and cherry yield. The study findings will be helpful for the researchers, policy makers, extension agents and most importantly the cherry producers. In the current study first time the determinants of cherry production and marketing are studied, for that the rest of the paper is organized as follows; in the second section empirical model i.e. the propensity score matching approach is described. In section three data and description of variables are presented. In the next section empirical results are presented and paper finally concludes with some policy recommendations.

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[2] The trees of sweet cherry (prunes avium) are large, can attain heights of 30 to 40 feet. Some varieties of sweet cherries are Napoleon, Bing and Black Tartarian are well known in all regions that produce this fruit in commercial quantities.

[3] Out of total world production approximately 18% have been produced in North America, 77% in Europe, 4% in Asia, and less than 0.5% each in South America and Oceania. Modern day cherry production began in the mid-1800s.

Empirical Model

Propensity Score Matching (PSM) Approach

Regression methods impose a form on relationships (usually linear) which may or may not be accurate and which PSM avoids: this is valuable since these functional form restrictions are usually justified neither by economic theory nor the data used (Dehejia and Wahba, 1998; Smith and Todd, 2005). Hence the present analysis is carried out by employing the propensity score matching approach. The propensity score is defined by Rosenbaum and Rubin (1983) as the conditional probability of receiving a treatment given pre-treatment characteristics:

$$p(X) \equiv \Pr\{D = 1 \mid X\} = E\{D \mid X\} \tag{1}$$

Where D = {0,1} is the indicator of exposure to treatment and X is the multidimensional vector of pre-treatment characteristics. Average effect of Treatment on the Treated (ATT), which is most prominent evaluation parameter and explicitly focuses on the effects on those for whom the programme is actually intended and can be given as

$$= E\{E\{Y_{1i} \mid D_i = 1, p(X_i)\} - E\{Y_{0i} \mid D_i = 0, p(X_i)\} \mid D_i = 1\} \tag{2}$$

The expected value of ATT is defined as the difference between expected outcome values with and without treatment for those who actually participated in treatment. Propensity score matching rests on two strong assumptions i.e. conditional independence assumption and common support condition[4]. The conditional independence assumption states that once the observable factors are controlled for participation is random and uncorrelated with the outcome variables. The common support condition ensures that persons with the same X values have a positive probability of being both participant and non-participant (Heckman et al., 1999). In practice, the choice of matching method often appears to make little difference (Smith and Todd, 2005). Pragmatically, it seems sensible to try a number of approaches because the performance of different matching estimators varies case by case and depends largely on the data structure at hand (Zhao, 2000). So in the current study a number of matching algorithms like nearest neighbour matching, caliper matching, radius matching and mahalanobis metric matching are employed.

Nearest Neighbour Matching

Nearest-neighbour matching (NNM) method is the most straight forward matching method. This method involves choosing individuals from the adopters and non-adopters that are closest in terms of propensity scores as matching partners.

In nearest neighbor matching the number of controls matched with observation $i \in T$ by N_i^C and define the weight $w_{ij} = \frac{1}{N_i^C}$ if $j \in C(i)$ and $w_{ij} = 0$ otherwise. Then, the formula can be written as follows (where *M* stands for either nearest neighbor matching or radius matching and the number of units in the treated group is denoted by N^T):

[4] Non-parametric matching methods can only be meaningfully applied over regions of overlapping support (Heckman et al. 1997).

$$\tau^M = \frac{1}{N^T}\sum_{i\in T}[Y_i^T - \sum_{j\in C(i)} w_{ij}Y_j^C]$$
$$= \frac{1}{N^T}\left[\sum_{i\in T} Y_i^T - \sum_{i\in T}\sum_{j\in C(i)} w_{ij}Y_j^C\right]$$
$$= \frac{1}{N^T}\sum_{i\in T} Y_i^T - \frac{1}{N^T}\sum_{j\in C} w_j Y_j^C \qquad (3)$$

where the weights w_j are defined by $w_j = \sum_i w_{ij}$.

Matching with replacement involves a trade-off between bias and variance (Smith and Todd, 2005). Allowing for replacement increases the average quality of matches but tends to reduce the number of distinct non-adopters observations used to construct the counterfactual mean, thus increasing the variance. Matching with replacement minimizes the propensity score distance between the matched comparison units and treatment unit: each treatment unit can be matched to the nearest comparison unit, even if a comparison unit is matched more than once. This is beneficial in terms of bias reduction. In contrast, by matching without replacement, when there are few comparison units similar to the treated units, we may be forced to match treated units to comparison units that are quite different in terms of estimated propensity score. This increases bias, but it could improve the precision of estimates. An additional complication of matching without replacement is that the results are potentially sensitive to the order in which the treatment units are matched (Rosenbaum, 1995). Hence, when using this approach it should be ensured that ordering is randomly done.

Caliper Matching and Redius Matching

Nearest neighbour matching faces the risk of bad matches, if the closest neighbour is far away. This can be avoided by imposing a tolerance level on the maximum propensity score distance (caliper). Caliper matching (Cochran and Rubin, 1973) is a variant of nearest neighbour matching that attempts to avoid "bad" matches (those for which P_j is far from P_i) by imposing a tolerance on the maximum distance $\|P_i - P_j\|$ allowed. That is, a match for person I is selected only if $\|P_i - P_j\| < \varepsilon, j \in I_0$, where ε is the pre-specified tolerance. For caliper matching, the neighborhood is $C(P_i) = \{P_j \mid \|P_i - P_j\| < \varepsilon\}$. Treated persons for whom no matches can be found within the caliper are excluded from the analysis. A drawback of caliper matching is that it is difficult to know a priori what choice for the tolerance level is reasonable. Dehija and Wahba (2002) employed a variant of caliper matching called "radius matching". In their variant, the counterfactual consists of the mean outcome of all the comparing group members within the caliper, rather than just the nearest neighbour.

With radius matching, each treated units is matched only with the control unit whose propensity score falls in a predefined neighbourhood of the propensity score of the treated unit. The benefit of this approach is that it uses only the number of comparison unit available within a predefined radius; thereby allowing for use of extra units when

good matches are available and fewer when they are not. One possible drawback is the difficulty of knowing a priori what radius is reasonable.

Kernel Matching

The Kernel Based Matching (KBM) method is also a non-parametric matching method that uses the weighted average of the outcome variable for all individuals in the group of non-adopters to construct the counterfactual outcome, giving more importance to those observations that provide a better match. This weighted average is then compared with the outcome for the group of adopters. The difference between the two terms provides an estimate of the treatment effect for the treated case. A sample average over all adopters is then the estimate of the sample average treatment effect for the treated group. Gaussian kernel matching using the weighted average of all the non-treated group, whereas Epanechnikov uses the weighted average of non-treated group within a fixed calliper.

The kernel matching method is given by

$$\tau^K = \frac{1}{N^T}\sum_{i\in T}\left\{Y_i^T - \frac{\sum_{j\in C} Y_j^C G(\frac{p_j - p_i}{h_n})}{\sum_{k\in T} G(\frac{p_k - p_i}{h_n})}\right\} \tag{4}$$

where G(.) is a kernel function and h_n is a bandwidth parameter. Under standard conditions on the bandwidth and kernel

$$\frac{\sum_{j\in C} Y_j^C G(\frac{p_j - p_i}{h_n})}{\sum_{k\in C} G(\frac{p_k - p_i}{h_n})} \tag{5}$$

is a consistent estimator of the counterfactual outcome Y_{oi}.

Generalized version of kernel matching is the local linear matching. Research demonstrates several advantages of local linear estimation over more standard kernel estimation methods.

Mahalanobis Metric Matching

This method randomly orders subjects and then calculates the distance between the first treated subjects and all controls, where the distance $d(i,j) = (u-v)^T C^{-1}(u-v)$ where *u* and *v* are the values of matching variables (including propensity score) and C is the sample covariance matrix of matching variables from the full set of control subjects.

Abadie and Imbens (2006) showed that using more than one continuous covariate for Mahalanobis metric matching (MMM) maymight result in matching discrepancy.

Data and Description of Variables

As Heckman et al. (1999) pointed out that for the matching property to hold, the data

for the participants and non participants should stem from the same sources[5] (e.g. the same questionnaire). Hence for the present study cross sectional data was collected during October-November 2003. The study was carried out in the Kalat and Ziarat districts of upland Balochistan, as the climatic conditions of these two districts are ideal for cherry production. In addition Kalat and Ziarat districts are main cherry producing districts in Balochistan province of Pakistan. The survey was carried out in the rural areas of Kalat and Ziarat districts and the targeted respondents were the cherry producers. The data was collected from both categories of the farmers having participated in the market and not participated in the market[6]. The Kalat and Ziarat districts are mainly the hilly areas and travelling is not easy due to poor infrastructure. Beside cherry production the other important fruit of the area is apple. Data was collected by employing a well structured comprehensive questionnaire. Various aspects regarding production and marketing of cherry were covered in the questionnaire like village infrastructure, socioeconomic characteristic of the household, varietals adoption, farm size, farm location, inputs application and farmers market participation. In addition constraints faced in production and marketing of cherry were also covered in the questionnaire. Before starting the formal survey, the pre-testing of the questionnaire was carried out. The questionnaire was modified in the light of pre-testing results. In total 60 cherry growers were interviewed[7]. Thirty cherry growers were interviewed from each Kalat and Ziarat districts. Within the district the farmers were selected at random. The data was collected from both categories of the farmers having participated in the market or sold at the farm gate. In the survey all the three farm categories i.e. small, medium and large were covered. Majority of the farmers about 67% fall in the small category, followed by medium and large categories.

The description of variables is presented in table 1. The mean age of the farmers was 41 years. The mean education level of the household was 7 years of schooling. The mean household size was 11 family members per household. Approximately 3 family members per household were involved in farming; while on average 5 permanent labourers were being hired for cherry production. Overwhelming majority about 78 percent farmers have carried out intercropping in the cherry orchard. Cherry was mostly intercropped with apple, however other fruit trees like apricot, plum, almond, pomegranate and peach were also intercropped. Vegetables such as potato, onion, tomato and peas were also intercropped between the orchard trees. Normally vegetables were intercropped when cherry trees were 1-3 years of age. When the cherry orchard is more than 3 years of age then the intercropping is stopped. About 54 percent of the households have taken credit from the informal credit source mostly from the local traders or commission agents. When the farmers take credit from local trader they are bound to sell cherry to that local person at the farm gate. Majority of the households, 72 percent had own tube well for irrigation purposes. About 34 percent of the villages in the study area had own school. The mean landholding was about 12 acres per household, while on average 5 acres the cherry orchard was planted. Majority of the farmers (70 percent)

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[5] Randomness in the data guarantees that persons with identical characteristics can be observed in both states (Heckman et al., 1998).

[6] Both categories of the farmers i.e. having sold cherry at the market or sold at the farm gate.

[7] As the area is mainly hilly area and the infrastructure is very poor, hence only 60 cherry producers were interviewed.

Table 1: *Data and Description of Variables*

Variable	***Description***	***Mean***	***Std. Dev.***
Age	Age of cherry growers in years	41.16	2.15
Education	Education level of cherry growers	6.68	0.83
Household size	Total household size of the cherry growers	11.43	3.45
Family labour	1 if the family members participate in farming, 0 otherwise	2.86	0.21
Permanent labour	Number of permanent labours hired for Cherry production	4.78	0.77
Intercropping	1 if the farmer carried out intercropping, 0 otherwise	0.78	0.07
Informal credit	1 if advance taken from local trader 0 otherwise	0.54	0.075
Tube well	1 if the household owns a tube well, 0 otherwise	0.72	0.067
Road	1 if the household have access to road, 0 otherwise	0.38	0.08
School	1 if the village have school, 0 otherwise	0.34	0.02
Land holding	Number of acres owned by the household	11.67	3.04
Cherry area	Number of acres under cherry orchard	5.16	1.05
Tenure ownership	1 if the farmer is owner of land, 0 otherwise	0.69	0.21
Farm location	1 if the farm is located in the same village, 0 otherwise	2.65	0.74
Cherry source	1 if the farmer takes plants from nursery, 0 otherwise	0.75	0.07
Cherry quality	1 if the cherry seed is of good quality, 0 otherwise	0.56	0.08
Cherry variety	1 if the cherry is of good variety, 0 otherwise	0.92	0.05
Orchard age	Age of cherry orchard in number of years	7.69	0.84
District Dummies			
Kalat	1 if the farmer belongs to district Kalat, 0 otherwise	0.50	0.20
Ziarat	1 if the farmer belongs to district Ziarat, 0 otherwise	0.50	0.20

Source: Survey results.

were the owner of the farm[8]. Farm was located on average 3 km from the farmers' house. Majority of the farmers about 75 percent had own cherry seed source. An overwhelming majority about 92 percent described cherry of good variety. The mean age of cherry orchard was about 8 years.

Empirical Results

Determinants of Area under Cherry Orchard

The empirical analysis was carried out by employing the STATA software. As cherry production has a lot of advantages as compared to other fruits in the study area because cherry is the first crop of the season and it covers the input costs of the other fruits. The second advantage is that cherry require less water[9] as compared to other fruits, in addition cherry is high yielding, short duration and its market value is high. Empirical results regarding determinants of area under cherry orchard are presented in table 2. The

Table 2: *Determinants of Area under Cherry Orchard (Poison regression)*

Variable	*Coefficient*	*t-values*
Education (years)	0.003*	1.94
Age (years)	0.018**	2.02
Household size (number)	-0.054**	2.28
Family labour (number)	-0.150**	2.06
Informal credit (dummy)	-0.076***	3.41
Permanent labour (number)	0.042*	1.82
Tube well (dummy)	0.149***	2.62
Road access (dummy)	-0.032	-0.99
Land holding (acres)	0.011***	2.52
School (dummy)	-0.068	-1.54
Cherry source(dummy)	-0.032**	-2.26
Cherry quality (dummy)	0.149***	2.83
Constant	1.98**	2.06
District/ Location dummy		
Kalat	0.117*	1.78
R^2	0.5549	
LR- χ^2	171.78	
Prob > χ^2	0.000	
Number of observations	60	

Note: The results are significantly different from zero at ***, **, * at 1, 5 and 10 percent level, respectively.

[8] The tenants were mostly the local people and in some areas the Afghan refugees also worked as tenant. The share of tenant in the production was one fourth.

[9] The irrigation interval on average was 15-20 days, while in comparison the water requirements for apple are quite high i.e. 8-10 days.

dependent variable is number of acres under cherry orchard. The empirical analysis is carried out by employing poisson regression model. Cherry farmer education coefficient is positive and significant at 1 percent level of significance, hence depicting the importance of education in allocating area under cherry orchard. The Age coefficient is positive and significant indicating that experienced farmers have allocated more area under cherry orchard as compared to farmers having less or no experience. Household size is negative and significant indicating that as the household size increases the area allocated for cherry production decreases. Family labour coefficient is negative and significant at 5 percent level of significance implying that households having less involvement of family members allocate less area under cherry orchard. Informal credit source[10] coefficient is negative and highly significant at 1 percent level of significance indicating that area under cherry orchard is negatively related with the informal credit, the household having more credit from informal source allocate less area under cherry orchard. Permanent labour coefficient is positive and significant at 10 percent level of significance indicating that households having more involvement of permanent labour have higher area under cherry orchard. Household tube well coefficient is positive and significant at 1 percent level of significance indicating that households having own tube well allocate more area under cherry orchard as the irrigation requirements can easily be fulfilled. The road access coefficient is negative and non significance indicating those households located close to road allocate less area under cherry orchard and vice versa. The household land holding is positive and significant at 1 percent level of significance indicating that households having more land holding allocate more area under cherry orchard. The school dummy was included in the model as a welfare indicator, however the school dummy was negative and non significant. The cherry source was included as dummy variable and coefficient was negative and significant at 5 percent level of significance indicating that household having own cherry seed plant less area under cherry orchard and vice versa. The cherry quality was positive and significant at 1 percent level of significance. The district dummies were also included in the model to control for regional variation and the results are positive and significant for the Kalat district indicating that in Kalat district the farmers have allocated more area under cherry orchard. The value of R-square was 0.55 indicating that 55 percent variation in the model was explained by the independent variables. The χ^2 value is significant at 1 percent level of significance, hence indicating the robustness of the variables included in the model.

Determinants of Cherry Farmers Market Participation

Cherry is perishable fruit, hence farmers have to market soon after harvesting, the cherry farmers have two choices regarding market participation, either to sell at farm gate or to sell cherry in the market. For the determinants of the cherry farmers' market participation the logit model is estimated and the results are presented in table 3. The dependent variable is farmers' decision regarding market participation i.e. 1 for selling at market and 0 for selling at farm gate. In the study area majority of farmers 80 percent farmers sold cherry at the farm gate, mainly due to transportation constraint the farmers sold cherry to contractor at the farm gate. At the time of contract the terms and condi-

[10] In the study area informal credit source mostly refers to the credit obtained from the informal sources, such as, family members and friends but more than 90 percent credit is obtained from the commission agents.

Table 3: *Determinants of Cherry Growers Market Participation (logit estimate)*

Variable	***Coefficient***	***t-values***
Education (years)	0.091*	1.84
Age (years)	-0.004	0.40
Household size (number)	0.034**	1.99
Family labour (number)	0.008*	1.95
Informal credit (dummy)	-0.029***	2.73
Permanent labour (number)	0.004**	2.22
Tube well (dummy)	0.041**	2.16
Road access (dummy)	0.037*	1.85
Land holding (acres)	0.077***	2.40
Tenure Ownership (dummy)	0.015*	1.85
Farm Location (dummy)	0.003	0.87
School (dummy)	0.012	0.84
Cherry source (dummy)	0.016	1.32
Cherry quality (dummy)	0.033	1.59
Cherry variety (dummy)	0.046***	2.67
Orchard age (years)	0.018**	2.05
Constant	0.021*	1.76
District/ Location Dummy		
Kalat	0.012	1.25
R^2	0.189	
LR- χ^2	142	
Number of Observations	60	

Note: The results are significantly different from zero at ***, **, * at 1, 5 and 10 percent level, respectively.

tions of the contract were finalized between the contractor and the farmer. According to the agreement the payment was made in three installments. The contractor paid first installment at the time of contract, while the second installment was paid when the fruit was harvested and the third after complete selling of fruit in the market. In case the rain occurred or the incidence of any severe disease occurred the contract was revised. After the contract the contractor equally contribute in the remaining management and other operations. In case the farmers sold cherry in the market, majority of them sold cherry in nearby district market i.e. Quetta while some wealthy farmers also sold cherry at a distinct market i.e. Karachi market. The education coefficient is positive and significant indicating that farmers having higher levels of education normally sold cherry at market and vice versa.[11] The age coefficient is negative and non significant indicating that nor-

[11] As they may be more aware from the self marketing benefits.

mally young farmers sold cherry in the market while old aged farmers sold at farm gate. Household size is positive and significant at 5 percent level of significance implying that as the number of family members in the household increases the chances of farmers' market participation also increases and vice versa. Similarly the family labour coefficient is also positive and significant at 10 percent level of significance indicating that as the family labour involvement in cherry production increases the chances of farmers selling cherry at the market also increases and vice versa. The informal credit source is negative and highly significant at 1 percent level of significance indicating that informal credit prevents cherry farmers' market participation. The policy implication of this finding is that formal credit source needs to be more functionalized, so that the cherry farmers' dependence on the informal credit source may be decreased and they can make independent decisions regarding market participation. The permanent labour coefficient is also positive and significant at 5 percent level of significance indicating that as the number of permanent labourers increases the chances of farmers market participation also increases. Household tube well coefficient is also positive and significant indicating that households having a tube well sell cherry in the market and vice versa. The road access coefficient is also positive and highly significant at 1 percent level of significance indicating that villages having road access normally sell at market and vice versa thus indicating the importance of village infrastructure regarding farmers' market participation. Farm to market roads are prerequisite for having access to markets. The farm to market roads in the study area was mostly in bad conditions. Because of lack of farm to market roads the transporter also charge high fare and the transportation charges were quite high in the study area. Also due to poor infrastructure the farmers sell to local traders in the markets. Land holding was included in the model as an indicator of wealth and the coefficient is positive and highly significant at 1 percent level of significance indicating that the large farmers have easy access to market and vice versa. The tenancy status coefficient is positive and significant indicating that owners have easy access to the market as compared to tenants' farmers. The farm location coefficient is positive and non significant. The cherry quality and source are positive and non significant. The cherry variety is positive and highly significant at 1 percent level of significance indicating that farmers planting black cherry variety mostly sell at market as the black variety has more market value and vice versa. The cherry orchard age is also positive and significant that more the age of the cherry orchard more are the chances that farmers will participate in the market and vice versa. The district dummies were also included in the model and the Kalat district coefficient is positive although not significant. The R^2 value is 0.189; the LR χ^2 is also significant at 1 percent level of significance thus indicating the robustness of the variables included in the model.

Impact of Market Participation on Net Returns

For estimating the difference in the outcomes of the farmers selling at market and selling at farm gate propensity score matching was estimated by employing a number of matching algorithms like nearest neighbour matching, kernel matching, radius matching and mahalanobis metric matching. The propensity score matching method was employed to correct for potential sample selection biased ness that may arise due to systematic differences between the participants and non participants i.e. farmers participating in the market and selling at the farm gate. In case the marketing participating farm-

ers have more resources and social status as compared to farmers selling at farm gate, so in this case the results will be misleading. The propensity score matching corrects for this potential sample selection biased ness as it creates the condition of a randomized experiment and every cherry grower have equal chance of being in the market participation group and non participation group. The results for net returns and cherry yield are

Table 4: *ATT Results for Propensity Score Matching*

Matching Algorithms	Outcome	ATT	t-values	Critical levels of hidden bias	Number of Treated	Number of Control	Balancing Property	Common Support
Nearest Neighbour Matching	Net returns	12305.19**	2.01	1.65-1.70	26	11	Yes	Yes
	Cherry yield	23.87*	1.68	1.80-1.85	26	11	Yes	Yes
Radius Matching	Net returns	10143***	2.56	1.15-1.20	23	10	Yes	Yes
	Cherry yield	20.40**	1.83	1.40-1.45	23	10	Yes	Yes
Mahalanobis Metric Matching	Net returns	14625*	1.72	1.55-1.60	25	09	Yes	Yes
	Cherry yield	27.21	1.29	1.20-1.25	25	09	Yes	Yes
Kernel Matching	Net returns	10554**	2.15	1.60-1.65	20	11	Yes	Yes
	Cherry yields	22.81***	3.23	1.95-2.00	20	11	Yes	Yes

Note: *ATT is the average treatment affect for the treated. Net returns are reported in rupees and yield is given in number of crates.

presented in table 4. The most important results in table 4 are the average treatment affect for the treated (ATT) i.e. difference in the outcome of the participants and non participants. The results in case of nearest neighbor matching algorithms are positive in case of net returns at 5 percent level of significance indicating that farmers selling cherry in the market have higher net returns in the range of rupees 12305 as compared to non participants. Similarly the participating farmers have higher cherry yield in the range of approximately 24 kgs as compared to farmers selling at farm gate. The results for radius matching algorithms are positive both in case of net returns and cherry yield indicating that farmers selling cherry in the market have higher net returns in the range of rupees 10143 and have higher cherry yield in the range of approximately 20 kgs as compared to non participants. The results for Mahalanobis Metric Matching are also positive both in case of net returns and cherry yield but significant only in case of net returns indicating that market participating households have higher net returns in the range of rupees 14625 as compared to non participating households. The results for Kernel Matching are also positive both in case of net returns and cherry yields indicating that participating households have higher net returns in the range of rupees 10554 as compared to non participants, similarly the participants have higher cherry yield in the range of 23 kgs as compared to non participants. Overall the average treatment affect for the treated (ATT) results are positive and significant in all the matching algorithms

for cherry net returns indicating that the farmers participating in market for cherry selling are obtaining higher net returns in the range of rupees 10143-14625 as compared to farmers selling at farm gate. Similarly the results for cherry yield are also positive and significant implying that cherry farmers having high cherry yield normally have higher market participation as compared to farmers having less cherry yield. The critical level of hidden bias is also presented in table 4. The critical level of hidden bias indicates the level up to which the participants and non participants differs in their odds of participation. For example a critical level of 1.60-1.65 indicates that the participants and non participants differ in their odds of participation from 60-65%. This does not imply that in the presence of hidden bias the results are not robust, this only indicates the level up to which the participants and non participants differ in their odds of market participation. For the estimation the common support[12] condition was imposed while the balancing property was also satisfied. As the matching can only be performed over the common support region indicating that participants and non participants have equal chance of being in the participation group or the non participation group. The number of control and number of treated are also presented in the table 4. The farmers market participation have significant impact on net returns and cherry yield. The policy implication of the study can be that cherry farmers need to be linked to the market to maximize their net returns which can help to improve the socioeconomic condition of the cherry producer in Pakistan.

Conclusions

It can be concluded from the empirical results that cherry production and marketing is influenced by number of factors like age of the farmers, education level of the household, family size and family labour and permanent labour contribution have significant influence on area under cherry production. The tube well is also positive and highly significant. The road access is negative and non significant, indicating the importance of village infrastructure. The household land holding as an indicator of household wealth is also positive indicating wealthy household allocate more area under cherry orchard. The cherry farmers market participation is influenced by a number of factors and the most important is the informal credit source indicating that farmers getting credit from the informal sources mostly sold cherry at the farm gate. The policy implication of this important finding is that credit provision from the formal sources needs to be made easy and accessible for the cherry growers so that they can make independent decision regarding cherry marketing. In other words the formal credit source needs to be made more efficient as farmers mostly sold cherry at farm gate when they take credit from the informal credit source. The most important finding of the study is that farmers participating in the market have higher net returns as compared to farmer selling at farm gate. The higher net returns can help to improve the financial conditions of the cherry growers and help them a way out of poverty and this is only possible through market participation. For the policy makers this is an important finding that cherry producers needs to be encouraged to sell cherry at the market, for that village infrastructure needs to be improved besides the provision of transport facility. The determinants of cherry produc-

[12] Propensity score matching can only be performed in the region of the common support.

tion and marketing can help to increase the area under cherry orchard and farmers' market participation. The general implication of the empirical results can be that by focusing on the marginal fruits and ensuring farmers market participation the farmers' net returns can be increased considerably in developing countries like Pakistan which can improve the socioeconomic conditions of the farmers.

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